Acta Logistica - International Scientific Journal about Logistics
Volume: 4 2017 Issue: 3 Pages: 9-13 ISSN 1339-5629



*DOI:10.22306/al.v4i3.8*

*Received: 05 Sep. 2017*
*Accepted: 19 Sep. 2017*

# LACK OF STOCKS RISK REDUCTION

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***Keywords:*** costs, stocks, price, average, standard deviation
***Abstract:*** Within the present market conditions, stock control is ranked among very complicated spheres. Stocks not only cover possible outages in deliveries but also mean cost burdens for the company. Lately, a number of companies makes effort to determine exactly the amount of the buffer stocks which can protect them against negative effects of the surrounding. Logical conceptions offer a possibility of the use of different instruments for the determination of the buffer stock. However, a number of them uses a complicated mathematical apparatus, which is unsuitable for the practical usage under the industrial conditions. This article deals with an analysis of the use of a simple operative instrument for the determination of the amount of the buffer stock. For the analytic part, data from selected industrial enterprises in the Czech Republic were used.

## 1 Stocks and their meaning for competitiveness

Stocks bring significant expenses for the company related to their keeping. We consider the stocks to be an immediate natural element in manufacturing organizations. Stocks are considered to be such a part of the utility values which were already manufactured but were not consumed yet [1]. Stocks keeping means not only benefits for the enterprise but also negative effects.

The main benefits of the stocks can be classified by the following points:

- continual production process,
- quick reaction to the customer's requirements,
- stability of all processes.

Negative consequences of the stocks are linked, firstly, to that they bind capital, consume other work and resources and bring with them a risk of devaluation, inapplicability and non-saleability. Increasing competition on the markets together with a high interest rate for short-term loans can bring to that the capital invested in stocks is missing for financing technical and technological development, and threatens liquidity (financial solvency) of the enterprise and decreases its trustfulness during its negotiation on loans [2]. Without question, they are a factor which fundamentally effects competitiveness of each company. A high level of the stocks causes allocation of the financial resources in the stocks, but at the same time optimizes adequate flexibility of supplies. Both these effects are, however, antagonistic, and it will be always important to find out a certain compromise. In case of manufacturing companies, stocks are ranked among financially bulkiest categories. That's also why decisions related to the stocks control system are often essentially strategic.

Japanese Material Flows Management Systems consider the stocks to be a strong negative factor. At present, the Japanese already consider the thought that stocks are necessity as wrong and harmful; that's why they constantly fight against their creation [3]. Stocks are considered to be a cause of hiding a series of operational problems. Where there are no stocks, there is no need to control their amount and movement. Storage areas are being saved; due to decreasing the waiting times, production cycles are also being decreased; a risk of inapplicability and non-saleability of the stocks is being eliminated [4]. Small stocks don't also enable us to significantly suddenly increase disproportionately a production cycle because they don't allow the increase of the working pace. Accordingly, no ripple effect occurs when the company tries to catch up a delay and losses within an extremely short time. Within this conception, the overall quality of production is naturally significantly being decreased. Thus low production stocks support a sufficient level of the production speed.

Stocks both bind a significant capital and also decline the enterprise's profit. Since they - being a part of the current assets - are mostly financed by a borrowed capital, the interest costs influence company's economy as well as storage costs and other expenses related to the stocks. By this, profitability is burdened by the stocks twice. Till this time, an opinion is very widened that stocks secure smooth and economic production, a constant level of loading and a high level of service for customers. Just hesitantly there is being promoted knowledge that stocks hide uncoordinated capacities and processes predisposed to failures and that they bind available means [5].

## 2 Risk of lack of stock

A lack of stocks can mean threatening of smoothness of production, or even loss of a customer. A lack of raw materials, then, can be given by unpredictable material consumption or by an outage in supplies. In case of companies dealing in the sphere of production of motor-cars, possible penalties resulting from breaching suppliers' relationships can be liquidating for the company. In this sphere, penalties for undelivered components can reach thousands of EUROs per minutes [6], [7]. One of the ways which enables prevention of the above-mentioned problems is keeping a supplementary, i.e. buffer stock. In this case, it is necessary to consider costs for keeping a buffer stock against a risk and loss linked to the depletion of stocks. A concrete amount of the buffer stock can be determined either by means of simulative or statistical methods. Maintenance of the buffer stock at such a level which should prevent from a lack of reserves for all cases would be uselessly expensive for the company. Impacts of a lack that occurs once a year can be much less that costs for year-round maintenance of sufficient stocks. By this reason, it is usual in practice that a company will make a decision to maintain a buffer stock which will protect it not in all cases but, for example, in 90 % of all cases. A percentage of cases when a lack of stock doesn't occur is called an operating level. In other words, it means a probability of that a size of demand in the course of the of order realization cycle will not be higher than the available stock [2]. The higher this operating level is, the higher the required buffer stock and connected with it costs linked to the maintenance of stocks are, but the lower a possibility of a lack of stock and its impact are. The hundred-per-cent operating level then means that the probability of a lack of stock is zero and the entire demand will be satisfied [8]. To determine a suitable amount of the buffer stock, we can use a series of logistic procedures. A very simple and practically easy applicable concept represents a model of determination of the buffer stock with help of a formula (1)

$$PZ = k\sqrt{\overline{R}\cdot(\sigma_d)^2 + \overline{D}^2\cdot(\sigma_R)^2} \qquad (1)$$

Separate variables in the formula mean:
$K$ - coefficient of provision,
$R$ - average durability of the order realization cycle,
$\sigma_D$ - standard deviation of the daily sale,
$D$ - average daily sale,
$\sigma_R$ - standard deviation of the order realization cycle.

