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The models of suply management in the conditions of constant influence of external factors, which are necessary for the application of the adaptive model, are investigated. The reasons for the application of the principles of adaptation are identified and characterized. The main limitations in the use of adaptation models are highlighted. The necessity of using a number of models to create an adaptive system is substantiated, given their characteristics and the probability of their application is determined. Given the objectives of suply management, the need for its use to manage costs and, as a consequence, increase the efficiency of the enterprise. It is established that the decision on the choice of supplier is considered as decisions made in conditions of uncertainty. The criteria for determining the best supplier are highlighted. The analysis of suppliers through distribution on criteria is executed. It is substantiated that in order to effectively apply the solution scheme, the buyer must identify options, criteria for evaluation and assess the probability of success and failure, so the article analyzes the methodology of building enterprise management systems and adaptive modeling of their development. To solve the problem of creating a model of adaptive suply management system of an industrial enterprise, it is proposed to make changes in the structure of operating processes, create a new rating system of suppliers without subjective assessments, which will further automate the procurement process in uncertainty.

Keywords: supply, management system, metallurgical enterprise, planning, modeling, automated analysis of suppliers

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ФУНДАМЕНТ ДЛЯ ФОРМУВАННЯ АДАПТИВНОЇ МОДЕЛІ МАТЕРІАЛЬНО-ТЕХНІЧНОГО ЗАБЕЗПЕЧЕННЯ ПІДПРИЄМСТВ

Досліджено моделі управління матеріально-технічним забезпеченням в умовах постійного впливу зовнішніх факторів, які необхідні для застосовування адаптивної моделі. Визначено причини застосування принципів адаптації та надано їм характеристику. Виокремлено основні обмеження при використанні моделей адаптації. Обґрунтовано необхідність використання ряду моделей для створення адаптивної системи, надано їм характеристики та визначено ймовірність їх застосування. Враховуючи цілі управління матеріально-технічного забезпечення, обґрунтовано необхідність його застосування для управління витратами і, як наслідок, підвищення ефективності діяльності підприємства. Встановлено, що рішення про вибір постачальника розглядається як рішення, що приймаються в умовах невизначеності. Виокремлено критерії для визначення найкращого постачальника. Виконано аналіз постачальників через розподілення за критеріями. Обґрунтовано, що для того щоб ефективно застосовувати схему рішення, покупець повинен визначити варіанти, критерії для оцінки і оцінити ймовірність успіху і невдачі, тому у статті здійснено аналіз методології побудови систем управління підприємством та адаптивного моделювання їх розвитку. Для вирішення задачі створення моделі адаптивної системи управління матеріально-технічним забезпеченням промислового підприємства запропоновано внести зміни в структуру процесів функціонування, створити нову систему рейтингування постачальників без суб'єктивних оцінок, що дозволить у подальшому автоматизувати процес закупівлі в умовах невизначеності.

Ключові слова. Постачання, система управління, металургійне підприємство, планування, моделювання, автоматизований аналіз постачальників

The problem. One of the main tasks of suply management (SM) of the enterprise is to create a system that will ensure the fulfillment of its goal - to provide the company with quality materials in a timely manner, at a minimum price. With a low level of implementation of the main goal of the SM system, the company has a number of problems: reducing the level of readiness of equipment; reduction of production volumes; reduction of product quality; loss of consumers.

At present, heavy industry enterprises in Ukraine have outdated materials supply management systems. This has led to a significant gap in the quality of products produced in the domestic market and abroad. Given the significant potential for the development of Ukrainian industry, it is necessary to create a new enterprise management system that will improve resource efficiency and create a deposit for future modernization of technologies and equipment. Given the new trends in the development of management systems, it is necessary to develop a self-regulatory system that will direct the system of heavy industry enterprises to reengineer existing business processes. For this purpose, the introduction of an adaptive model of equipment management of industrial enterprises is proposed.

The aim of the article is to analyze the methodology of building enterprise management systems and adaptive modeling of their development to solve the problem of creating a model of adaptive suply management system of industrial enterprises and make changes in the structure of operational processes and create a new rating system of suppliers without subjective assessments. further automate the procurement process in conditions of uncertainty.

Analysis of recent research and publications. The study of the problems of organization, planning and evaluation of the effectiveness of internal relations of the company's divisions was devoted to the study of many domestic and foreign scientists, such as Bryukhovetskaya N. [1], Buleev I [1], Malandina G. [1], Prokopenko N. [1],

Krush P. [2], Tulchynska O. [2], Tulchynsky R. [2], Vinogradova O. [3], Hrynyova V. [4], Novikova M. [4], Krykavsky E. [5] , Kubiv S. [5], Didyk A. [6], Kohut U. [6], Kuzmin O. [6], Melnyk O. [6], Fridag HR [7], Schmidt W. [7] and others.

