Stage Decisions of Stochastic Model in Production Processes

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Abstract: - As a complex economic process, stock management has a broad scope, covering both the management problems, sizing, optimizing stocks placement in the field, sharing them on keepers, their training and registration and reception problems, warehousing and storage, tracking and control, redistribution and method of use. Taking into account the influence of the storage process it is necessary to find models and methods for the formation of some stocks, which by volume and structure, should ensure normal performance of the economic activity, but under the minimum necessary storage conditions and expenses as low as possible.

Keywords: **-** logistics, flexible production systems, management, quality.

1 Introduction

Competition between organizations addressing the same market segment is increasingly supported. Each manufacturer has increased its product quality and production moved to Flexible Manufacturing Systems (FMS) diversified, in small batches and to keep competitive costs and better satisfy customers. These arguments reflect the importance of the concept of Total Quality Management (TQM). To reduce logistics costs, and to finally get customer satisfaction, logistics managers are trying to take advantage of this environment for data integration. This led to the development of mathematical models for example to determine the optimal amount of products given the constraints of data centers where production and storage / distribution. Global optimization is done so within the organization and not a series of local optimizations, [7].

Stocks represent those existing quantities of materials in spaces meant for depositing, storage, during certain periods and with a certain consuming destination. Theory of stocks is appeared because of the need to provide a rhythmic supply rate and minimum raw materials costs during the production process, or of finished goods and consumer goods stocks in the business of selling goods. Stocks are designed to provide safety and guarantees that production will take place at predetermined time while the products will reach at time to the beneficiary.

The goal of an optimal stocks system is to minimize costs associated with managing stocks, which are actually subject to operation under conditions of economic efficiency.

Stocks are an important real estate for industrial enterprises. Indeed, if the customers debts and suppliers credits are offset, stocks represent on average 20 to 80% of the total assets of industrial enterprises. Increase in stocks should be subject to a rigorous management: too often, stocks are unduly exaggerated, without avoiding for this interruptions, for certain items. To manage stocks is to decide their level, to decide how and when to acquire each product.

As a complex economic process, stock management has a broad scope, covering both the management problems, sizing, optimizing stocks placement in the field, sharing them on keepers, their training and registration and reception problems, warehousing and storage, tracking and control, redistribution and method of use. Taking into account the influence of the storage process it is necessary to find models and methods for the formation of some stocks, which by volume and structure, should ensure normal performance of the economic activity, but under the minimum necessary storage conditions and expenses as low as possible.

2 Economic model of stock management

The best known economic model of stock management is found in book named Wilson model. It is based on a set of simplifying assumptions. It has been much analyzed and criticized within the specialty literature, [1],[3],[4].

Model assumption:

1. *Physical data:* a) requirement is known, uniform, with a constant norm; b) regeneration is instantaneous; c) re-supplying period from the supplier is fixed; d) stock discontinuation is not allowed.
2. *Economic data:* unit costs are fixed, independent of time and the quantity supplied and managed independent of other articles.
3. *Supply Strategy*: a) corresponds to the (Q, S) strategy - fixed quantity and point of control; b) economic evaluation of supply policy is based on the time unit management cost; c) seeking an optimal strategy - corresponds to the search for a compromise between the costs of launch transmission, which increase with frequency of supply and cost of storage, which decreases when the number of supplies increases.

Notation of variables: Q – launched quantity, T – period of restocking in time unit; d – demand of the unit / time unit (e.g. 1000 parts consumed per month); C_L- launching cost command / transmission in money unit (regardless of quantity); C - unit cost of the item (purchase price); r – coefficient of ownership in % per unit of time; C_S – storage cost equal to C multiplied by r.

Relations between variables:

$$Q = d\,x T \qquad (1)$$

$$C_S = C\,x\,r \qquad (2)$$

The stock passes from the maximum Q level to level 0. It is then to find the value of Q that minimizes the total management cost by unit of time, Figure 1.

In a period T, the cost consists of launching cost (C_L) and average storage cost (C_S) associated to the stock medium $\frac{Q}{2}$, equal to: $C_S \cdot \frac{Q}{2T}$.

