

MODELS AND ECONOMIC MECHANISMS OF THE COMPANY'S STAFF PROFICIENCY CONTROL AND MANAGEMENT

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The present article highlights the economic mechanisms, accorded due to the proficiency level, of the in-house control and management of professional knowledge which ensure and meet the economic interests of all the services, branches and the company's workers. The issue develops interrelation models for making decisions which describe the subject's behavior strategy in respect to selecting proficiency within the company which is regarded as the active system.

The conditions of competition set can lead to the emerging changes in the structure and influence of factors of competitiveness within the economy which is based upon certain knowledge. In order to achieve a long-term and competitive advantage the most significant attention is focused upon the factors of development which are created with the help of unique non-material resources which in their turn include knowledge and proficiency of the staff. That is why a special place within the way of how to solve the problem of the company's activity's efficiency development and improvement is devoted to the economic mechanisms of the company's staff proficiency control and management¹.

The basic objective of the economic mechanisms of the in-house proficiency control and management consists in coordination, with due accordance with the level of classification, of the economic interests of all the services, branches and the company's workers by pursuing its main aim – to achieve the stable and efficient functioning.

The difficulty of this problem's solution lies in the fact that the staff's (worker's) behaviour within the company is generally defined by a set of factors of moral, material (monetary), prestigious and psychological character. The formalization of some of these features is the very circumstance that leads to the notion "active system" and "active element". A worker and his/her presence precondition certain activity of the system while demonstrations of this very activity are quite diverse. The active element of the system is the element which has some interests (aims) and is capable of perverting or misinterpreting information and working with different efficiency.²

By the proficiency control and management we mean here the influence which is produced upon the staff (since they are active agents) in order to upgrade efficiency of their activities with due consideration of the company's own interests. By the coordinated control and management of the staff's professional development we mean here such an influence which ensures efficiency of the worker's activities particularly and the company on the whole.³ Consequently, the upgrade of qualification and proficiency should be profitable to all the elements of the system "director – staff".

Let us consider the company's activity and functioning which consists of the managing body-centre performing the management and control over the subordinate staff (agents). The strategy pursued by the agent is the choice of actions and proficiency types. On the other hand, the strategy which guides the centre is the choice of the product volumes as the final result of the company's activity as well as functions for stimulating the agents which in its turn depends upon actions and proficiency of every single agent. By action we mean here a variable that reflects the results of how the company's workers perform their professional duties.

Let us mark that $y_i \in Y_i$ is an action of i -agent, while $i \in N = \{1, 2, \dots, n\}$ is the set of

agents and $y = (y_1, y_2, \dots, y_n) \in Y = \prod_{i=1}^n Y_i$ is

the vector of the agents' actions.

Let us assume that i -agent is characterized by proficiency $r_i \in R_i$. The vector of knowledge level of all the agents is to be marked as $r = (r_1, r_2, \dots, r_n)$. Let the result of the compa-

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ny's activity z , consisting of n agents, is the function of their actions y level of knowledge r : . Interests of the centre and its agents are all expressed through their criterion function. The criterion function of the center $\Phi(\delta, r)$ is the difference between the revenue from selling of goods $H(z(y), r)$ and the overall expenses for stimulation $\delta(y, r)$ and for upgrading of proficiency :

$$\Phi(r, z) = H(z, r) - \delta(y, r) - \omega(r),$$

where $H(z, r) = u(r)z(y)$ is the revenue of the com-

pany; $u(r) = u_0 + k \sum_{i=1}^n (r_i - r_{0i})$ is the price the company's final product; $k > 0$ is the coefficient characterized by the rate of the price increase together with the increase of the company's staff proficiency; u_0 - is the initial price of product under the initial proficiency of the staff

$r_{0i}, i \in N$; $z(y) = \sum_{i \neq 1}^n y_i$ - the result of the com-

pany's activity; $\delta(y, r) = \sum_{i=1}^n \delta_i(y_i, r_i)$ - expenses for reward of the staff; $\delta_i(y_i, z_i)$ - the function

of stimulation of i -agent; $\omega(r) = \sum_{i=1}^n \omega_i(r_i)$ - direct expenses for upgrading of the company's staff proficiency; $\omega_i(r_i) = \frac{1}{2} \gamma_i (r_i - r_{0i})^2$ - direct expenses for upgrading of the i -agent's proficiency; $\gamma_i > 0$ - the coefficient which characterizes the increasing expenses along with the upgrading the level of qualification; r_{0i} - the initial level of i -agent's qualification.

