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NEWSBOY PROBLEM ON THE LOGISTICS NETWORK EXAMPLE

METODA ZAPASU JEDNOOKRESOWEGO NA PRZYKŁADZIE SIECI LOGISTYCZNEJ

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Abstract: *The article presents the method of one-period inventory on the example of logistics chain. It shows the typical newsboy the problem and its solution based on the strategy of the national logistics operator which distributes the press to the selected retail points.*
Streszczenie: *W artykule zaprezentowano zastosowane metody zapasu jednookresowego na przykładzie sieci logistycznej oraz klasyczny problem „Roznosiciela gazet" na przykładzie krajowego operatora zajmującego się dystrybucją prasy.*
Keywords: *logistics network, one-period inventory method.*
Słowa kluczowe: *sieć logistyczna, metoda zapasu jednookresowego.*

Introduction

The effective management of the inventory is related with so-called "trade-off relation" (something for something), therefore with such collection, so on the one hand to maintain an adequate level of customer service and thus secure its needs, and on the other hand to minimize logistics costs. Rational inventory management does not only concern the stocks and their optimization problem is more complex. It

also concerns the supply of raw materials in the process of purchasing, maintaining continuity of supplies in the production process, under the conditions of limited capital or delivery of goods in logistics networks.

In the literature several conventional statistical methods that enable effective control of inventory at each stage of the flow of supply logistics network are provided. These are mainly both deterministic and stochastic cases, which are associated with control supply of homogeneous or diverse uplift in the cycle, ie. They have many stages of decisions that are made.

However, in business practice there also often appears a problem of the 1-stage purchase for which the maintenance of stocks in subsequent periods is not justified economically. This article aims to analyze this particular problem, which is called "the newsboy problem" and it will be solved on the example of retailers operating in the logistics network. The research method that is used to solve the task is a one-period inventory method, the essence of which is based on the relations of expected costs deficiency and excess of a specified range.

1. One-period inventory method and methodology

One-period inventory cannot be properly utilized in subsequent periods. One--period inventory method supply is used, therefore, for the demand occurring only in one period. The methodology consists of two stages (Sarjusz-Wolski, 2010):

1. Determination of the target level of customer service (DPOK).
2. Determination of the target level of the replenishment (DPZ).

In the one-period inventory method the target level of customer service is the probability demand, therefore, the expected cost of deficiency is equal to the expected cost of the surplus. If the cost of a deficiency is k_{br} and the cost of excess k_{nad} then:

$$k_{br} = k_{nad} \tag{1}$$

The expected cost of the deficiency is associated with the probability of absence, and the expected cost of the surplus from the probability of coverage of demand supply. Therefore:

$$(1-p)\cdot k_{br} = p \cdot k_{nad} \tag{2}$$

Where:
p – probability of coverage of the demand with the supply
(1 – p) – probability of deficiency

Determination of the formula (2) p also defines the target level of customer service (DPOK):

$$p = DPOK = \frac{k_{br}}{k_{br} + k_{nad}} \tag{3}$$

In the one-period inventory method unit cost of deficiency and surplus is determined by the following formulas:

$$k_{br} = c_{sp} - c_{zak} \tag{4}$$

$$k_{nad} = c_{zak} + k_p - k_o \tag{5}$$

where:
c_{sp} – the offer price (revenues from sales),
k_{zak} – the purchase price,
k_p – the cost of getting rid of the product (recycling),
k_o – the cost of recovered value.

Determination of a target level of replenishment (DPZ) is related to the analysis of demand, its volatility and target level of customer service specified in the first stage (DPOK). DPZ is determined from the following formula:

$$DPZ = P + ZB \tag{6}$$

where:
P – average demand in the considered period,
ZB – safety stock.

Safety stock is maintained to ensure the target level of the customer service and is determined from the formula:

$$ZB = \omega \cdot \delta_p \tag{7}$$

where:
ω – safety factor,
δ_p – the standard deviation of the demand.

The safety factor ω is a multiple of the standard deviation and depends on DPOK. This relation presents a Figure 1 (Bozarth, Handfield, 2007, p. 546-547).