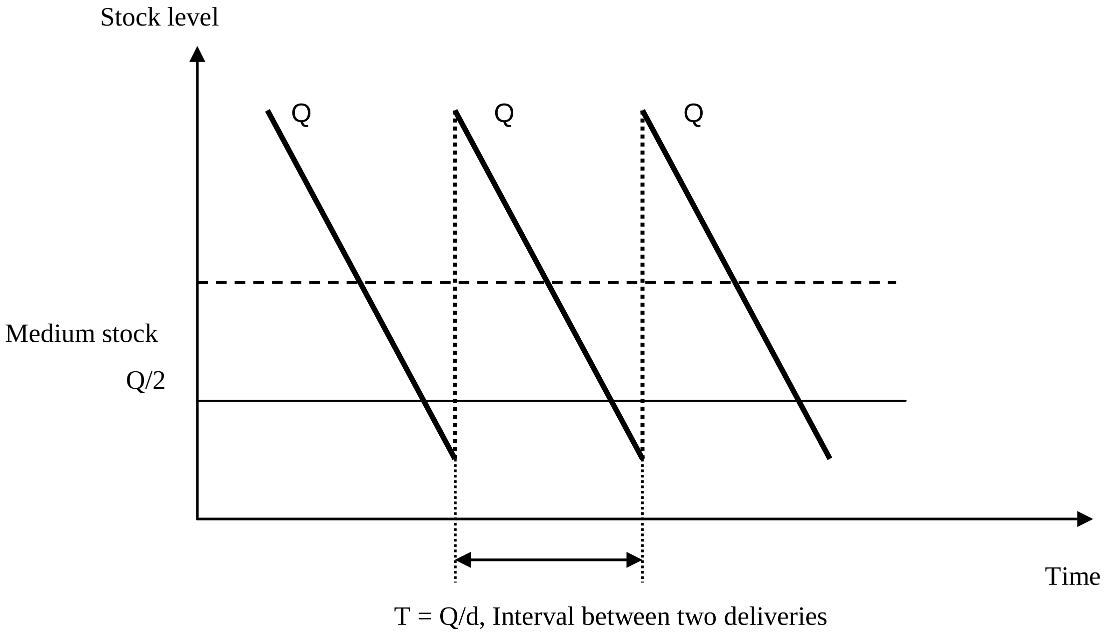

Fig.1 The basic model

For a given strategy (Q, T) and a period T, the cost of storage is:

$$C_S \cdot \frac{Q}{2T} = C_S \cdot \frac{Q^2}{2d} \qquad (3)$$

For a given range $Q = n \cdot T$, the cost of storage is expressed mathematically as to the relationship:

$$nC_S \cdot \frac{Q^2}{2d} = \theta T\, C_S \cdot \frac{Q^2}{2d} = \theta C_S \cdot \frac{Q}{2} \quad (4)$$

The launching cost (C_L) is:

$$nC_L = \theta T \cdot C_L = \frac{\theta\, d}{Q \cdot C_L} \qquad (5)$$

Resulting total cost (C):

$$C = \theta\left[\frac{dC_L}{Q} + C_S \cdot \frac{Q}{2}\right] \quad (6)$$

This function is therefore minimized as compared with Q. The total cost is so minimal for:

$$Q^* = \sqrt{2d\frac{C_L}{C_S}} \quad (7)$$

$$Q = Q^* \quad (8)$$

It also can be deducted (T* = periodicity and N* = number of order to be passed during the period being the inverse of periodicity T*):

$$T^* = \frac{Q^*}{d} \quad (9)$$

$$T^* = \sqrt{\frac{d}{2}\frac{C_L}{C_S}} \quad (10)$$

$$N^* = \sqrt{\frac{d}{2}\frac{C_S}{C_L}} \quad (11)$$

By substituting Q * into the total cost expression, we get:

$$C(Q^*) = \sqrt{2dC_LC_S} \quad (12)$$

3 Stochastic model of stock management

Stocks management is very important for any company engaged in the manufacture, storage, shipment and sale of products and goods. Therefore, operational research is involved in solving the stock management through the development of mathematical algorithms and economic models, [2], [8], [9].

Model objective is to minimize costs related to stock management (storage process) and transportation and distribution costs of goods to consumers, which is actually subject to operation under conditions of economic efficiency.

Stochastic problem will be solved in two stages of decision [2]:

1. The first step is to determine the optimal distribution, rational use of resources or products to be stored in certain warehouses with known storage capacity.
2. The second step is the distribution – transport of products to customers in an optimal way, having in view the random nature demand.

Stochastic model developed will be a complex mathematical model that takes into account various factors specific to storage and distribution processes - transport of goods to consumers. Therefore, the mathematical model must ensure that unitary decision-making, which will take into account both stages of decision, to minimize storage costs and find the optimal solution for the distribution – transport products / resources.