This model enable determination of the buffer stock by means of an analysis of data about consumption and delivery times. Arithmetic average and standard deviation values are specified for these indicators.

## 3 Experimental determination of the buffer stock amount

Within the performed analysis in company Hahn Automation, (hereunder referred as Company A) and in company Humpolecké strojírny (hereunder referred as Company B), experimental determination of the buffer stock amount were performed. As input data, there were used data about thirty-days consumption. For analysis of data, a month was chosen in which consumption complies with the average consumptions during the entire year.

Table 1 shows development of consumption in tons. At the same time, data about delivery times are recording into the table. On the basis of these data, we can determine an amount of the buffer stock. For the data about consumption, we will determine the chosen statistic indicators that we need for the determination of the buffer stock (the simple arithmetical average, the standard deviation). Values of these statistic indicators are displayed for the above-mentioned data within Table 1.

*Table 1 Development of consumption of Company A*

| | Company A | |
|---|---|---|
| | Consumption | Delivery time |
| Day | (t) | (day) |
| 1. | 25 | 6 |
| 2. | 6 | 6 |
| 3. | 14 | 7 |
| 4. | 14 | 6 |
| 5. | 2 | 8 |
| 6. | 2 | 5 |
| 7. | 20 | |
| 8. | 21 | |
| 9. | 1 | |
| 10. | 16 | |
| 11. | 18 | |
| 12. | 6 | |
| 13. | 10 | |
| 14. | 32 | |

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| | | |
|---|---|---|
| 15. | 12 | |
| 16. | 25 | |
| 17. | 10 | |
| 18. | 12 | |
| 19. | 8 | |
| 20. | 12 | |
| 21. | 17 | |
| 22. | 20 | |
| 23. | 6 | |
| 24. | 90 | |
| 25. | 20 | |
| 26. | 10 | |
| 27. | 10 | |
| 28. | 17 | |
| 29. | 16 | |
| 30. | 10 | |
| Average | 16.06 | 6.33 |
| σ | 15.48 | 0.94 |

To determine an amount of the buffer stock, we have to use - together with above-mentioned statistical indicators - coefficient of provision. Its value in principle shows us a risk level which the enterprise is willing to accept during creation of the buffer stocks. Concrete values of the coefficient of provision are specified in Table 2. Then, the operating level of 15 % means that the enterprise is willing to accept a risk of a lack of stocks in the amount of 15 %. A higher level of provision then naturally means a higher volume of stocks in storehouse and thus also higher cohesion of the capital in stocks. The determination of the buffer stock will be performed for all values of the coefficient of provision that is specified in table 2.

*Table 2 Values of coefficient of provision*

| Operating level (%) | Coefficient of provision (k) | Risk of lack of stocks (%) |
|---|---|---|
| 85 | 1.036 | 15 |
| 86 | 1.08 | 14 |
| 87 | 1.126 | 13 |
| 88 | 1.175 | 12 |
| 89 | 1.227 | 11 |
| 90 | 1.282 | 10 |
| 91 | 1.341 | 9 |
| 92 | 1.405 | 8 |
| 93 | 1.476 | 7 |
| 94 | 1.555 | 6 |
| 95 | 1.645 | 5 |
| 96 | 1.751 | 4 |
| 97 | 1.881 | 3 |
| 98 | 2.054 | 2 |
| 99 | 2.326 | 1 |

The calculation of the buffer stock for the consumption and delivery times specified in Table 1 can be written as follows:

$$PZ = k\sqrt{\overline{R}\cdot(\sigma_d)^2 + \overline{D}^2\cdot(\sigma_R)^2}$$

$$PZ(99\%) = 2,326\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{97,13}}$$

$$PZ(98\%) = 2,054\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{85,77}}$$

$$PZ(97\%) = 1,881\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{78,55}}$$

$$PZ(96\%) = 1,751\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{73,12}}$$

$$PZ(95\%) = 1,645\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{68,69}}$$

$$PZ(94\%) = 1,555\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{64,93}}$$

$$PZ(93\%) = 1,476\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{61,63}}$$

$$PZ(92\%) = 1,405\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{58,67}}$$

$$PZ(91\%) = 1,341\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{56,00}}$$

$$PZ(90\%) = 1,282\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{53,53}}$$

$$PZ(89\%) = 1,227\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{51,23}}$$

$$PZ(88\%) = 1,175\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{49,07}}$$

$$PZ(87\%) = 1,126\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{47,02}}$$

$$PZ(86\%) = 1,080\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{45,10}}$$

$$PZ(85\%) = 1,036\sqrt{6,33\cdot 15,48^2 + 16,06^2\cdot 0,94^2} = \underline{\underline{43,26}}$$

The highest degree of provision then represents by a buffer stock for the operating level of 99 %. In this case, the monitored company accepts only a 1 % risk of a possible lack of stocks. The determined value of the buffer stock for this degree of provision is 97.13 tons. By comparing this value with the statistic indicators specified in Table 1, we can determine that it is a consumption multiply higher than the average consumption.

