Conceptual Problem-Oriented Model of Organization and Management of Machine-Building Enterprises' Production Activity

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Abstract— In this article, the necessity to build a problem-oriented model of the organization and management of industrial activity of a small-scale machine-building enterprise is examined. It is shown that management of enterprises' production activities is a decision support system that governs planning, organization and management of reserves, production and personnel, as well as analysis, control and regulation of processes based on information received from other structural units. Following a systematic approach and utilizing decomposition methods, a conceptual model of management of small-scale production enterprises is constructed. The model is presented in form of an adhocratic multidimensional organization of interactions between the main components – goals and objectives, components and subsystems, methods and control mechanisms. The specifics of small-scale production are reflected in the chosen basic models included in the macro-level model of the control system. A sextuple model is chosen to describe concept-object-attribute relations.

Keywords— conceptual problem-oriented model, tuple modeling, decomposition, management, small-scale production, planning, control, accounting, regulation.

Introduction

Taking into account modern markets’ rapid fluctuations in demand, the development of machine-building enterprises is driven by the necessity to create products competitive both in technical characteristics and in terms of cost. Under the conditions of an unstable market, the most effective enterprises must be perceptive to constant changes in the functional environment and adapt accordingly, which leads to a tactic of releasing a variety of diverse products in small batches. Adaptability must be provided by flexibility and mobility of production, scientifically based methods of organizing and managing production, as well as system modeling and modern information support [7,8].

This leads to the conclusion that management of enterprises' production activities is, in essence, a decision support system that governs planning, organization and management of reserves, production and personnel, as well as analysis, control and regulation of processes based on information received from other structural units.

Task statement

The goal of creating the management concept is to set up effective production activity through integrated automation of all major business processes of the enterprise in order to maximize profit. One of the most important ideas is the concept of a model - a system that displays a specific group of the subject’s properties. To implement information interaction processes at a constructive level, it is necessary to create formalized models describing the composition, structure, tasks, technologies, methods and algorithms of interaction [2,3,5,7,8].

The problem-oriented model of the organization and management of production activities of a machine-building enterprise is built on the concept of a balanced system of indicators. There are four modules of the structure which determine the main factors which improve the efficiency of the enterprise system and increase competitiveness of products: marketing module that determines the strategy of market activity (meeting customers’ needs, retaining existing customers, attracting new ones); production module that governs the operational management of the enterprise (operational planning, optimizing resources and productive capacity); innovation module that manages the strategy of development (task monitoring, motivating workers, implementing an information system); economic module that regulates resource usage (minimizing costs, maximizing profit).

Fundamental to the infrastructure is an information system for managing the enterprise's production activities. An infrastructure developed to organize and manage the enterprise's production activity enables establishing the exact complex of measured indicators of production activity characterizing customer satisfaction, innovative activity, development [1,4,6]. This, in turn, allows formulating measurements that gauge the achieved results and, subsequently, indexes that describe the processes contributing to the achievement of these results. Methods of improving
efficiency are determined; for example, in order to achieve certain important indicators of production activities such as increased productivity and reduced labor intensity, it is necessary to distribute reasonable workloads throughout the workforce.

A tuple-adhocratic conceptual representation of a problem-oriented model

Based on the methodological provisions set forth in [3,4,9], a conceptual tuple-adhocratic macro-level model \( M \) of organization and management of a small-scale machine-building enterprise was built in order to formalize the description and solution of the identified problems. The macro-level model is defined as a complex production system functioning in the modern conditions of decentralized management and competitive market relations in order to develop self-sufficient, individual strategies of survival, stabilization and management in an unstable period. The radial structure of the macro-level model is constructed in the form of an adhocratic multi-dimensional organization of interactions between the main components – goals and objectives, components and subsystems, methods and control mechanisms.

Taking into account the identified specificity of the object of organizational management, the radial structure of the macro-level model \( M \) (Figure 1) is represented by a decomposition of six basic models of the essential characteristics necessary to perform the basic tasks of managing small-scale machine-building enterprises:

\[
M = M1U M2 U M3 U M4 U M5 U M6 \quad (1)
\]

\( M1 \) - model of the enterprise’s market strategy; \( M2 \) - model of the enterprise’s management development; \( M3 \) - model of production processes’ organization; \( M4 \) – structural model of production activities; \( M5 \) - model of development of the organization and management system; \( M6 \) - model of performance indicators.

The axial structure of each basic composite model \( M_l \) is represented by hierarchic multidimensional problem-oriented models in the form of the following sextuple sequence:

\[
M_l = \{Q_l, P_{lm}, S_{lmk}, F_{Ml}, N_{lm}, J_{lmk}\} \quad (2)
\]

\( Q_l \) - essential content of the problem; \( P_{lm} \) - structures of the main problem \( M_l \)'s decomposition; \( S_{lmk} \) - functional tasks formalizing the isolated structures \( P_{lm} \); \( F_{Ml} \) - methodological tools of solving the problem \( M_l \); \( N_{lm} \) - methods of solving the decomposed problems \( P_{lm} \) and functional tasks \( S_{lmk} \); \( J_{lmk} \) - the complex of information necessary to solve the problems \( P_{lm} \) and tasks \( S_{lmk} \) through methods \( N_{lm} \).

In distinguishing indicative properties and characteristics \( P_{lm} \) and \( N_{lm} \) the index \( m \) corresponds to the criterion of isolating the structures of the problem \( \Pi_{m} \); the index \( k \) in the constructions \( S_{lmk} \) and \( J_{lmk} \) corresponds to the criterion of determining the components’ functional properties.

The obtained efficiency for "Region-avto", LLC is presented in Figure 2 below.
Fig. 2 - Obtained efficiency for "Region-avto", LLC

![Bar chart showing efficiency measurements for different expenses.](image)

Of which the most important problems of organizing and managing a system of production can be solved.

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### Conclusion

The tuple model is a sample of a problem-oriented model that allows to consider the system from the viewpoint of the interactions of heterogeneous factors that determine the integrity of the system. In general, the system is determined by a set of features, the elements of which characterize the entire set of its properties: algorithms of functioning, structure, numerical values of parameters, external environment behavior, controlling influence, information data and system quality indicators [3,5,7,8].

The tuple sample of the model determines purposes and attributes of the functioning system, as well as its structure and its basic models’ properties. Tuple models offer methodological tools for determining the functions and characteristics of production systems and make it possible to build a correct constructive mathematical model, on the basis of which the most important problems of organizing and managing a system of production can be solved.