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METHODOLOGY FOR LOGISTICS SYSTEM MANAGEMENT IN MEDIUM SERIAL PRODUCTION

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ABSTRACT: *The set logistic parameters have a significant impact on industrial production, investment decisions and economic performance. The degree of detail also depends on the available information flows embedded in the batch production process from a logistical point of view. The established logistical parameters directly affect the flows themselves (material, personnel, information, technological, and waste disposal) along the entire production chain-from production to marketing- including their changing state in terms of technological features of the equipment and aggregates. It also affects the management and organizational structure.*

KEY WORDS: *production, logistics, distribution, logistics system, management*

Modularity and multi variety of processes are considered to be one of the basic prerequisites for assisting producers in the logistical indemnity of production. This in its turn benefits for their effective organization and management. In this context, the multivariate nature of logistics activities must be taken onto consideration. Multiple variance is the ability to combine different job options and/ or automated technology modulesin order to provide the necessary technological route for the production/ installation of a final product or component [3]. The opportunities for automation of technological processes are parallel to the development of the new product. Each process is monitored by modern equipment that records defects or defects. 3D laser scanners are being incorporated into recognition, replacing the personnel in hard working conditions. Ensuring their reliable connectivity for feedback with the main control modules is a prerequisite for preventing huge quantities of marriage [6, 7]. The purpose of the study is to systematize the basic principles of design and development of a logistic system for managing and controlling medium-sized technological production of products and to prove its advantage in the organization and management of production processes.

In order to accomplish this, it is imperative to solve the following tasks in the study of technological operations:

1. Systematization of logistical functions which examine the batch production, as well as the administrative management.

2. The flow of inland transport activities is subject to additional analysis, 10-48% are detailed depending on the assets of the company.

Within each of the production phases typical technological methods are applied. They are made up of substructural elements - partial processes that are a sequence of production operations forming a technologically complete and organizationally independent part. The sequence of operations relating to the mechanical or thermal treatment of a product of the manufacturing process in the production unit concerned constitutes a separate partial process from the processing phase. In the assembly phase, partial processes for node assembly, general assembly, testing and tuning, etc. can be distinguished. The analysis shows that multimodal deliveries of material flows can be optimized up to 68.32%, including costs related to organization and management. Storage, production and distribution, production time average 2-5% out of the total time related to delivery. The remaining 95% have to do with logistics operations. It is here that there is considerable potential for optimization. Transportation costs are reduced by optimizing in-house transportation routes, reconciling schedules, reducing empty runs, managing warehouse facilities, etc. Thus, various technological routes or virtual cells- that are interchangeable- are obtained alternatively. Whereas the 'titular routes' are engaged in the production of their other components, they are engaged in finished products. We draw up the graph model and use the data in tabular form. They should correspond conceptually to the actions of the technologist, on the one hand. On the other hand, logical and mathematical design will depend on the algorithmic provision of the logistic system for the design of technological processes.

This requires compliance with the following requirements: compiling a complete database, which includes the characteristics and parameters of problem-oriented configurations of machines, appliances, tools and parts for a particular type of batch production; selection of an appropriate database management system for the formation of a dynamic type of data with the possibility of determining the permissible homogeneous relations providing the necessary production; formation of tables of correspondence with the technological map, taking into account the existing relationships in the technological production database[12]. The technology forecasting aims at defining the anticipated trends in the development of the technologies applied by the company and the opportunities for the emergence of new technologies in technological fields of interest to the company. There are other numerous, diverse in nature, technological forecasting methods that can be grouped into two groups -

qualitative and quantitative. The natural indicators of a logistic system for managing batch production are arranged in accordance with the formula [3]:

(1) $$M_{\text{ч.м}} = \frac{G\text{изх.}}{H\text{мат.}},$$

$M_{\text{ч.м}}=$- shows the relative share of the consumer value $G_{изд}$ to the material consumption rate $H_{мат}$.

For the sake of accuracy, data on the quantity of usable items should also be given if another technological product is manufactured. The ratio of the relative share can be used for comparative analysis, but only if the products have the same or very similar production and structural characteristics. The consumption value of a product is measured by the nominal value of its characteristic technological parameter or indicator. As such, the nominal time of preparatory or final operations, the minimum cost of elements, the consumption of energy resources, the amount of interchangeable structural elements, etc., may be used. The value index ($P_{мат}$) or assumed material coefficient - absorption shows the relative share of material costs $P_{мат}$ in the total production costs $P_{пр}$ for manufacturing a certain amount of final products.