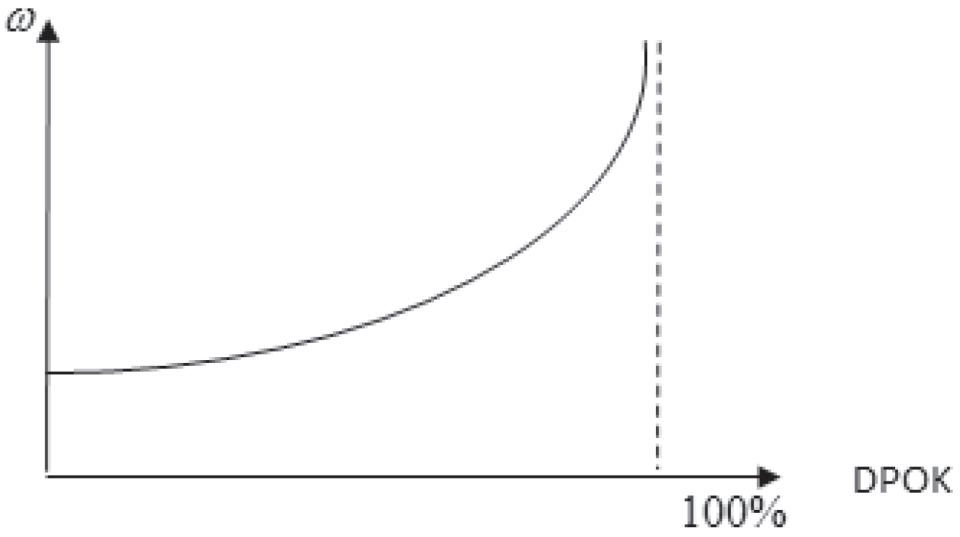

Fig. 1. The graph of the function $\omega = f(DPOK)$
Source: own

2. Application of the one-period inventory method in the economic practice

Research related to verification of the methods have been carried out in a retail establishment. The company addresses its offer to individual customers. Referring to his role in the logistics network, the company occupies a position between the producer and the final customer. The company, on which the inventory method was used, delivers newspapers to more than 22 000 retail outlets. Is the national logistics operator engaged in:

- distributing press for retailers,
- rental of warehouse space,
- examining of the complaints,
- accepting returns,
- additional services.

The company has a fleet of modern internal means of transport that facilitate and accelerate the implementation of the processes occurring in the enterprise. Infrastructure of the company consists of the office building directly connected with the warehouse. The warehouse has a separate areas, which are designed to meet specific phases of the process (receiving goods, picking and shipping, segregation and storage of returns, repair and maintenance of internal means of transport). The company has more than

6000 press titles. Among the company's suppliers there are major producers of this sector. The company mainly engages in distributing press, articles (these quickly transferable ones) and subscription, operates therefore on the demanding press market, where the priority is the quality of transport and customer service process. The implementation of these priorities is possible through the use of continuous monitoring of the reliability of the distribution, the competent forecasting of the demand, minimizing transport costs, delivering the press in an appropriate amount and form to a specific point of retail.

The daily press is a product that has a short life cycle and is characterized by a lack of price elasticity, so it is important to correct analysis of the demand and overall distribution of goods.

Currently, the company uses a specific algorithm to create the store. This algorithm consists of several parameters that are taken into account during creating the store. These parameters are related to the historical data of the sale and the information transmitted from sellers from retailers. Analysing the data, the most critical parameters are determined, that are taken into account while creating the store for the selected types of newspapers, as follows:

- the history of title sale from the period up to 6 months,
- information about the returns of unsold newspapers for a specified period,
- the possibility of increase/decrease of sales under the prevailing market conditions,
- characterization of the newspaper (range, number of mutations, etc.)
- guidelines from the publisher.

Application of the information above and using them in an optimal way in the process of inventory from a practical point of view is very difficult. This task is performed by a number of organizational units in the company, among whom there are often disruptions in the flow of information. It has a negative impact on the implementation process of creating the supplies and consequently leads to financial losses due to the surplus of the goods.