As for the function of stimulation of i -agent $\delta_i(y_i, r_i)$ let us assume that it is made of two constituents: tariff which is paid depending upon the level of qualification and reward which in its turn depends upon the choice of professional action:

$$\delta_i(y_i, r_i) = \alpha_i r_i + \beta_i y_i, i \in N,$$

where $\alpha_i > 0, \beta_i > 0$ - the coefficients which characterize the rate of increasing stimulus depending upon the level of qualification and the chosen action.

The objective of the centre consists in selection and definition of certain optimal actions

for each agent and the level of their qualification which, combined, provide the maximum number of the criterion function. This very objective in a formalized form with due consideration of the accepted symbols and equation (2) is expressed in the following way:

$$\Phi(y, r) = [u_0 + k \sum_{i=1}^n (r_i - r_{0i})] \sum_{i=1}^n y_i - \sum_{i=1}^n (\alpha_i r_i + \beta_i y_i) - \sum_{i=1}^n \frac{1}{2} \gamma_i (r_i - r_{0i})^2 \xrightarrow{y, r} \max$$

$$r_{0i} \leq r_i \leq \bar{r}_i, \underline{y}_i \leq y_i \leq \bar{y}_i, i \in N,$$

where \bar{r}_i, \bar{y}_i - the upper limit of the level of qualification and actions of i -element; \underline{y}_i - the lower limit of actions of i -element.

As the equation of the criterion function of objective demonstrates (3), the level of qualification of the staff produces certain influence upon the formation of the product's price. This is due to the fact that the price depends upon the quality while the latter is preconditioned and ensured by the desired and according to the level of qualification. Consequently, the increase of the level of qualification is followed by the price and revenues of the centre, though at the same time there can be seen the increase of expenses for stimulation and training of the company's staff.

Making optimal decisions of the objective (3) means that it is necessary to calculate some partial derivatives of the centre's criterion function and the successful solution of this system in regard to the level of qualification and actions.

Thus, for example, taking into consideration the conditions of the optimality according to the level of qualification for i -agent:

$$\frac{\partial \Phi(y_i, r)}{\partial r_i} = k \sum_{i=1}^n y_i - \alpha_i - \gamma_i (r_i - r_{0i}) = 0, i \in N,$$

we may conclude that $\alpha_i = k \sum_{i=1}^n y_i - \gamma_i (r_i - r_{0i})$.

The economic interpretation of the disparity (4) consists of the following: the very first con-

stituent $k \sum_{i=1}^n y_i$ is the rate of increasing of profits and revenues together with the rate of the staff's proficiency increase, while the quantity α_i characterizes the rate of increasing expenses

for stimulation of i -agent depending upon the level of qualification and the third constituent $\gamma_i(r_i^0 - r_{0i})$ - the rate of increasing expenses for training of i -agent. In connection with this, the economic essence of the equality (5) consists in the centre's choice of the stimulating influence of i -agent α_i in accordance with the level of qualification is to be equal to the difference between the rate of the increasing revenues and profits and the rate of increasing expenses for training. At the same time this very difference is not to be negative while the criterion function is to be at its maximum rate provided that $r_i = r_i^0$.