Thus, in the stock management models, the following main elements appear:

- size of demand for the period considered;
- optimum size of the order of supply;
- total cost of supply for the time considered;
- maximum level of stocks;
- average level of stock;
- amount of time advance;
- number of supply orders in the period considered;
- size of the supply cycle.

Resulting model complexity and difficulty of the objective-function, because it is not clearly, explicit known, the dependence of this function to decision makers and because it is a undifferentiated objective-function relative to the control factors. Determining the exact value function is also experiencing a high degree of difficulty, sometimes impossible to solve, since a part of it is calculated as an average of a random function and an analytical dependence of the average has to be found.

But these problems can be solved based on stochastic approximation methods and techniques. An example is the use of stochastic models with two or more stages, which by mean of the Lagrangian function allow the assessment of stochastic gradients - suitable vectors. Stochastic gradients stay on the ground of development of mathematical algorithms to solve these kinds of problems.

3.1 Mathematical model

In the first stage of decision, it is considered necessary to organize the process of optimal storage products / resources (r), determined by the sizes R1, ..., Rk, ..., Rr, in warehouses (n). The next stage is the problem of organizing the transport of

these resources to consumers, under optimal conditions with minimal cost.
Economic and mathematical model consist in optimizing (minimizing) the objective-function value that expresses the total average costs, subject to the processes of storage and transport to consumers [2].

$$F(y) = \sum_{l=1}^{p} \sum_{i=1}^{m} d_i^l y_i^l + M_\theta\left[f\left(y, b(\theta)\right)\right] \rightarrow min \quad (13)$$

Respecting the restrictions:

$$0 \le y_i^l \le a_i^l$$

$$\sum_{i=1}^{m} y_i^l = A_l$$

$$\sum_{i=1}^{m} a_i^l \ge A_l\,, \quad l = 1, 2, \dots, p \qquad (14)$$

where:

d_i^l - storage cost of one unit of product for warehouse *i;*

y_i^l – volume of the item *l* to the warehouse *I*

a_i^l – capacity of warehouse i for storage of the product *l*;

$M_\theta[\circ]$ - operator of average value to the state of nature *θ*;

θ – elementary event defined on the probabilistic space (*θ, F, P*).

Function $f\left(y, b(\theta)\right)$ represents minimal cost of transportation, for y_i^l and $b_j^l(\theta)$ known, that are determined solving the module:

$$f\left(y, b(\theta)\right) = \min_{x_{ij}^l} \sum_{l=1}^{p} \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}^l x_{ij}^l \qquad (15)$$

$$\sum_{i=1}^{m} x_{ij}^l \ge b_j^l(\theta)$$

$$\sum_{j=1}^{n} x_{ij}^l \le y_j^l$$

$$x_{ij}^l \ge 0$$

where:

$b_j^l(\theta)$ - random size representing consumer demand j $(j = \overline{1, n})$, for the item l $(l = \overline{1, p})$.

c_{ij}^l – conditioned expenses of transporting a unit product *l*, from the warehouse *I* to the consumer *j;*

x_{ij}^l - quantity of product l to be transported from the warehouse *I* to the consumer *j*.

4 Quality management systems in logistics

A company that holds ISO 9001 is telling its customers and the world that it has a top quality management system and is totally committed to quality products and services. Companies that go through the process find that profits increase thanks to opening up market opportunities.
Also costs reduce due to improving efficiency. Logistics is an ideal candidate for a quality management system. Your business of controlling the flow of materials and information from the retailer back to the warehouse is a process driven, supply chain operation with customer focus that is well suited to ISO 9001 attention to improving process and delivering quality service to customers, [11].
Quality Management System (QMS) for any organization is more vital than a customer's perception of quality because of the intimate relationship it has on every aspect of the business, yet it is constantly given second class treatment with external and manufacturing processes taking precedent in a crowded environment of scarce resource. A company's QMS forms the structure of how an organization realizes the products and services it manufactures. Processes must be made simpler within the QMS, measures must be formulated to judge processes from the customer perspective, [12].
ISO 9001 quality system standards identify the features which help you meet your customers' requirements consistently and then evaluate how and why things are done the way they are. Think of ISO 9001 as a two-step process. First, examine and refine your existing processes to reach the ISO 9001 standard. Second, once you have ISO 9001 certification, include it in your marketing to show your customers your dedication to quality management. In any organization, ISO 9001 controls quality and brings clear financial benefits. It also gives customers a high degree of confidence and assists in keeping the organization ahead of its competitors.
In Figure 2 is presented the Quality Management in supply process, [11].
Supply chain management is based on the truth that it is inconceivable to view competitiveness without the development of logistics services, without reaching acceptable levels of effectiveness, efficiency and quality, [5],[10]. For achieving this, there should be focus on: improving the availability of products based on the efficient management of stocks and market requirements; coordinating the

production, distribution, stock levels and deliveries between the main links (members or organizations) of the logistics chain, with the support of the integrated information systems that provide real-time sales, programming and information tracking; the creation of alliances and strategic partnerships with customers, suppliers, warehouse managers and those who develop information technology; the customer's direct involvement in defining the product/service and the specification of the requirements regarding with the quality standards of operations which compose the physical flows of materials and products.

