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Development and Implementation of Adaptive Science-Intensive Manufacture Management System Based on Management Processes Automation

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Abstract: The paper substantiates theoretic and methodic basics and formulates practical recommendations related to the formation and development mechanism of the adaptive science-intensive manufacture management on the basis of the management processes automation. It is shown that, above all, the economic stability of the science-intensive manufacture is contemplated by the innovation stability, characterizing innovation strategy taking into account the flexibility and orientation of the innovation cycle implementation including the creative phase, phases of ratioanization and invention.

Key words: Adaptive management system · Science-intensive manufacture · Management processes automation · Manufacture enterprise economic stability · Research and development works

INTRODUCTION

The basis for the implementation of the Russian economy modernization strategy, refusal from the raw materials orientation of manufacture and using its competitive advantages on the world markets is science-intensive enterprises of the real sector that have all necessary resources' [1], labor and innovation potentials to manufacture highly technological, intellectual products.

It stipulates the necessity to develop and implement strategies of the functioning stability and development of the science-intensive manufacture focused on the manufacture of products with high technical and economic and exploitation characteristics with the use of highly-developed technologies to the peculiarities of the contemporary stage of the national system development [3].

Structural transformation of the Russian economy in the 1990s and the world crisis of 2008 caused the drop of basic macroeconomic indicators that came out the most vividly in science-intensive manufacture areas that was stipulated by the decrease in the budgetary R&D financing, the lack of large private investments, ambiguous result of privatization processes, complexity of adapting modern management technologies to the operating enterprises and low efficiency of the nationwide strategy of the manufacture complex development. Decreasing of the level of research and technology and personnel potential cause the drop of the research intensity level of the economy real sector which plays the role of the main source of economic growth in states with developed economy.

At the present time in the forming multipolar world there are 4 main centers of the scientific progress-the USA (35% of the world expenses for R&D according to the purchasing power balance (PPB)), the European Union (24%), Japan and China (approximately 12% each). According to the official data, the Russian Federation (the RF) percent is less than 2% of the world expenses for R&D according to the PPB and 1% according to the exchange rate. Thus, according to the expenses for R&D Russia falls behind the USA by 17 times, the European Union by 12 times, China by 6.4 times, India by 1.5 times. About 40% of the RF GDP is generated through raw materials export while machinery building, electronics and other highly technological areas form 7-8% of GDP. Highly technological products export makes 2.3 of the manufacture e xport of Russia, the specific weight of which does not exceed 0.3 in the global export of science-intensive products.

It is reflected in the index of competitiveness introduced by the World Economic Forum. In accordance with its calculations Russia is on the 70th place.

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Consequently, the decrease in the science-intensive manufacture competitiveness and developing of competitive advantages of Russian enterprises is the most important task of the social and economic development of the national economy, the condition of the level and quality of the people's life [5].

Thus, for example, there is no methodology of implementing the system of adaptive science-intensive manufacture management, methods of adaptive regulation of the management activity parameters are not developed well enough; ways of accounting the influence of the enterprise external and internal factors, elements of adapting the science-intensive enterprise to the influence of the external environment have not been developed. Peculiarities of the mechanism implementing the adaptive management of the science-driven manufacture through making and implementing management decisions and issues of forming the corporate informational system of the science-intensive enterprise in the competitive environment have not been studied well enough.

RESULT

The undertaken study allowed to give a definition to the economic stability of a science-intensive manufacture enterprise as pa level combination of financial (characterized by the organization ability to be liable for its financial obligations), innovation (characterized by the innovation strategy taking into account the flexibility and orientation to constant improvement), organizational and management (characterized by the level of the enterprise internal resources use), technical (characterized by the level of the enterprise technical base, level of its correspondence to the modern requirements and possibility to use new equipment and technologies taking into account the area specificity), personnel (characterized by the stability and personnel professional personnel) stability.

The availability of economic stability allows the economic entity to perform fundamental and applied researches, to create the external conditions of the development characterized by the indefiniteness, to increase the indicators of the products research intensity and to guarantee their competitiveness in the long-term run.

The study of the management thought evolution and adaptive management genesis showed that adaptive management appeared when the manufacturer descended to the market orientation as a response to the enterprise need to take into account the influence of factors of the competitive influence and take preventing measures related to the provision of competitive advantage, competitiveness and achieve the enterprise stability.

Above all, economic stability of the science-intensive manufacture is achieved by innovation stability characterized by the innovation strategy that takes into account the flexibility and orientation to the realization of innovation cycle including the creative phase, phases of rationalization and invention, development and experiments, innovation, commercialization and innovation spreading, innovation consumption (utilization), renewal, transformation and diversification.

