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Management

ITERATIVE ALGORITHM IN DETERMINISTIC INVENTORY MODEL FOR NON-DETERIORATING ITEMS

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ABSTRACT Proper inventory model includes replenishment rate, keeping the necessary inventory reserve according to demand and production process. Ordering price that is based on a fixed agreement of regular delivery is different from the reordering price. Researchers in the articles available in the literature consider mostly the inventory model for constant demand or linearly changing demand. The presented deterministic inventory model describes the system of replenishment rate in terms of un-regular, non-fixed demand that is typical especially for SMEs. The model prevent the situation if, due to the lack of some material, production has to be stopped or interrupted for a certain period of time. The model is based on iterative method using the advantages of modern information technology.

KEYWORDS : deterministic inventory model, replenishment, information technology, demand, iterative method

INTRODUCTION

Small and medium sized enterprises (SMEs) play an important role in the development of the country economy, but the conditions for their production are rather specific. Ján Dobrovič with a group of co-authors [3] focused especially on the processes, which are typical for small and medium sized enterprises (SMEs). One of the typical processes is inventory problem, which has within SMEs its specific features. This article describes the inventory problems setting the deterministic model that is based also on the previous experiences [2] that used sequence properties.

Increasing the profitability of stocking processes is one of the aims in setting the proper inventory models [8]. Cyclical behaviour of inventories [6] in connection with the specific investment policy is also typical during the different macroeconomic periods. Nevertheless, certain features of the processes are typical in general.

To describe the problem in more details, it means especially: setting the optimal size quantity in storage, period of time for new orders, order size and optimum level of spare parts in stock. Replenishment rate depends not only on the size of inventory level that is necessary for keeping the production and on demand but also on ordering cost that varies according to the amount of material per one container or vehicle. Ordering price that is based on a fixed agreement of regular delivery is different from the reordering price. Scientists Chung and Huang modelled both cases [5]: for internal as well as the external supplier when replenish rate is finite. The model also takes into account the delay in payment. The situation of infinite replenish rate is described as the special case. The inventory problem is also influenced by the stock capacity, the price of storage per item and per time unit in the context of mutual guarantee period of both materials and individual items.

Another criterion to set the model is the item character regarding the deterioration. Possible approach to set the model for deterioration items is for instance using the Weibull distribution [9] where the failure rate is proportional to power of time. Such model is more statistical, while example of model with a recursive algorithm where used to derive the optimal run time [4] represents more mathematical approach.

Anna Antonyová with Robert Bucki [1] proposed also model for process of stocking with setting the locations for a few distribution centers. However the model that is now proposed is based especially on iterative algorithm that is very suitable especially for application the modern information technologies where a great amount of the process repetition might take only a moment.

RESEARCH METHODOLOGY

Specific guidelines to inventory decisions are described in Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ) Models in the coherence with the certain aspects of inventory, production processes and the demand. Demand which often seems unpredictable can influence many aspects of the inventory planning.

Inventory management where items are time dependent deteriorating is mostly expressed with the formula [7]:

$$\frac{dQ(t)}{dt} + \theta(t)Q(t) = -R, \qquad 0 \le t \le T \qquad (1)$$

where Q(t) is the on-hand inventory and rate of units in inventory follows the Weibull distribution function given by

$$\theta(t) = \alpha \beta t (\beta - 1), \; 0 \le t \le T \qquad (2)$$

where α $(0 \le \alpha \le 1)$ denotes scale parameter β $(\beta \ge 1)$ denotes shape parameter and t $(t > 0)$ is time to deterioration.

Our specific inventory model uses mostly iterative method of numeric analysis and is designed for the items, which are non-deteriorating and the shortages are not allowed.

The data are obtained from the factory for production of boxes for the packing of goods. The boxes are made of the corrugated paper. The production uses several types of corrugated paper depending on the properties required from the resulting boxes. Corrugated paper, which is intended for the production of boxes, is stored in rooms with prescribed humidity and temperature. However the corrugated paper is nevertheless regarded as a non-deteriorating item. The company has built its own premises for storing the material for production. This means that they neither have to rent additional premises for this purpose nor they allocate additional funds for the storage. However, the storage space is limited and also requires maintenance. These reasons predict the company's tendency to order and store only the amount of material that is necessary for immediate production.

Managing the inventory, of course, requires that you order a minimum quantity but also that the ordered quantity is often larger than the production consumption. As the production of boxes requires continuous operation when the production line is switched on, shortages are not allowed what influences the amount for necessary reserve.

PROBLEM FORMULATION

Setting the optimal order is influenced with a few conditions:

- The optimal order frequency is once a week also due to the availability of trucks.
- Orders of different materials do not affect each other, since each truck is loaded with only one type of material at each order. This is also the reason why we decided to determine the optimal order just for one sort of material (one sort of the corrugated paper).
- The most reasonable price is in case if all orders are in the same amount.
- Shortage backordering is not appropriate, because it is very expensive in comparison with the regular replenishment.

According to the previous conditions our task is to set the optimal amount of material (corrugated paper in square meters [m^2]) for regular order of the same price.

Data contain consumption of specific material (corrugated paper) in square meters [m^2] and were collected for 27 weeks of production. Figure 1 illustrates daily consumption [m^2].

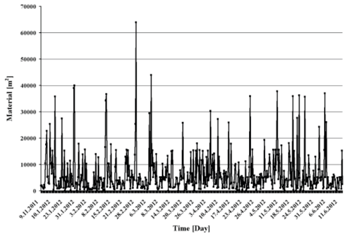

Figure 1: Consumption of corrugated paper during the certain days for 27 weeks of production

Figure 2 illustrates the weekly production through the data analysis. To model the problem we decided for iteration using the advantages of information technology that enables rapid processing even in repeated cycles.