If the disparity (4) is executed, the centre is interested from the economic viewpoint in upgrading the qualification up to the optimal value $r_i^0, i \in N$. Consequently, the optimal solution of the objective (3) is followed from the equation:

$$r_{ui}^0 = \begin{cases} r_{0i} + (k \sum_{i=1}^n y_i^0 - \alpha_i) / \gamma_i, & \text{если } k \sum_{i=1}^n y_i^0 - \alpha_i > 0, \\ r_{0i}, & \text{если } k \sum_{i=1}^n y_i^0 - \alpha_i < 0, i \in N \end{cases}$$

The centre, making the choice of stimulation influence upon every single i -agent, ensures the execution of the equality (4) and, in connection with this, providing extra profits and revenues together with the increasing level of qualification.

Under condition that

$$\frac{\partial \Phi(y_i, r)}{\partial y_i} = [u_0 + k \sum_{i=1}^n (r_i - r_{0i})] - \beta_i \geq 0, i \in N,$$

we are to find that $\beta_i \leq u_0 + k \sum_{i=1}^n (r_i - r_{0i}), i \in N$.

The very first constituent in the disparity

$$(7) [u_0 + k \sum_{i=1}^n (r_i - r_{0i})]$$

characterizes the rate of increasing revenues and profits of the centre together with the increase of the professional actions while the second one is the rate of increasing expenses for rewarding of i -agent. That is the reason why the centre is interested in increasing the actions, volumes of product output provided that the rate of its revenue increase is no less than the rate of increasing expenses along with their intensification.

The solution of the objective (3) about the selection of the optimal actions is followed from the equation:

$$y_{ui}^0 = \begin{cases} \bar{y}_i, & \text{если } [u_0 + k \sum_{i=1}^n (r_i - r_{0i})] - \beta_i \geq 0 \\ \underline{y}_i, & \text{если } [u_0 + k \sum_{i=1}^n (r_i - r_{0i})] - \beta_i < 0, i \in N \end{cases}$$

The received and calculated solution (8) implies that if the revenue is higher than expenses or equal to zero, the centre is aimed at sustaining actions at the upper limit \bar{y}_i , if in other case expenses for stimulation are higher than revenues, the centre is aimed at sustaining actions at the lower limit \underline{y}_i .

Consequently, the centre, choosing the function of stimulation for every single agent by means of setting its coefficients α_i, β_i , ensures execution of the equitation (4), the inequality (7) and getting the maximal value of the criterion function while realizing the strategy:

$$r_{ui} = r_{ui}^0, y_{ui} = y_{ui}^0, i \in N.$$

Therefore, the realization of the strategy (9) is only possible provided that every single agent is economically interested in its qualification and professional actions upgrade. In this connection, it is necessary to consider the strategy of the agents' behavior during the course of selecting the qualification level and actions, to describe its interrelations with the centre and, on this basis, to choose the mechanism of the staff's proficiency management and control which ensure the company's efficient functioning.

In order to define the conditions of the coordinated interrelations within the work there is a specially created model of the i -agent and qualification level objective choice in the following way:

$$f_i(\delta_i, r_i) = \delta_i(y_i, r_i) - C_i(y_i, r_i) \xrightarrow{y_i, r_i} \max$$

$$r_{0i} \leq r_i \leq \bar{r}_i, \underline{y}_{0i} \leq y_i \leq \bar{y}_i, i \in N,$$

where $C_i(y_i, r_i)$ - the function of expenses for i -agent depending upon the preferable level of qualification r_i and actions y_i .

During the work there is the following order of the company's functioning accepted and approved: the centre and the agents at the moment of making decisions upon the preferable strategies (functions of stimulation, actions, levels of professional knowledge) know the criterion functions and acceptable

sets of all the participants of the system. The centre that reserves the right of making the first step is to choose the functions of stimulation and inform the agents on that matter, after that the agents under the known functions of stimulation choose the actions and the level of qualification which combined maximize their criterion functions.

