ECONTECHMOD. AN INTERNATIONAL QUARTERLY JOURNAL – 2014. Vol. 1. No. 1. 75–80

Improving administrative management costs using optimization modeling

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Received January 15.2014: accepted February 20.2014

Abstract. It is important to determine the optimal level of administrative costs in order to achieve main targets of any enterprise, to perform definite tasks, to implement these tasks and not to worsen condition and motivation of the workers. Also it is essential to remember about strategic goals in the area of HR on the long run. Therefore, the main idea in using optimization model for assessing the effectiveness of management costs will be to find the minimum level of expenses within the given limits.
Key words: administrative costs, optimization model, levels of management.

INTRODUCTION

Optimization involves finding the best index of the selected function in a particular opportunity set. Thus the solution of the optimization model means finding its optimal solution or proving that there is no solution [3, 4, 8]. Optimization models are arranged in two categories: minimization problems and maximization problems. In our research, we will use the second category in order to find the optimal level of management costs for the enterprises of gas industry.

MATERIALS AND METHODS

The peculiarity of the formation of the optimization model is to determine the efficiency unit. We must install the effectiveness of administrative costs for the selected unit. Many recent studies on construction and solving of optimization models have focused on choosing such measurement units as: product unit, unit of cost, unit of sown area, etc. [5, 20]. However, it is not irrelevant to take into account these units of measurement as administrative costs are not included into production costs [10]. We therefore propose to calculate administrative costs per head of the company. Thereafter, the function will have the following expression:

$$F(x) \rightarrow min, \quad (1)$$

where: x – number of administrative employees.

However, the analysis of gas industry enterprises proves the importance of assessing the effectiveness of the administration costs on various levels of management, as there is a kind of asymmetry in terms of allocation of administrative expenses. Taking into account this problem we should specify the objective function as follows:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \rightarrow min, \quad (2)$$

where: a_1, a_2, a_3 – average amount of administrative costs per top manager, middle manager, low line manager accordingly, thousands of UAN; x_1, x_2, x_3 – number of top, middle and low line managers accordingly.

Further investigations are needed to choose the most important limits to solve the optimization model. The choice of factors depends on the main objectives and personnel management strategies as well as administration costs of the company. Analysis of the domestic gas sector companies showed the following priority objectives for HR management and administration costs, which can be displayed in the limits of the optimization model:

- development of chief executive officers, including their qualifications, practical skills, managerial skills

and competence [14], active participation in retraining, advanced training and re-qualification;

- rejuvenation of staff, particularly managers of industrial subdivisions;
- reducing losses because of making inaccurate management decisions and improving of management decisions in the company;
- increasing the loyalty of chief executive officers [1, 6, 9] and reducing the number and level of risk and risk of personnel activity [16];
- reducing the number of duplicate management structures, units and chiefs;
- improving the quality of labor input through the effective selection of personnel;
- reducing bureaucracy and corruption;
- increasing salaries and wages and reducing a number of employees;
- low turnover level of administrative employees;
- reducing administrative costs to raise competitive capacity of a company.

Thus we represent the schematic model of optimization of management costs at the enterprises of gas industry (Fig. 1).

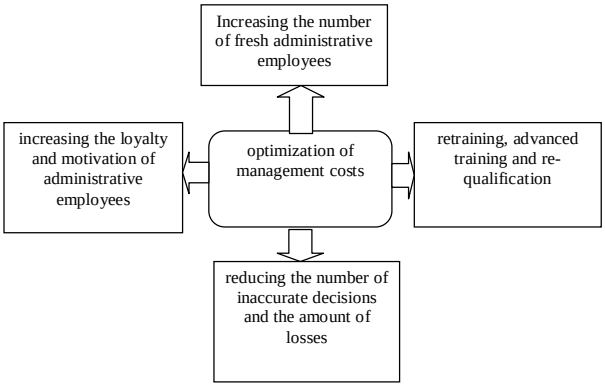

Fig.1. Directions of optimization of an enterprise management costs

The first limit to optimize administrative costs is a wages fund, which on the one hand should be as low as possible in order to reduce administrative costs and on the other one, it should be sufficient enough to meet the demands and to stimulate employees. The other aspects of the wages fund are to ensure sufficient loyalty of administrative employees, to avoid the loss of top managers, to create the decent staff reserve [2, 15]. Thereafter, the wages fund function will have the following expression:

$$b_1 x_1 + b_2 x_2 + b_3 x_3 \le D, \quad (3)$$

where: b_1, b_2, b_3 – average administrative costs for wages per top manager, middle manager, low line manager accordingly, D– wages fund.

According to the priority objectives in the field of personnel management and administrative management costs, it is important to ensure a continuous process of employees training. Any company budgets the expenditures on conducting of training. These limits will be as follows:

$$c_1 x + c_2 x + c_3 x \le K_{max}, \quad (4)$$

$$c_1 x + c_2 x + c_3 x \ge K_{min}, \quad (5)$$

where: c_1, c_2, c_3 – average management costs for training, advanced training and re-qualification of administrative employees; K_{min}, K_{max} – expenditures on training, advanced training and re-qualification of administrative employees, minimum and maximum accordingly.

A significant amount of administrative losses is associated with the correction of errors and defects as a result of inaccuracy of management decision-making. Therefore, we should set the maximum expenditure level that would be aimed to eliminate wrong decisions and minimize their number various levels of management. The amount of additional costs for revisal is the time spent on their average wages. The function will be as follows:

$$e_1 x_1 + e_2 x_2 + e_3 x_3 \le P, \quad (6)$$

where: e_1, e_2, e_3 – average management costs spent by top, middle and low line managers on elimination of the result of inaccurate management decisions; P – highest possible management costs spent on elimination of the result of inaccurate management decisions.

Studies have shown that loyalty of staff has a direct impact on productivity and the result of the company's activities. It is therefore important to increase staff loyalty and set clear limits on the level of expenditures on the following measures:

$$g_1 x_1 + g_2 x_2 + g_3 x_3 \le L, \quad (7)$$

where: g_1, g_2, g_3 – average expenditures for increasing the level of loyalty of top, middle and low line managers; L – highest possible level of expenditures on increasing the level of loyalty of administrative employees of the company.

In general, proposed optimization model will be as follows:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \to min,$$
$$\begin{cases} b_1 x_1 + b_2 x_2 + b_3 x_3 \le D \\ e_1 x_1 + e_2 x_2 + e_3 x_3 \le P \\ g_1 x_1 + g_2 x_2 + g_3 x_3 \le L \\ c_1 x_1 + c_2 x_2 + c_3 x_3 \le K_{\max} \\ c_1 x_1 + c_2 x_2 + c_3 x_3 \ge K_{\min} \end{cases} \quad (8)$$

In present years, researchers have become increasingly unanimous in declaring that there is no balance between different levels of management costs. Particularly, they are more considerable and often unnecessary at the top levels of management and significantly lower than it is should be at the middle and lowest line levels of management of gas industry enterprises. Especially, this misbalance is observed with the administrative costs of the state gas producing companies. Therefore, the objective function will remain

the same as in the previous optimization model. Only limits will be changed for the optimization model:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \rightarrow min. \quad (9)$$

The system will consist of six inequalities that set the maximum and minimum amount of administrative costs for the three levels of management - institutional, administrative and manufacturing [11,12,13]. Expenditures are planed and budgeted by the administration of the company. It is possible to establish the amount of administrative costs for each level of management by an expert way. Hereby, the amount of management costs of each level of management should provide staff development for each of the studied levels and motivate to perform their tasks and goals on the one hand, but on the other hand, it should eliminate duplication, bureaucracy, corruption in the system of management at the enterprises of gas industry. The system of limits can be written as follows:

$$\begin{cases} l_1 x_1 + l_2 x_2 + l_3 x_3 \geq R_1 \\ l_1 x_1 + l_2 x_2 + l_3 x_3 \leq R_2 \end{cases}, \quad (10)$$

where: R_1, R_2 – minimum and maximum amount of administrative costs for providing the work of administrative employees at the institutional, administrative and manufacturing (technical) level; l_1, l_2, l_3 –amount of administrative costs per top manager, middle manager, low line manager accordingly.