It is calculated by the formula:

(2) $$P_{\text{м.п}} = \frac{P_{\text{мат.}}}{P_{\text{пр.}}}$$

The methods of research and selection of mathematical apparatus are based on the integral direction, namely: "Logistics represents: strategic, tactical, operational and technological of the company and its partners, as the main integrator is the material flow, defined by its main complex characteristic - the value chain ". Management has its development and in its current stage it has IP capabilities. This provides the standard interconnection of multiple nodes for measuring, calculating and performing tasks. The actuators in such productions must have ample opportunity to execute arbitrary user programs. The future occupations will increasingly depend on the mindset of working programmers and less on human physical labor [8].. We consider two types of models related to material flows X (t) and define the objective function of the study. The first type is in itself non-stationary random variables in the exact sense of the word, the density of distribution p (x, t), which slowly changes over time. The slow change in the density of distribution is understood as the possibility of dividing the duration of the technological process assuming the property of quasi-stationarity (in the exact sense of the word). We analyze a one-dimensional, stationary random process X (t) represented by a separate realization X(t) in the form N in step h, i.e. x (xn), n = 0,1,2,…, N-1.

It is assumed that the implementation is already centered, ie.

(3) $$\frac{1}{N}\sum_{n-1}^{N-1} x\,(nh) = 0$$

The estimate of the distribution density for X (t) can be calculated by the formula:

(4) $$P(x) \quad = \frac{N}{NW},$$

where: N_x - a number falling below the centered realization x (t) represented by N with the meaning of the interval $x \pm \frac{W}{2}$.

An estimate of the distribution density for the midpoint of each i-th interval is calculated by:

(5) $$p_{i=}\frac{N_i k}{N(b-a)},\ \text{i=1,2,…k},$$

where: k – an integer at regular intervals broken down by the whole range of variation; [b, a] - the considered range of variation x (t).

The estimate of the density of distribution p (x) is variate.

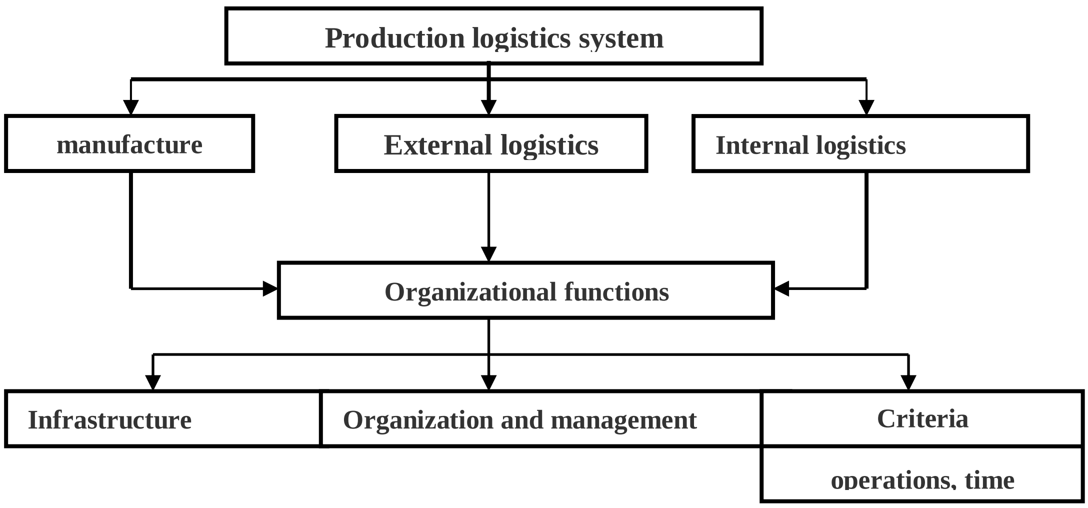

Fig. 1. Organization of technological production

The variate evaluations are approximately: b[p(x)]=E[p(x)-1]p(x):

(6) $$b[p(x)] \approx \frac{W^2}{24}p(x),$$

where: - a second derivative for p (x) by x.

Then we shall determine the variance for the estimation by the formula:

(7) $$D[p(x)] \approx \frac{c^2 p(x)}{2BTW}$$

where: c a constant value, it equals one.