The general outline of the model of the agents' stimulation function choice objective is expressed in the following way:

$$\Phi(\delta(y, r), r) = H(z(y), r) - \sum_{i \in N} \delta_i(y_i, r_i) - \sum_{i \in N} \omega_i(r_i) \xrightarrow{r_i, y_i} \max$$

$$(r_i^0, y_i^0) = \text{Arg} \max_{r_i, y_i} [\delta_i(y_i, r_i) - C_i(y_i, r_i)],$$

$$r_{0i} \leq r_i \leq \bar{r}_i, \quad \underline{y}_{0i} \leq y_i \leq \bar{y}_i, \quad i \in N.$$

Let us consider one the possible approaches towards the solution of this objective. At the same time there is a suggestion that the expenses for every single agent $C_i(y_i, r_i)$ slow down under the increase of qualification. For instance, by increasing the level of qualification the agent is able to execute the same actions with lesser expenses or during the same period of time achieve greater quantitative results, or improve the quality of the output products and so on. Consequently, is necessary to develop and research the system of stimulation (motivation) which induces an agent to increase his/her professional level and actions.

Let us formulate the requirements in regard with the function of expenses for i -agent:

$$\forall r_i \in [r_{0i}, \bar{r}_i], \forall y_i \in [\underline{y}_i, \bar{y}_i]$$

- 1) $\frac{\partial C_i(y_i, r_i)}{\partial r_i} < 0$ - expenses slow down under the increase of the level of qualification;
- 2) $\frac{\partial C_i(y_i, r_i)}{\partial y_i} > 0$ - expenses increase under the increase of actions.

The example of the expenses function which meets all the enumerated above requirements is the following function:

$$C_i(y_i, r_i) = C_i^y(r_i)y_i + \frac{1}{2}C_i^r(r_i - r_{0i})^2 = [C_{0i} - d_i(r_i - r_{0i})]y_i + \frac{1}{2}C_i^r(r_i - r_{0i})^2,$$

where C_{0i} - cost per unit under the initial level of qualification of i -agent; $d_i > 0$ - the coefficient

which characterize the value of decrease of cost per unit together with increase of the level of qualification; $C_i^r > 0$ - the coefficient which characterize the rate of the increasing expenses along with upgrading of proficiency of i -agent.

The first requirement to the function of expenses is executed provided that the disparity is performed:

$$\frac{\partial C_i(y_i, r_i)}{\partial r_i} = d_i y_i \geq C_i^r (r_i - r_{0i}), \quad i \in N.$$

The economic essence of this disparity consists in that the rate of the specific expenses decrease, related to the choice of i -agent's action, is not to be less than the rate of the increasing expenses together with the increase of its level of qualification.

The second requirement is performed provided that the disparity is performed:

$$\frac{\partial C_i(y_i, r_i)}{\partial y_i} = C_{0i} - d_i(r_i - r_{0i})^2 > 0, \quad i \in N$$

i.e. the difference between the initial specific expenses and the value of their decrease along with the increase of the level of qualification is not to be the negative value.

With due consideration to the function of stimulation (2) and the expenses function (11) the model of qualification and actions level choice objective by i -agent will have the following form:

$$f_i(y_i, r_i) = \alpha_i r_i + \beta_i y_i - [C_{0i} - d_i(r_i - r_{0i})]y_i - \frac{1}{2}C_i^r(r_i - r_{0i})^2 \xrightarrow{y_i, r_i} \max$$

$$r_{0i} \leq r_i \leq \bar{r}_i, \quad \underline{y}_{0i} \leq y_i \leq \bar{y}_i, \quad i \in N.$$

The agent is economically interested in upgrading his/her level of qualification up to the value r_i^0 provided that for the coefficients of the criterion function the equality is executed:

$$\frac{\partial f_i(y_i, r_i)}{\partial r_i} = \alpha_i + d_i y_i - C_i^r (r_i^0 - r_{0i}) = 0$$

The economic essence of this very equality consists in that the sum of rates of increasing

rewards from the centre α_i and slowdown of the cost per unit $d_i y_i$ is to be equal to the rate of increasing expenses $C_i^f(r_i - r_{oi})$ together with increasing level of qualification.

One should mention that the execution of the equality (15) is done by means of choice by the centre of the coefficient of the increasing reward of an agent α_i for upgrading his/her level of qualification.