The model of algorithm is expressed using the flowchart that is expressed in Figure 3.

RESULTS AND DISCUSSION

Analysing the daily consumption we determined the weekly consumption through the sum of the data, using the formula:
formula:

$Q_i = q_{1i} + q_{2i} + \ldots + q_{ji}$ (3)

where

Q_i means consumption in a certain week;

$i\epsilon[1;27]$ is an integer that expresses the serial number of the week respectively;

qji means consumption in a certain day of the week; $j\epsilon[1;7]$ is an integer that expresses the serial number of the day in the week I respectively.

The inventory model uses the flowchart (Figure 3) to express the optimal replenishment of the stock weekly.

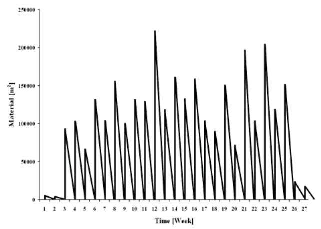

Figure 2: Consumption of corrugated paper weekly

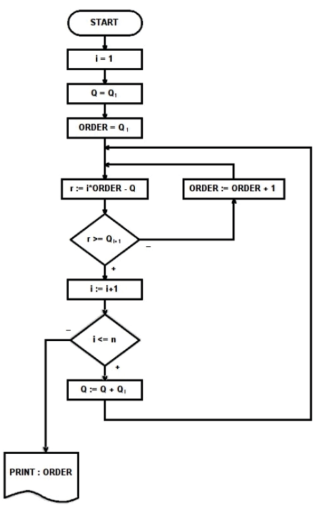

Figure 3: Designed algorithm to determine the optimal order to manage the replenishment of the stock

The flowchart represents the algorithm that was tested also using the program language Pascal. The result was obtained after 120018 repetitions of the cycle but however it means a split second of running the program.

The initial value of Q (consumption) is gradually increased by further Q_i values up to Q_{27}. The value i, which determines the order of the Q_i in the array, is gradually ranked from 1 to 27.

Value r represents the difference between the order and consumption for the production in the next week.

The ORDER value expresses the current value of the optimal order so that r value is always smaller, at most equal to the consumption for production in the following week. To meet this condition, the ORDER value increases incrementally by 1 for each cycle, as material orders can only be made in whole square meters [m^2]. The ORDER value is multiplied by the current week's order number. This formula (4) represents a new value of r:

$r := i * \text{ORDER} - Q$ (4)

The r value is again tested by comparing with next week's consumption requirements.

In this way, an optimum order of 125817 square meters of corrugated paper was set while storing 335678m^2 of corrugated paper for the next production.

The total amount of used corrugated paper for production purposes is expressed as follows:

$Q_1 + Q_2 + \ldots + Q_{26} + Q_{27} = 3061381 m^2$

The total amount of the ordered corrugated paper is:

$27\,x\,125817 m^2 = 3397059 m^2$

So the difference expresses 335678 m^2, what means approximately 10.96%.

CONCLUSIONS

The presented inventory model was designed for one kind of material (corrugated paper). The data obtained represents consumption according to the production requirements for 27 weeks. The model is suitable for application for more types of materials as well as during the longer period. Iterative method of numerical analysis has proved to be suitable for the given type of tasks. In our future work in the field we intend to design some inventory models when individual supplies of materials affect each.

The model is also suitable for use in other industries, such as tourism, for example in supplying hotels with non-food items.

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REFERENCES:

[1] Antonyová, A., and Bucki, R. (2010), "The process of stocking with setting the locations for a few distribution centers.", Proceedings of the Workshop "Information Logistic", The College of Informatics and Management, Bielsko-Biala, 30-33.

[2] Antonyová, A., Antony, P., and Soewito, B. (2018), "Deterministic Inventory Model of Non-Fixed Demand Rate." Far East Journal of Mathematical Sciences, (FJMS), 105(2), 207-213.

[3] Dobrovič, J., Lambovska, M., Gallo, P., and Timková, V. (2018), "Non-financial indicators and their importance in small and medium-sized enterprises." Journal of competitiveness: the scientific periodical published by the Faculty of Management and Economics of Tomas Bata University in Zlín, 10(2), 41-55.

[4] Chiu, S. W., Chou, Ch.-L., and Wu, W.-K. (2013), "Optimizing replenishment policy in an EPQ-based inventory model with nonconforming items and breakdown." Economic Modelling, ELSEVIER, 35, 330-337.

[5] Chung, K.-J., and Huang, Y.-F. (2003), "The optimal cycle time for EPQ inventory model under permissible delay in payments." International Journal of Production Economics, ELSEVIER, 84(3), 307-318.

[6] Kashyap, A. K., Lamont, O. A., and Stein, J. C. (1994), "Credit Conditions and the Cyclical Behavior of Inventories." The Quarterly Journal of Economics, 109(3), 565-592.

[7] Mishra, P., and Shah, N. H. (2008), "Inventory Management of Time Dependent Deteriorating Items with Salvage Value." Applied Mathematical Sciences, 2(16), 793-798.

[8] Pando, V., San-José, L. A., and Sicilia, J. (2019), "Profitability ratio maximization in an inventory model with stock-dependent demand rate and non-linear holding cost." Applied Mathematical Modelling, ELSEVIER, 66, 643-661.

[9] Wu, K.-Sh. (2001), " A mixed inventory modelwith variable lead time and random supplier capacity." Production Planning & Control, Taylor & Francis, 12(4), 353-361.