Advances in Economics, Business and Management Research, volume 47
International Scientific Conference "Far East Con" (ISCFEC 2018)

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:

$$M = M1 U M2 U M3 U M4 U M5 U M6 \quad (1)$$

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:

$$Mi = \{Qi, Pim, Slmk, FMi, Nim, Jlmk\} \quad (2)$$

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} ; FM_l - 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_{im} the index *m* corresponds to the criterion of isolating the structures of the problem Π_{pl}; the index *k* in the constructions S_{lmk} and J_{lmk} corresponds to the criterion of determining the components' functional properties.

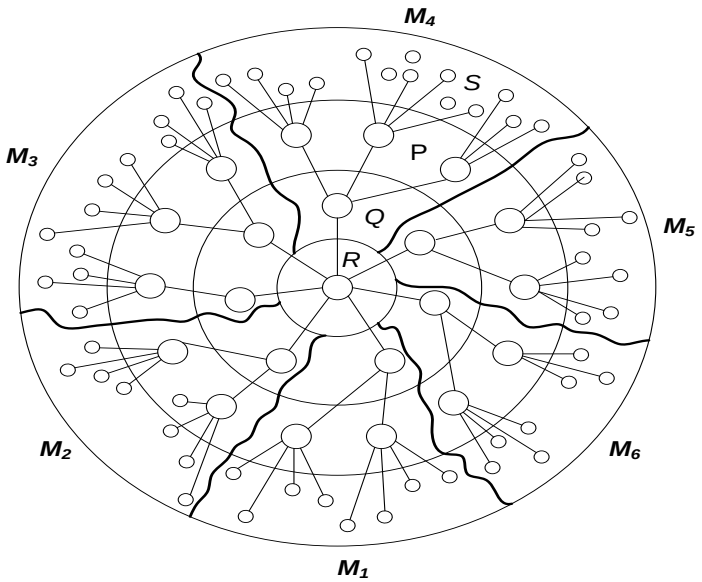


Fig. 1- Tuple-adhocratic representation of the conceptual problem-oriented model of organization and management of an enterprise production activities

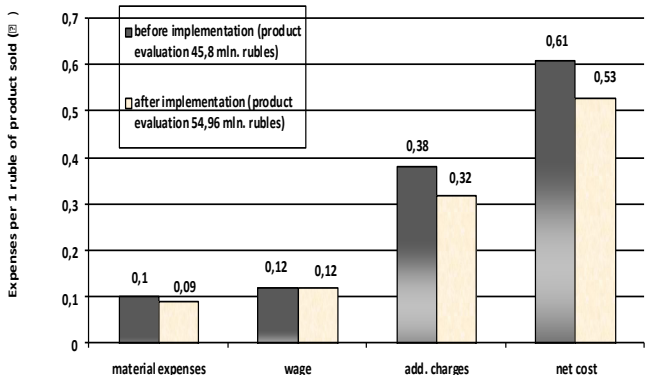
The developed model was approved and employed to create information systems for production management at a number of industrial enterprises of the Samara region: "Zavod neftyanogo mashinostroyeniya" OJSC, "Mayak" OSJC, "Samarskiye kanatnye dorogi" JSC, "Region-avto" LLC, etc.

Modeling and optimizing the main processes of production allowed the enterprises to:

- *Obtain technical effect:* reduce the labor intensity of production processes, improve the utilization of equipment and production areas, shorten the durations of production cycles, reduce the consumption of materials and working capital, decrease the costs of components and stock supplies.
- *Increase effectiveness of management organization:* ensure accurate accounting of the transfers of materials and finished products, improve the methods of planning production processes, increase the quality of regulation and reduce the number of administrative and management personnel, streamline the information flows and improve the quality of document processing.
- *Receive an economic effect:* increase the output and diversity of products, improve the quality of financial and economic management, raise enterprise profits, lower the net cost of production, increase product sales and market competitiveness.
- *Produce a social effect:* increase budgetary allocations, create new jobs, improve the level and culture of production.

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

Fig. 2 - Obtained efficiency for "Region-avto", LLC



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.

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