The process of balancing of administrative costs can be carried out not only with aggregate expenditure of each management level but also with the elements of management costs to ensure stable work of each level of management at the enterprises of gas industry. Our research will explore how to balance administrative costs at three levels of management: material costs, wage bill, amortization, cost of social charges and other administrative costs. These costs at different levels of management will have different amount. Therefore, the proposed model will be as follows:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \rightarrow min,$$

$$\begin{cases} d_1 x_1 + m_1 x_1 + z_1 x_1 + s_1 x_1 + f_1 x_1 \geq R_{11} \\ d_1 x_1 + m_1 x_1 + z_1 x_1 + s_1 x_1 + f_1 x_1 \leq R_{12} \\ d_2 x_2 + m_2 x_2 + z_2 x_2 + s_2 x_2 + f_2 x_2 \geq R_{21} \\ d_2 x_2 + m_2 x_2 + z_2 x_2 + s_2 x_2 + f_2 x_2 \leq R_{22} \\ d_3 x_3 + m_3 x_3 + z_3 x_3 + s_3 x_3 + f_3 x_3 \geq R_{31} \\ d_3 x_3 + m_3 x_3 + z_3 x_3 + s_3 x_3 + f_3 x_3 \leq R_{32} \end{cases}, \quad (11)$$

where: d_1, d_2, d_3 – management costs for wages of top, middle and low line management levels; m_1, m_2, m_3 – material management costs for providing the work of top, middle and low line managers; z_1, z_1, z_3 – amortization of assets and facilities used for the activities of top, middle and low line management levels; s_1, s_2, s_3 – costs on social payroll at top, middle and low line management levels; f_1, f_2, f_3 – other management costs for providing the work of top, middle and low line managers.

We should also develop database to record administrative management costs. Thus, the use of ABC analysis is intended to allocate costs in accordance with the activities of management and to identify factor that influence these costs [7, 19]. Thereby, ABC analysis or also called functional and value analysis [17], allows us to track the connections between expenditures and their reasons.

Having examined the peculiarities of activities of the enterprises of gas industry, it is reasonable to set the appropriate grouping of departments of management according to the joint functions. We can specify the following centers: the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the research centre, the centre of manufacturing service, the centre of personnel management.

1. The finance and economic centre (accounting department, planning and economic department, financial department, investment department);

2. The centre of production (manufacturing department, technical department, drilling department, the department of capital construction);

3. The centre of legal aid and monitoring (law department, safe-custody department, internal audit department);

4. The centre of manufacturing service (department of chief engineer, department of purchasing, administration department and secretariat, the department of power and water supply, department of occupational safety and health, department of information support and computer service);

5. The research centre (department of geology, laboratories, budgeting department);

6. The centre of personnel management (department of work organization and wages, personnel department).

It is important to identify factors that impact the expenses of the selected centers in the process of their formation. The factors of expenditures of the finance and economic centre can be the number and size of reports (administrative and financial), the number of documents that needs processing , organization of record-keeping, the number of mistakes and errors made by employees and identified in the process of different revisions, the amount of fines imposed due to errors of employees.

The factors of expenditures of the centre of production can be the number of oil wells, the regional location of oil fields, and the production volume of gas, oil and other related products. It is necessary to introduce the value coefficient of complexity and the level of infrastructure development of the area where energy resource are mined.

The factors of expenditures of the centre of legal aid and monitoring can be payment discipline, reliability of suppliers and contractors, the level of prevention of theft

and abuse, the amount of leakage of commercial information and the level of losses due to it, the level of physical and psychological protection of workers (measured in points by inquiry).