Results. Adaptive models must be used to create an effective model of suply management in the conditions of constant influence of external factors.

Adaptive models are data discounting models that are able to quickly adapt their structure and parameters to changing conditions [8].

Adaptive systems are divided into types:

- optimal (provide automatic support in the control mode of the best mode);
- Self-tuning - adaptation is carried out by changing the parameters;
- Self-organizing - adaptation is carried out by changing the parameters and structure of the control system;
- Systems with adaptation in special phase states - adaptation is carried out by changing the control modes depending on the nature of the control object within the specified limits;
- Self-learning - adaptation is carried out due to the accumulation of information about the decisions made in accordance with the conditions, in the future the system by coincidence will make a similar decision, according to its database [9].

The reasons for applying the principles of adaptation can be combined into two groups:

1) Variability and complexity of the characteristics of objects and the environment.

It is accepted to allocate destabilizing factors of external environment: climatic; mechanical; loading; others.

2) Increasing requirements for accuracy and technical and economic parameters of systems.

The main limitations when using models.

1. Models can be expensive and take a long time to develop and test.
2. They are often not used and misunderstood due to their mathematical complexity.
3. They reduce the role and importance of information that is not taken into account by the model (non-computational information).
4. They often have preconditions that oversimplify real-world variables.

To create an adaptive system, you must use a number of models.

1. Algebraic models. Algebra is a basic mathematical tool that can be used to solve common operational problems, such as critical point analysis and cost-benefit analysis.

2. Statistical models. Because many solutions involve uncertainty, it is very important to use probability distribution and statistical theory. Three types of statistical models are presented.

a) Forecasting - the process of creating projections on future variables such as sales, costs.

b) Quality control - helps to measure and adjust the degree of compliance to which the product or service meets specific standards.

c) Decision theory - used in decision trees and decision tables to help present and solve problems at risk.

3. Models of linear and mathematical programming. Linear programming is widely used in decisions about product mixing, placement analysis, planning.

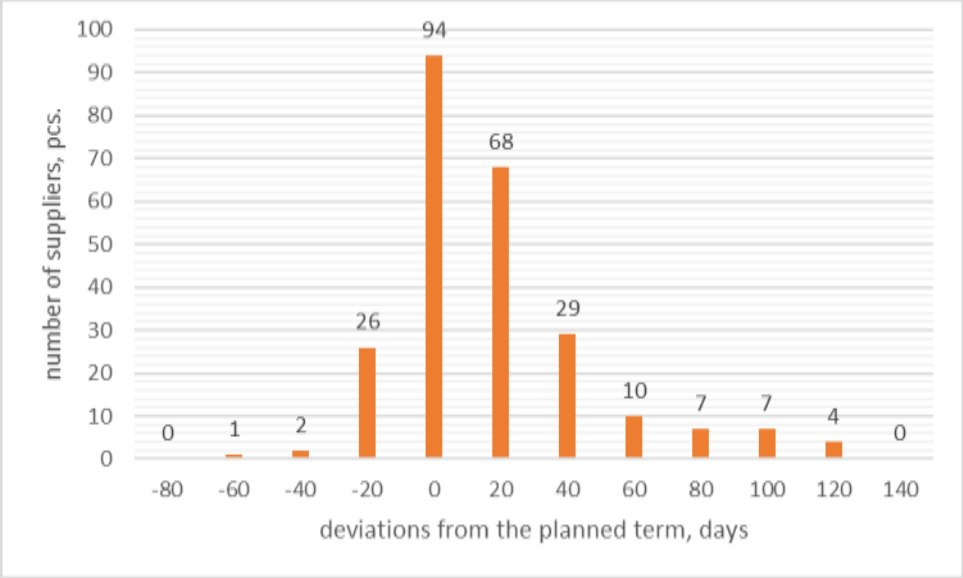

Fig. 1. Distribution of suppliers of the enterprise PJSC "Zaporizhvognetriv" by parameter: deviation from the planned deadlines.

It is established that at the enterprise of PJSC "Zaporizhvognetriv" there is a dependence of deviation from the planned tasks on the number of suppliers: the greater the number of suppliers, the smaller the deviation.