Technical stability means renewal and modernization of basic funds, increasing of the level of basic funds and manufacturing capacities use. Financial stability is characterized by the enterprise ability to be liable for its financial obligations. Personnel stability means the staff composition stability, steadiness and professional potential of the personnel.

External factors defining the level of economic stability include customers, competitors, suppliers, laws and regulations, dynamics of basic macroeconomic indicators, political climate and the level of technologies in the area, the labor market state and the availability of professional personnel. The analysis of the external state of science-intensive enterprises in the modern Russian economy allows to define it as the one characterized by the high level of indefiniteness that stipulates the necessity of active influence and formation of external conditions by the economic entity.

This strategy is based on the implementation of synergetic innovations or qualitative (changing system forming and/or strategic factors) innovations leading to the revolutionary development of science-intensive enterprises. The precondition for implementing this type of strategy is the conduction of fundamental and applied researches and developments with the use of scientific and technological and innovation potential of separate enterprises, integrated entities.

In this connection the preference in profiles of priority branches of national economy must be given to the branches with high level of research intensity and innovation attractiveness (air vehicles manufacture including space, etc.). Herewith, the enterprise can influence the external environment on the basis of the adaptation to the external environment changes that allows to keep its stable state. Above all, stable development of a science-intensive enterprise is guaranteed due to the formation and implementation of the innovation potential and the competitiveness has the stimulating function here.

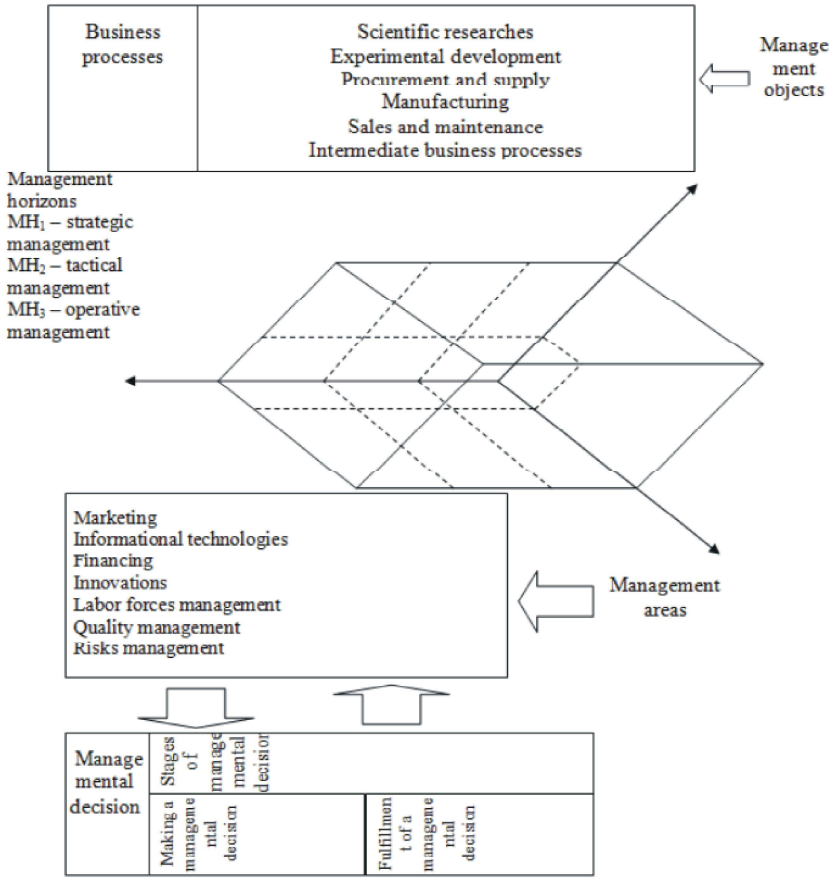

Fig. 1: Model of adaptive science-intensive manufacture management

The system of adaptive science-intensive manufacture management is based on the use of its abilities to transform taking into account the peculiarities of internal and external environment of the economic entity, combination of actions that are necessary to influence business processes at all stages of the science-intensive product life cycle and in all areas of management that guarantees innovation, organizational and management, technical, financial and personnel stability of the sciebce-driven manufacture enterprise.

The enterprise adaptivity under the indefiniteness conditions is presented as its ability to quickly and with fewest expenses react to the changes of the external environment factors through managing the internal environment factors. The adaptive model of the science-intensive manufacture management system is a model in which, as a result of changing of the object internal and external features parameters, the structure and management parameters undergo relevant changes at the least expenses and within as short period of time as possible with the aim to provide the object stable functioning.