The factors of expenditures of the centre of manufacturing service can be the number of suppliers, the regional location of facility, the size of suppliers and supply chains length, width of supply chains, infrastructure of the area, the number of discounts and amount of resource savings obtained as a result of discounts.

The factors of expenditures of the research center can be the number of projects, the number of objects of geological research, the complexity of geological research, peculiarities of projects accomplishing (joint activity, economic way, and outsourcing), the number of confirmed reserves and successful projects.

The factors of expenditures of the centre of personnel management can be the number of personnel, qualifications and structure of staff, turnover rate of personnel, experience in the company and the industry, the amount of documentary support for each of the employees, the number of training programs and advanced training courses, their frequency and methods of their conduct (internal, inviting outside experts/trainers and mixed), the number of social programs and programs of developing loyalty in the staff.

Having divided administrative management costs into the groups of the centres, we may follow their dynamics in accordance with the factors of expenditures. For example, we may trace the change of expenditures of the finance and economic centre in case of the introduction of a new accounting program or electronic document control, the change of expenditures of the centre of manufacturing service in case of closing down the parts of wells temporarily, the change of expenditures of the centre of personnel management in case of changing the number of employees, etc. In addition, this division will help to optimize management costs, to balance them between centres, to save costs, to improve the structure of organizational management and to develop the company.

Certainly, the expenditures of the centres can not proportionally be altered according to changes in the factors of expenditures, and it is obvious that the change takes time. The changes happen with some delay, there are lags. It is important to consider the time factor while finding the connection between the amount of expenditures and factors influencing them [18].

It is important to create a sharp system of organizational and informational support to administer management costs for the responsibility centres. We suggest appointing responsible persons to the centres to ensure a high level of administration (they can be deputy chief in the functional areas). They should be in charge of performing system monitoring the level and the pattern of expenditures (previous, current and final) according to changes in the factors related to the centres of administration management costs.

The proposed division into centres of administration management costs can be used to construct an optimization model to balance administrative costs. This criterion of separation of administrative costs determined the structure and quality of the staff in each of the proposed centres. Therefore, the proposed model will be as follows:

$$q_1y_1 + q_2y_2 + q_3y_3 + q_4y_4 + q_5y_5 + q_6y_6 \to min, \quad (12)$$

where: q_1, q_2, q_3, q_4, q_5, q_6 – average amount of management costs per workers in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; y_1, y_2, y_3, y_4, y_5, y_6 – average number of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management.

Limits of the optimization model should be formed according to expenditures for providing the work of each of the established centres for administration of management costs. Therefore, the system of limits will be as follows:

$$\begin{cases} d_{c1}y_1+m_{c1}y_1+z_{c1}y_1+s_{c1}y_1+f_{c1}y_1 \le \Psi_1 \\ d_{c2}y_2+m_{c2}y_2+z_{c2}y_2+s_{c2}y_2+f_{c2}y_2 \le \Psi_2 \\ d_{c3}y_3+m_{c3}y_3+z_{c3}y_3+s_{c3}y_3+f_{c3}y_3 \le \Psi_3 \\ d_{c4}y_4+m_{c4}y_4+z_{c4}y_4+s_{c4}y_4+f_{c4}y_4 \le \Psi_4 \\ d_{c5}y_5+m_{c5}y_5+z_{c5}y_5+s_{c5}y_5+f_{c5}y_5 \le \Psi_5 \\ d_{c6}y_6+m_{c6}y_6+z_{c6}y_6+s_{c6}y_6+f_{c6}y_6 \le \Psi_6 \end{cases}, \quad (13)$$

where: d_{c1}, d_{c2}, d_{c3}, d_{c4}, d_{c5}, d_{c6} – managements costs for payment for administrative employees work in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; m_{c1}, m_{c2}, m_{c3}, m_{c4}, m_{c5}, m_{c6} – financial management costs for providing the work of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; z_{c1}, z_{c2}, z_{c3}, z_{c4}, z_{c5}, z_{c6} – amortization of assets and facilities used for the activities of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; s_{c1}, s_{c2}, s_{c3}, s_{c4}, s_{c5}, s_{c6} – costs on social payroll for administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; f_{c1}, f_{c2}, f_{c3}, f_{c4}, f_{c5}, f_{c6} – other management costs for

providing the work of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; $\Psi_1, \Psi_2, \Psi_3, \Psi_4, \Psi_5, \Psi_6$ - maximum level of management costs to provide the work of the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management.