The logistics system has the following areas with quality concerns:

- Logistics facilities;
- Logistics process and its sub-processes;
- Human factors of service, organisation, management.

Quality management in logistics, involving indicators of performance, productivity and cost, [6] presented in Table 1.

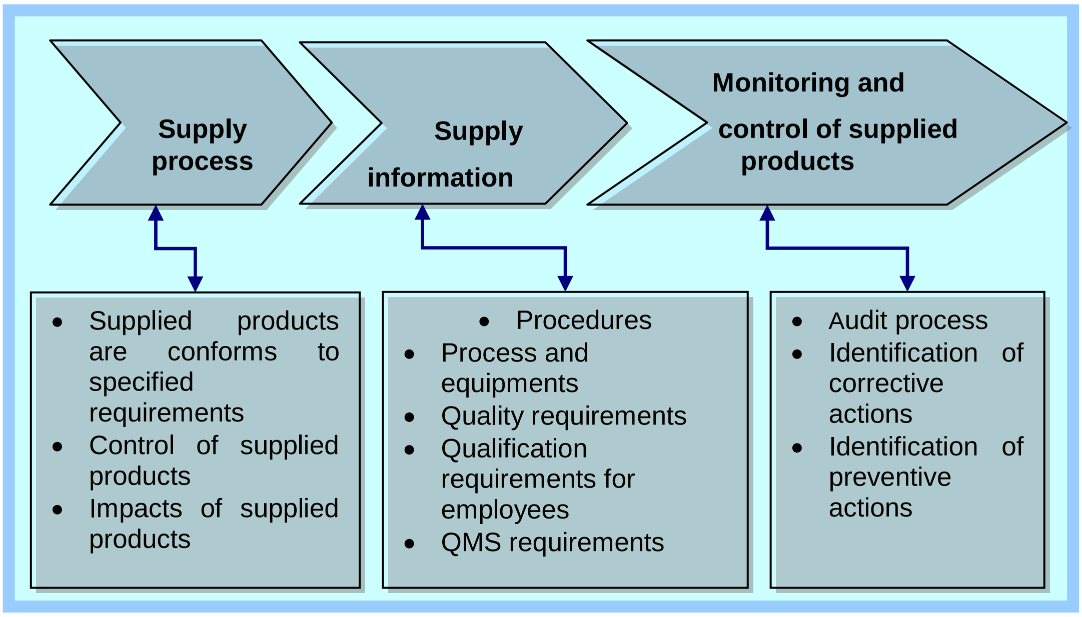

Fig.2 Quality management in supply process

Table 1. The performance and productivity indicators

Quality in logistics systems	Quality indicators
Quality indicators of logistics facilities	▪ load capacity , performance ▪ modern design ▪ suitability to jobs ▪ maintenance background ▪ man-facilities relation (ergonomy, environment protection)
Quality indicators of logistics process(es)	▪ capacity supply/capacity demand ▪ appear time/ordered time ▪ damage events/total activities (packaging also) ▪ missing volume/total volume (packaging also) ▪ error delivery/total delivery commitments

5 Conclusion

The decisive role of inventories in flexible production systems is evidenced by the fact that they provide certainty, security and guarantee the uninterrupted supply of production and selling regularity of its results. In other words, the storage appears as a regulator of uninterrupted supplies and production and the stock is the "inevitable buffer” that provides synchronization for consumer applications at times of supply of material resources. Flexible Manufacturing Systems (FMS) offers many strategic operational benefits over conventional manufacturing systems; its efficient management requires solution to complex process planning problems with multiple objectives and constraints. Mathematical modeling of optimizing problems offers the opportunity to find the optimal solution (solutions), with immediate consequences for the system’s economical efficiency increasing.
The researches will be also extended in the field of FMS management and control in real environment. The implementing of a flexible manufacturing system in an integrate fabrication system, represents an important result, which leads to the optimization of the entire material and informational flux of the enterprise.

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