The most important factor of adaptivity to the market needs is innovation flexibility, namely the transformation of the scientific researches and developments results into a new and improved product introduced on the market or improved technological process. The model of adaptive management is shown on Fig. 1.

Methodology of adaptive management integrates the theory, economic categories, laws and principles, methods, functions, technology into a comprehensive system that is implemented through the management mechanism. The basic mechanism of implementing adaptive management is a combination of principles, tools and technologies of making and implementing management decisions.

CONCLUSIONS

The system of adaptive science-intensive manufacture management is a management activity that is presented in the form of interrelated influences on the adaptability of the object being managed and aimed at keeping competitive ability with the aid of the

Table 1: System of adaptive management efficiency indicators in respect of science-intensive products life cycle

Stability type/ Product life cycle stage	Indicators
Innovation stability	Specific weight of new products in the general flow of production
Scientific preparation of manufacture	Products renovation coefficient
	Products specific weight corresponding to the world level
	Degree of new products technical progressiveness
Engineering preparation of manufacture	Engineering unification coefficient
	Engineering frequency coefficient
	Engineering standardization coefficient
	Engineering portability coefficient
	Share of synergetic engineering innovations
Technical stability	Basic funds tear coefficient
	Basic funds renewal coefficient
	Capital-labor ratio
	Equipment progressiveness level
	Renewal coefficient of basic funds active part
Technological preparation of manufacture	Specific weight of progressive technological processes in the total volume of new processes
	Specific consumption of materials
	Technological cost
	Materials use coefficient
	Specific weight of typical technological processes
	Level of mechanization and automation of manufacture processes Level of technological standardization and unifications
	Specific weight of technical processes certified in accordance with GOST ISO 9001
Personnel and organizational and management stability	Personnel professional level
	Average salary
	Coefficient of personnel turnover rate
	Periodicity of professional development
	Availability of obligatory social assurance
	Availability of corporate social assurance
	Level of past-due debt on remuneration of labor
	Conflict situations number
	Graichunas coefficient
	Organization reliability coefficient
Manufacture organization stage	Operation rate
	Capacity utilization rate
	Rythmical production coefficient
	Resource productivity coefficient
	Number of shifts down-time
	Efficiency of making and implementing management decisions
	Expenses for management in the total amount of expenses for manufacture
Organizational preparation of manufacture	Duration and structure of preparation cycle
	Level of parallelism and continuity of new equipment creation
	Level of works centralization and level of subdivisions specialization
	Specific weight of labor norms, covered by technical norm setting
	Level of employees' labor organization
	Efficiency of employees' moral and material stimulating
	Use of economic and mathematic methods and computing equipment in management work
Products manufacture stage	Workforce productivity (labor coefficient)
	Materials productivity (material coefficient)
	Capital productivity (capital coefficient)
	Number of current assets turnover
	Manufactured products volume
	Sold products volume
	Products cost
	Employees number
Financial soundness	Enterprise liquidity indicators
	Financial soundness indicators
	Enterprise business activity indicators
	Enterprise profitability indicators (according to the types)

management mechanism of making and implementing management decisions when the desired system state is defined on the basis of the prior management process (i.e. on the basis of the received experience) through following management indicators.

The paper suggests integral indicators of estimating the efficiency of the science-intensive manufacture adaptive management from the position of a value approach: the basic strategic criteria of the adaptive management functioning is positive dynamics of the fundamental enterprise cost; the tactic functioning criteria is stable fulfillment of the condition of non-negative value of economic value added cost; the integral indicator of estimating adaptive management on the operative level is stable support of the inherent profitability on the level being not less than medium.

The system of indicators developed to estimate the adaptive management efficiency of the science-intensive manufacture at the enterprise taking into account the life cycle of the science-intensive products is shown in Table 1. The system of indicators is a criteria base for making efficient decisions at all stages of the science-intensive product life cycle and contains the combination of basic characteristics that allow to estimate the level of products renewal, products specific weight corresponding to the world level, terms of new products output on the market, level of technical and technological progressiveness of products.

The suggested system will guarantee optimal materials consumption indicators, technological cost, manufacture cost, level of mechanization and automation of manufacture processes, labor organization level, capital-labor ratio, equipment progressiveness level, personnel professionalism level, etc. and allow to concentrate efforts of managers and specialists on forming the most important competitiveness indicators: quality, price, terms of new products output on the market, service provision convenience, exploitation cost. Another task of the suggested system is to increase the efficiency of the enterprise resources use on the basis of discovering and using internal reserves at all stages of the science-intensive product life cycle.

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