A high value of the buffer stock in this case is also given by a relatively high standard deviation, which shows a measure of variability of the statistic set. Higher variability will be then mean a higher value of the buffer stocks and a higher cohesion of the capital in stocks.

*Table 3 Development of consumption of Company B*

| | Company B | |
|---|---|---|
| | Consumption | Delivery time |
| Day | (t) | (day) |
| 1. | 6 | 8 |
| 2. | 10 | 10 |
| 3. | 8 | 7 |
| 4. | 14 | 10 |
| 5. | 8 | 9 |
| 6. | 8 | 8 |
| 7. | 11 | |
| 8. | 9 | |
| 9. | 12 | |
| 10. | 6 | |
| 11. | 14 | |
| 12. | 10 | |
| 13. | 9 | |
| 14. | 12 | |
| 15. | 16 | |
| 16. | 13 | |
| 17. | 13 | |
| 18. | 9 | |
| 19. | 12 | |
| 20. | 11 | |
| 21. | 10 | |
| 22. | 11 | |
| 23. | 9 | |
| 24. | 9 | |
| 25. | 9 | |
| 26. | 8 | |
| 27. | 14 | |
| 28. | 12 | |
| 29. | 12 | |
| 30. | 13 | |
| Average | 10.60 | 8.67 |
| σ | 2.43 | 1.11 |

An amount of the buffer stock for the data from Company B specified in Table 3. It will be performed by the same method. Again, there were determined values of the statistic indicators for the analyzed data. In this case, it is clear that the consumption has significantly steadier character. The average consumption and the standard deviation value is significantly lower.

On the basis of these values and the coefficient of provision, we can determine values of the buffer stock as follows:

$$PZ = k\sqrt{\overline{R}\cdot(\sigma_d)^2 + \overline{D}^2\cdot(\sigma_R)^2}$$

$$PZ(99\%) = 2,326\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{32,02}}$$

$$PZ(98\%) = 2,054\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{28,28}}$$

$$PZ(97\%) = 1,881\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{25,90}}$$

$$PZ(96\%) = 1,751\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{24,11}}$$

$$PZ(95\%) = 1,645\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{22,65}}$$

$$PZ(94\%) = 1,555\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{21,41}}$$

$$PZ(93\%) = 1,476\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{20,32}}$$

$$PZ(92\%) = 1,405\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{19,34}}$$

$$PZ(91\%) = 1,341\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{18,46}}$$

$$PZ(90\%) = 1,282\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{17,65}}$$

$$PZ(89\%) = 1,227\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{16,89}}$$

$$PZ(88\%) = 1,175\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{16,18}}$$

$$PZ(87\%) = 1,126\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{15,51}}$$

$$PZ(86\%) = 1,080\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{14,87}}$$

$$PZ(85\%) = 1,036\sqrt{8,67\cdot 2,43^2 + 10,60^2\cdot 1,11^2} = \underline{\underline{14,26}}$$

The calculated amount of the buffer stock for the degree of provision of 99 % in this case is 32.02 tons. Thus, it is approximately one third of the value of the buffer stock compared to the previous company. In case of this degree of provision, the company will have therefore a significantly lower value of the tied financial means in the stocks. At selection of a suitable degree of provision, it is necessary to evaluate a series of factors, first of all, a risk of possible outages, but also its possible consequences. In case of big economic impacts resulting from a lack of stocks, it will be therefore more suitable to use a higher degree of provision. Provided the eventual risk of a possible lack of stock and their consequences is small, from the economic point of view, it is more suitable to use a lower degree of provision.

## 4 Conclusion

The determination of the correct value of the buffer stock can fundamentally contribute to the competitiveness of the enterprise. High quantity of stocks brings a possibility of a quick reaction to the customer's requirements, but at the same time means increasing the costs. In case that within a longer period of time the company keeps an above-limit quantity of stocks, it can influence their economic results. In a series of industrial branches however it will be necessary to maintain a certain level of the buffer stocks by technological reasons. The key aspect then will be the setting of a suitable level of the buffer stocks which will enable you to minimize risks resulting from a possible lack, but also will not mean the costs increasing.

**Acknowledgements**
The work was supported by the specific university research of the Ministry of Education, Youth and Sports of the Czech Republic No. SP2017/67 and SP2017/63.

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**Review process**
Single-blind peer reviewed process by two reviewers.