It is assumed that the random process X (t) has the highest frequency B (in hertz), whereas the realization x (t) is defined in the finite time interval T (c). To solve the problem of diagnosing or predicting the condition of the equipment, the estimate of the distribution density will be in the form:

(8) $$P_{\text{откл.}} = P_E - P_T$$

where: $P_{откл}$. –deviation of parameters; PE - measured operational status; Pt - theoretically determined condition (technical passport). In order to determine the exact product manufacturing activities, a mass factor $\kappa_м$ is applied, which is calculated by the formula:

(9) $$\kappa_м = \frac{t_{Hcp}}{R_{усл_г}} = \frac{\frac{\sum_{j=1}^{J} t_{H_j}}{J}}{\frac{F_{e_г}}{Q_г}} = \frac{Q_г \sum_{j=1}^{J} t_{H_j}}{F_{e_г} . J},$$

where: $t_{H_{cp}}$ the average time to perform a technological operation [min / pc]; $R_{усл_г}$ - conditional rhythm of production of the product [min / pc];
t_{H_j} - time norm for the j-th technological operation [min];
$F_{e_г}$ -the approved effective timeframe of the industrial enterprise or production unit in which the product is manufactured [min / year];
$Q_г$ - annual production volume of the product [pcs / year].
The mass ratio indicates the average number of jobs required to perform a technological operation in the manufacture of a product or semi-factory. The results of the model work at different acquisition costs and conversion costs are given in Table. 1 and 2.
The organization of the production process in time and space has a significant influence on the production and economic performance of the industrial enterprise.

A particularly striking imbalance between the needs of the average consumer and the resources invested, such as financial resources, time and labor, to provide great opportunities, which remain very often and largely unused, is noticeable in the production and marketing of the PC market. Research in this area shows that, at the expense of optimizations in the process of use - at hardware and software levels, excellent results can be achieved with much more compact and simple devices, such as the Raspberry Pi, leading not only to drastically curved production cost, but also improved other performance parameters. Such improved parameters can be weight, volume, greatly reduced power consumption - all the features that make it extremely efficient to use such devices in remote-controlled platforms.

The construction and operation of remote controlled aviation platforms are particularly demanding in terms of low mass and volume, high computational performance, low power consumption, options for optimal configuration of hardware and software, low cost of projects. The features of the systems, built on the various implementations of the Raspberry Pi single-board computer, fully satisfy the complex and rigorous requirements that such platforms place. The conditions for conducting research and experiments with Raspberry Pi-based systems are as follows: fully accessible, in most cases even free of charge, knowledge of the field - literature, network information resources; interest societies for working with the Raspberry Pi; open source software modules; educational programs and more. On the other hand, the hardware resources - Raspberry Pi single-board computers and numerous standalone plug-ins, are also quite affordable. [9]

Another example is the production and consumption of LED luminaires. The idea is that using this type of lighting is significantly more cost-effective for the end user because of its significantly lower power consumption while maintaining the same illumination. Unfortunately, in the pursuit of economic benefits, light fixtures with a simplified construction are designed, leading to frequent damage and short life of such appliances. As a result, the end user is harmed, although using more economical lighting appliances, due to the fact that he has to replace the damaged ones more often and at the same time more expensive ones. Studies and experiments by different authors show that, due to design modifications, which significantly increase the cost and complexity of production, a significant increase in the efficiency and credibility of the final product can be achieved - in this case, LED lighting.

In addition to households, the results and conclusions of such studies and experiments to modify LED lighting can be applied to significantly more powerful and more expensive lighting based on LED projectors for illumination of manufacturing premises or protected areas, where the economic impact of extending the life cycle of these lighting fixtures would be much more tangible [10].

It is clear that as a result of the modifications, the operating temperature of the LED crystals may be reduced, which will extend their life. In addition, the proposed modification can be applied to LED lamps of any type, especially if they are of high power. It is then suggested that it would be more appropriate to use two or more luminaires, but with a reduced operating temperature [11].

Therefore, a good judgment and balance of the losses and benefits of complicating the design and production process are also needed here, and as a result, the price and placement of the final product.

It is therefore necessary to evaluate it with appropriate indicators. Private and aggregate metrics can be used for this purpose. The private indicators characterize the degree of realization of the basic principles of construction of the production process in space and time.

Table 1: Overall deliverables results

Distributing center	**customer center**	**amount of flows**	**size of deliveries**	**interval between deliveries**	**total costs**
i	**j**	**Dij**	q_{ij}	τ_{ij}	**Lij**
1	11	27,51	2	3	2,325
1	15	29,23	4	2	5,127
2	17	31,45	8	11	6,381
2	21	46,71	8	14	8,263
3	34	53,69	11	17	9,554