For the research purposes, one-period inventory method was used, which refers to the optimization of creating inventory for products such as daily newspapers. The target level of customer service is the level at which the expected cost of the shortage is equal to the expected cost of the occurrence of surpluses. Data obtained from the company calculated the cost of excess and deficiency and the target level of customer service and the level of replenishment for each position of the newspapers (Świątek, 2014, p. 52-53).

3. Analysis of research results

For the purposes of imaging problem of the company associated with the occurrence of financial losses, arising because of the surplus, the analysis of four types of daily newspapers (of type "A", "B", "C" and "D"; from the same period) was made.

These are the newspapers which circulation on the market is of great importance for the company, due to a certain amount in circulation, as well as costs related to the excess that result from a significant number of returns. Analyzing the data, conclusions concerning the percentage of returns in the general circulation were reached. It is noted that in the newspapers of types "A"; "B"; "C" and "D" the contribution of the amount of returns is high and oscillates in the 50% relatively to the total effort. This is a serious signal for the enterprise. Such a large amount of returns, despite the low cost of disposal, is an additional financial burden, noticeable especially in a period of time up to 1 year.

For each of the selected newspapers the methodology described in point. 1 of this article is used, taking into account specific data for each of them (sales price, cost of disposal, the cost of purchase, average demand, the standard deviation of demand). The size of the safety factor is taked from the tables presenting the normal distribution. Applying the one-period inventory method on the selected example allowed the comparison of the target level of creating inventories, obtained using this method with the data obtained in the company. Table 1 shows the difference arose in the amount of the created inventory for each newspaper.

Table 1. Comparison of the amounts of the target inventory level

Title of the newspaper	Historical data of the company	The data after applying the one-period inventory method	The difference
"A"	23 809	22 203	**1606**
"B"	6 568	6 134	**434**
"C"	17 818	16 641	**1177**
"D"	55 700	51 969	**3731**

Source: own: based on data from the company

The results presented in Table 1 clearly show the differences between target levels of inventory in the case of the method used in the enterprise, and the proposed one--period inventory method. The reduced inventories allow, with the full satisfaction of demand, to minimize losses due to surplus.

Table 2 shows the costs due to surplus for each of the newspapers when applying the one-period inventory method and compares them with the results when applying the method that is used in the enterprise (Świątek, 2014, p. 61-69).

The data provided in Tables 1 and 2 in the part concerning the application of the one-period inventory method have been calculated for the target level of service amounting to DPOK = 90%, and the safety factor $\omega = 1{,}3$.

Table 2. Costs due to surplus, data comparison

The method used in the enterprise					**Total**
Name of the newspaper	The newspaper "A"	The newspaper "B"	The newspaper "C"	The newspaper "D"	
The amount of the returns and the surplus cost excess cost	237,36 zł	53,64 zł	190,36 zł	273,60 zł	**754,96 zł**
The one-period inventory method					
	The newspaper "A"	The newspaper "B"	The newspaper "C"	The newspaper "D"	**Total**
The amount of the returns and the surplus cost excess cost	205,24 zł	44,96 zł	167,42 zł	198,98 zł	**616,60 zł**
The difference	**32,12 zł**	**8,68 zł**	**22,94 zł**	**74,62 zł**	**138,36 zł**

Source: own: based on data obtained from the company

Conclusions

Analyzing the results obtained when using one-period inventory method for daily newspapers the following conclusions were reached:

- method allows a reduction of the costs due to surpluses,
- use of the research method made it possible to reduce the amount of the inventory created with the full satisfaction of demand for the commodity,
- method allows to maintain an adequate level of customer service,
- in the long term (eg. one year period of time) allows to obtain financial savings of approx. 50 thousand zł dut to optimal one-period inventory creating for the analysed types of newspapers.

Data used in the article, concerning the daily type of the newspapers, derived from the company, has a low cost of a surplus and a small difference between the cost of the deficiency and the cost of the excess. All these factors make the one-period inventory method a good tool to streamline the process of creating the stock in the enterprise that is responsible for the distribution of the press.

LITERATURE

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