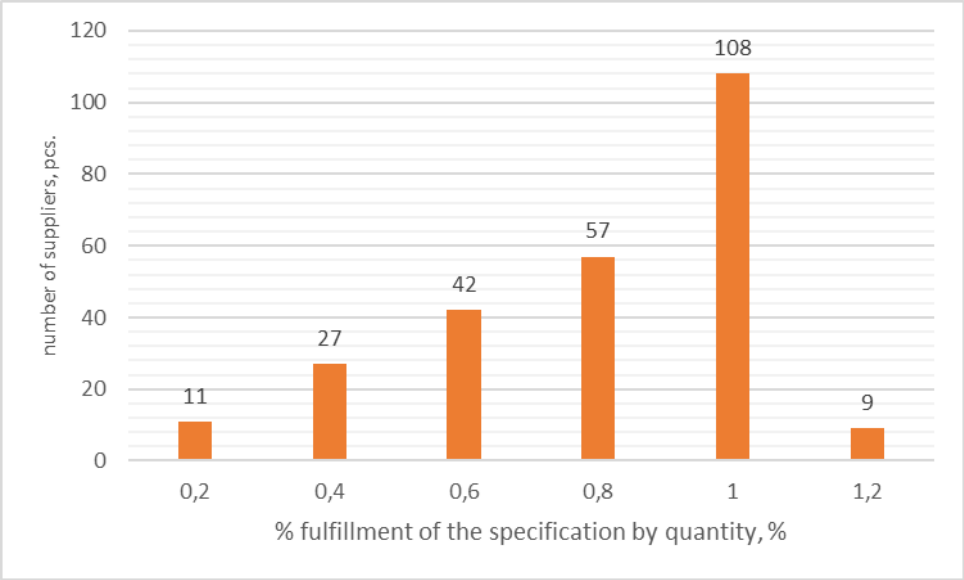

Fig. 2. Distribution of suppliers of the enterprise PJSC "Zaporizhvognetriv" by parameter: deviation from the planned amount of goods and materials.

Figure 2 showed that there is a dependence of the deviation from the planned number of goods and the number of suppliers: the larger the number of suppliers, the smaller the deviation.

We consider it expedient to analyze also the distribution of suppliers of the enterprise PJSC "Zaporizhvognetriv" on the parameter: deviation from the planned prices (Fig. 3).

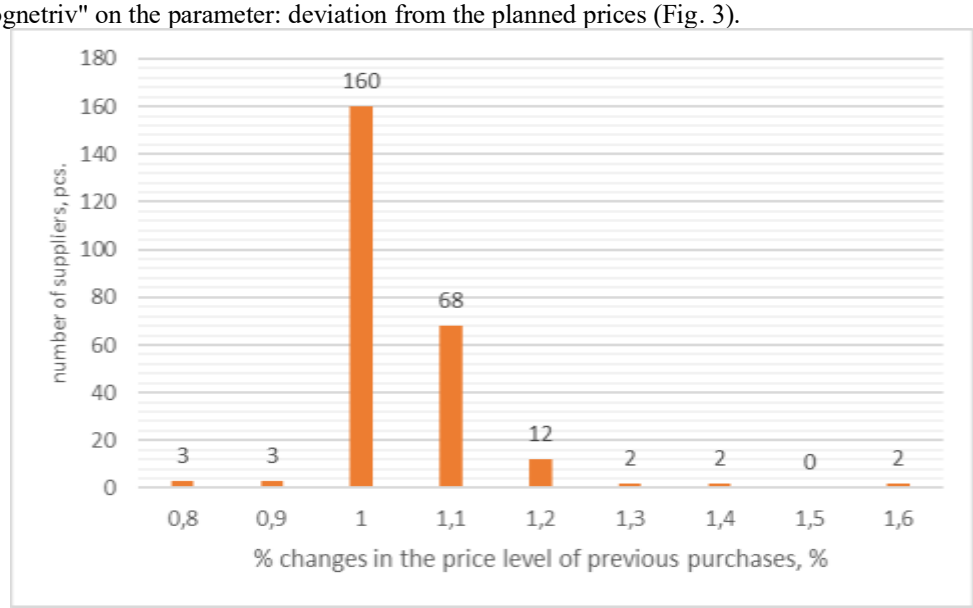

Fig. 3. Distribution of suppliers of the enterprise PJSC "Zaporizhvognetriv" by parameter: deviation from planned prices.

To create a foundation for an adaptive model that will ensure the implementation of the objectives of logistics of the enterprise, it is proposed to use the formula of the rating of suppliers, which does not contain subjective assessments.