The solution of the objective (14) upon the choice of the optimal level of qualification is defined by the equation:

$$r_{Ai}^0 = \begin{cases} r_{oi} + (\alpha_i + d_i \bar{y}_i) C_i^f > 0, \\ \text{если } d_i \bar{y}_i \geq C_i^f (r_i^0 - r_{oi}), \\ r_{oi}, \text{ если } d_i \bar{y}_i < C_i^f (r_i^0 - r_{oi}), i \in N \end{cases}$$

The solution of the objective (14) upon the choice of the optimal action is defined by the correlation:

$$y_{Ai}^0 = \begin{cases} \bar{y}_i, \text{ если } \beta_i - [C_{oi} - d_i(r_i - r_{oi})] \geq 0, \\ \underline{y}_i, \text{ если } \beta_i - [C_{oi} - d_i(r_i - r_{oi})] < 0, i \in N \end{cases}$$

(16) and (17) follow that the strategy of the agents on the choice of level of qualifications and actions

$$r_{Ai}^0 = r_{oi} + (\alpha_i + d_i \bar{y}_i) / C_i^f, \\ y_{Ai}^0 = \bar{y}_i, i \in N$$

secures the maximum rate of their criterion functions while (6) and (8) follow that the strategy of the centre on the choice of levels of qualifications, actions of agents

$$r_{ui}^0 = r_{oi} + (k \sum_{i=1}^n \bar{y}_i - \alpha_i) / \gamma_i, \\ y_{ui}^0 = \bar{y}_i, i \in N$$

secures the maximum rate of the criterion function of the center.

In this article the mechanism of proficiency and actions management and control is called coordinated provided that agents are oriented for achieving the level of qualification and actions set and established by the center. This definition implies that the coordinated mechanism of management and control creates agents' interest in the choice of and realization of such

a kind of strategy on upgrading proficiency and actions which would be oriented for achieving both personal and centre's aims. The centre, choosing the parameters α_i and β_i of the function of stimulation (2), forms the coordinated mechanism of management and control according to the level of qualification.

With due regard to correlations between (5) and (16), (7) and (17) the range of parameters changes α_i, β_i is expressed through the following correlation:

$$(C_i^f (r_i - r_{oi}) - d_i \bar{y}_i) \leq \alpha_i \leq \\ \leq k \sum_{i=1}^n \bar{y}_i - \gamma_i (r_i^0 - r_{oi}), i \in N \\ C_{oi} - d_i (r_i - r_{oi}) \leq \beta_i \leq u_0 - \\ - k \sum_{i=1}^n (r_i^0 - r_{oi}), i \in N$$

The centre, choosing the values of parameters α_i, β_i of the function of stimulation $\delta_i(y_i, r_i)$ from the range of (18) and (19) creates economic conditions under which agents are interested in upgrading the level of qualification while for the centre its is profitable to stimulate them for the increasing proficiency and actions by means of guaranteeing rewards. The presence of the ranges of parameters changes α_i, β_i in form of closed region (18), (19) comes as the requirement to the mechanism of management and control of agents' proficiency which can be realized by changing the parameters of models of agents' (14) and the center (3) making decisions.

To sum it all up, the present article features development of interrelated models of making decisions which describe the strategies of the subjects' behavior according to their professional position within the company which is, in turn, considered as the active system; the models of formation of knowledge which are coordinated upon according to proficiency level as well as the mechanism of stimulation of the company's staff.

¹ Notin A.G. Features of management of knowledge within the network business-structures // Creative Economics, №11, 2008., pp. 9-11.

² Burkov V.N., Novikov D.A. Theory of active systems: present state and prospects. M.: Sinteg, 1999.

³ Vasilieva O.N., Zaskanov V.V., Ivanov D.Y., Novikov D.A. Models and methods of material stimulation (theory and practice) / Edited by Prof. V.G. Zaskanov and Prof. D.A. Novikov. M., 2007. 288 p.