In such a model it should also be established the minimum amount of management costs to ensure the performing of necessary tasks and work. Therefore, the model takes the following form:

$$\begin{cases} c_1 \le d_{c1}y_1 + m_{t1}y_1 + z_{c1}y_1 + s_{c1}y_1 + f_{c1}y_1 \le \Psi_1 \\ c_2 \le d_{c2}y_2 + m_{t2}y_2 + z_{c2}y_2 + s_{c2}y_2 + f_{c2}y_2 \le \Psi_2 \\ c_3 \le d_{c3}y_3 + m_{t3}y_3 + z_{c3}y_3 + s_{c3}y_3 + f_{c3}y_3 \le \Psi_3 \\ c_4 \le d_{c4}y_4 + m_{t4}y_4 + z_{c4}y_4 + s_{c4}y_4 + f_{c4}y_4 \le \Psi_4 \\ c_5 \le d_{c5}y_5 + m_{t5}y_5 + z_{c5}y_5 + s_{c5}y_5 + f_{c5}y_5 \le \Psi_5 \\ c_6 \le d_{c6}y_6 + m_{t6}y_6 + z_{c6}y_6 + s_{c6}y_6 + f_{c6}y_6 \le \Psi_6 \end{cases}, \quad (14)$$

where: $C_1, C_2, C_3, C_4, C_5, C_6$ - minimum level of management costs to provide the work of the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management.

We will find the solution of this model using the data of the gas manufacturing department "Lvivhazvydobuvannya". The function with data will be written as follows:

$$156457y_1 + 160963y_2 + 129917y_3 + 141060y_4 + 146912y_5 + 177716y_6 \; min,$$

$$\begin{cases} 3730904 \le 156457\, y_1 \le 5577701 \\ 2971625 \le 160963 y_2 \le 4442579 \\ 1299171 \le 129917\, y_3 \le 1942261 \\ 4991342 \le 141060 y_4 \le 7462057 \\ 2373190 \le 146912 y_5 \le 3547919 \\ 956933 \le 177717 y_6 \le 1430616 \end{cases}. \quad (15)$$

RESULTS

The solution of the optimization model makes it possible to establish the crucial number of employees for each of the centres of administration management costs: the finance and economic centre - 23 persons, the center of production - 18 persons, the centre of legal aid and monitoring - 10 persons, the centre of manufacturing service - 35 persons, the research centre - 16 persons, the centre of personnel management - 6 persons.

Our research has proved that this number of administrative employees will lead to reduction of expenditures and the number of managerial staff by combining the individual functions and optimization of interaction processes. The quality and amount of work performed will not be reduced, and in some centres will be increased by improving the social and psychological environment, eliminating duplication of functions, decentralizing operations and improving of productivity. Our research has revealed that reduction of the staff is: the finance and economic centre - 8 persons, the center of production - 4 persons, the centre of legal aid and monitoring - 4 persons, the centre of manufacturing service - 11 persons, the research centre - 5 persons, the centre of personnel management - 1 person. Total staff reduction may reach 28 % and reduction of management costs by 30%.

CONCLUSIONS

Optimization models will enable managers to balance the functioning of different levels of administrative employees, to optimize management costs, and thus to increase productivity and staff loyalty, to reduce economic risks and turnover rate of personnel, to develop staff reserve and to improve other financial and economic indicators of enterprises. We have elaborated the model of optimization of management costs spent by top, middle and low line managers, composed the optimization model for the three levels of management - institutional, administrative and manufacturing. Using ABC analysis, another optimization model has been formed to administer management costs at the basis of specialized centres: the finance and economic centre, the center of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre, the centre of personnel management.

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