Generally go for the implementation on delivery

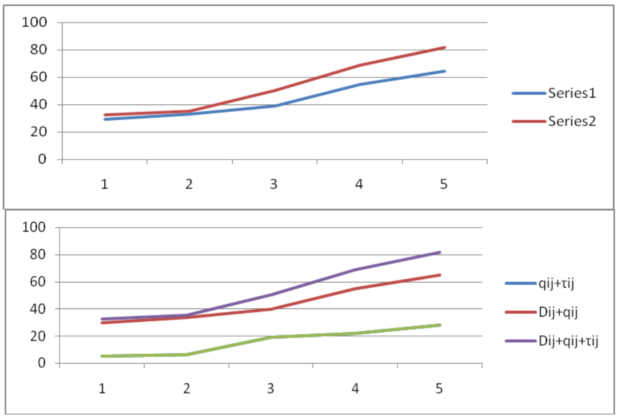

Fig.3. Quantity of flows for a distribution center

The overall indicators serve to comprehensively evaluate the degree of organization of the production process in an industrial enterprise. The relevant coefficients are used as private evaluation indicators: technological specialization coefficient; coefficient of subject specialization; coefficient of rectilinearity; proportionality factor; coefficient of concurrency; rhythm coefficient; coefficient of flexibility.

Table 2: General results for query flow conversions

от център	до център	D_{ij}	S_{ij}	λ_{ij}	τ_{opj}	брой доставки		Q_r	L_{opij}
						час	ден		
1	13	1,123	0,223	0,1	1,783	4	15,6	16,8	1,246
3	15	2,546	0,374	0,3	1,386	3	17,3	17,9	2,143
5	17	3,257	0,672	0,5	2,652	6	19,6	25,3	3,379
7	23	4,356	0,362	0,7	2,821	4	21	28,6	4,137
9	27	5,259	0,839	0,8	3,738	8	17,1	31,4	4,839
11	34	6,379	0,926	0,9	4,248	5	14,2	44,7	5,253

Dij - intensity of the flow of supplies;
Sij - storage costs per unit of output per unit of time;
λij - intensity of request flow;
torj - optimal delivery time for materials;
Lopij - the real costs of managing technological production.

The graphical dependencies between the cycles are the intensity of the flow of requests, the cost of storage per unit of production, the intensity of the flow of requests and the real time to manage the technological production. Based on the obtained results, we can conclude that the optimal number of deliveries for a certain planning period (month and day) on the basis of the already received flows of requests (models with determined volume). The principle of operation of systems with a deterministic order volume is based on the need to determine the exact moment when ordering, the appropriate level of stock at that moment. The prerequisites of the deterministic model are: - demand is constant and evenly distributed over a period of time; - the execution time of the order is determined; - the unit price of the material is determined; - storage costs are determined on the basis of the average stock size; - the cost of ordering or reconfiguration is constant; - sufficient resources to purchase the required quantities and exclude the possibility of non-fulfillment of the contract. The basic model with deterministic order quantities is presented.

The current stock decreases linearly over time and upon reaching Rop a new order is made, which is delivered for time L (Fig. 4).

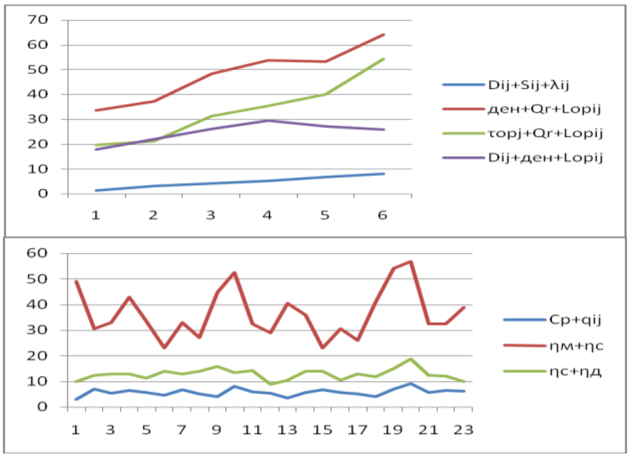

Fig . 4. The intensity of the flow of requests and the real time management of technological production

The software manages and optimizes all activities such as: acceptance of raw materials and semi-finished products from production, inventory management, loading of picking points, value-adding operations and quality control, as well as order fulfillment activities (picking, preparation for shipment, packaging, loading and expedition) [5]. Automatic data exchange between the control system and the ERP system of technological production is ensured. Based on the drawn analysis, the following conclusions and suggestions can be made:

1 The condition and development of the equipment in the course of its operation depend on the alteration of its parameters. This change can be managed by examining the influencing factors and determining the relative share of dominant parameters in determining the capacity of the equipment.

2. The density of distribution of the error in the spectral plane of the parameters characterizes and which of them are dominant for the capacity of the equipment. The main directions for the development of production capacities in the process of operation, providing their capacity in one degree or another are: repair, maintenance, prevention, modernization, replacement of machines with new ones, outsourcing, etc.

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