Principle of supplier rating:

If the specification is fulfilled ahead of schedule and the quantity according to the specification is fulfilled within 95-105% (tolerance):

$$\text{Rating score} = \frac{\sum_{i=1}^{n}(dp_i - df_i)}{n} x \frac{\sum_{i=1}^{n}(qp_i - qf_i)}{n} x \frac{\sum_{i=1}^{n}(pp_i - pf_i)}{n} x 1 - \frac{\sum_{i=1}^{n} yf_i}{n}$$

If the specification is fulfilled ahead of schedule, but not in quantity:

$$\text{Rating score} = \frac{120x\frac{\sum_{i=1}^{n}(qp_i - qf_i)}{n}}{1 - \left|1 - \frac{\sum_{i=1}^{n}(pp_i - pf_i)}{n}\right|} \Big/ 1 - \frac{\sum_{i=1}^{n} yf_i}{n}$$

If the specification is not met on time:

$$\text{Rating score} = \frac{\frac{\sum_{i=1}^{n}(dp_i - df_i)}{n} x \frac{\sum_{i=1}^{n}(qp_i - qf_i)}{n}}{1 - \left|1 - \frac{\sum_{i=1}^{n}(pp_i - pf_i)}{n}\right|} \Big/ 1 - \frac{\sum_{i=1}^{n} yf_i}{n}$$

Where

Dp - planned delivery date according to the specification;

df - actual delivery date according to the specification;

i - serial number of delivery;

qp - planned delivery price according to the specification

qf - the actual delivery price according to the specification;

pp - the planned amount of goods delivered in accordance with the specification

pf - the actual amount of goods delivered in accordance with the specification;

yf - the presence of comments on quality when delivered to the specification (binary score 0; 1);

120 - days, number of days according to the planned cycle of purchase of goods and materials, according to regulations.

The following is an example of the distribution of suppliers of PJSC "Zaporizhvognetriv" for further decision-making (Fig. 4).

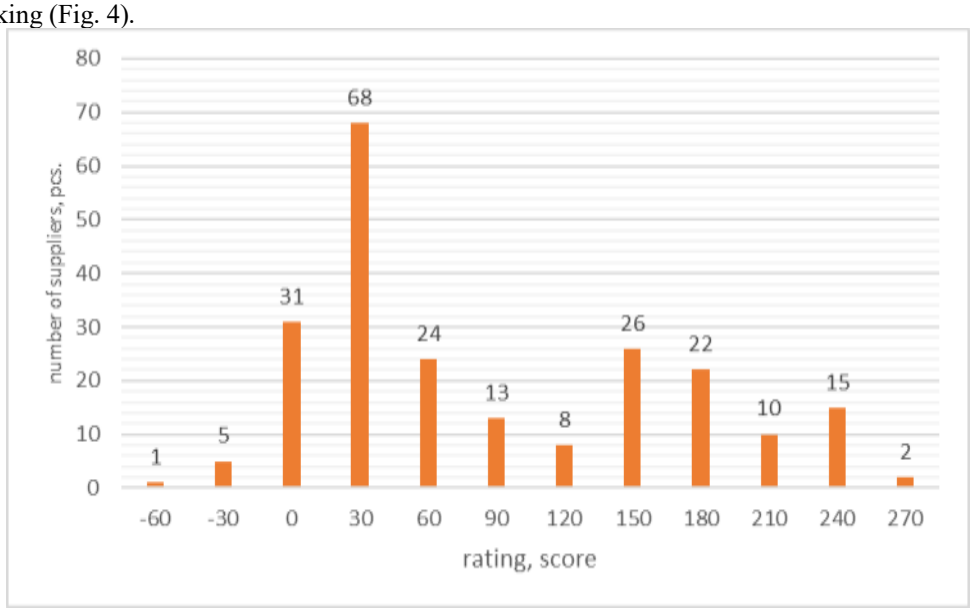

Fig. 4. Rating of suppliers of the enterprise PJSC "Zaporizhvognetriv" 2020

Conclusions. According to the calculation formula, the lower the rating score, the more reliable the supplier.

All suppliers in the range up to 0 are suppliers who meet their obligations in terms of quantity and time. According to the above distribution, the number of reliable suppliers (in the green zone) is 14.6%, ie when conducting a tender and providing access to the tender, the supplier will have a priority position. 44.5% of suppliers are in the yellow zone (from 0-120 points), ie deviations from the planned period within 120 days, less than the planned cycle of procurement of goods and materials.

40.9% of suppliers are in the red zone, ie they are not reliable contractors.

This rating is necessary for decision-making in the tender and as a consequence to motivate suppliers, creating additional competition for the quality of services provided.

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