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Optimization model of motivational process as a basis of management decisions

T L Bezrukova¹, S S Kirillova¹, Kuznetsov S A¹, Pecherskaya O A¹

¹Voronezh State University of Forestry and Technologies named after G.F. Morozov, 394087, 8, Timiryazeva str., Voronezh, Russian Federation

bezrukova_t_l@mail.ru

Abstract. Management decision making is based on an assessment of employee performance and is an essential management practice for any organization, because employee progress is important for improving the efficiency and development of each organization. The study is aimed at identifying the dependencies which take into account all the factors contributing to the improvement of quality and productivity of labor, in other words, identifying the features of motivational process building that contributes to effective management. The assessment has been carried out using correlation analysis of indicators for assessing the interrelationships of the motivational process factors to create an optimization model as the basis for making adequate management decisions using the example of furniture industry enterprises. The optimization model proposed in the article connects motivation of employees with the effectiveness of organization in making effective management decisions.

1. Introduction

In modern conditions, the issues of motivational process optimization in industrial enterprises are particularly important, since management decisions are largely dependent on how well the staff is satisfied with the work and existing working conditions. Saving money on motivating and incentives negatively affects the development of any enterprise. [1]

The efficiency of industrial enterprises is determined by the goals and interests of management, and the goals and interests of employees. If the main task of a manager is making profit and success in the market, then the main task of an employee is to get the maximum reward for his/her work and realization of personal interests. [2] At the same time, recognizing the personal interests of employees and upgrading the efficiency of the work are serious problems in motivational process optimization which is a basis for management decisions.

Issues of optimization of the motivational process are one of the most significant problems. These issues are of great importance for Voronezh furniture industry enterprises. To date, enough attention has been given to the problems of motivation and many papers have been published on this topic. [3] A large number of existing theories of motivation are divided into two categories: content and process ones. The theories of A Maslow, D McClelland, F Herzberg, C Alderfer and others were wide-spread among the content theories, the theories of K Levin, V Vrum, S Adams, Porter-Lawler, D MacGregor and others were wide-spread among the process theories. Among the works of domestic scientists studies of the motivational process by V A Yadov, A G Zdravomyslov, V P Rozhin, A N Leontyev, N F Naumova, I F Belyaeva and others should be noted. [4]

However, the issues of motivational process optimization as the basis of management decisions are poorly developed. Therefore, the development of an optimization model of motivational process as the basis of management decisions (on the example of furniture industry) is quite relevant.

2. Theoretical, Informational, Empirical, and Methodological Grounds of the Research

Various factors influence personnel motivation, but material factor has the highest ranking, as a result of which material motivational effect is of particular relevance. There are many definitions of



motivation. Motivation refers to the instinctive component of human behavior. Mental concept of the human will does not significantly affect motivation. It is also believed that motivation is the cause of bodily reactions of the organism in response to external influences. Unconscious behavior of people is a reaction to an external stimulus. [5] Motivation arises with changes in internal needs of the body, and its formation is influenced by expectations about the future. The nature of labor norms and values acquired by an individual is of great importance for the formation of labor motivation.

For competent management decision-making in an enterprise, it is necessary to identify specific needs that motivate its employees with an offer of optimal remuneration that would help the employee to meet these needs, bearing in mind personal characteristics of individual's needs. [6]

Process motivation theories primarily rely on the perception and cognition of people. [7] Therefore, the task of a competent leader, according to these theories, should be expressed in effective time distribution of rewards and punishments with provision of continuous reinforcement of the employee.

The main attention should be paid on the analysis of factors which form the basis of motivation. Based on several surveys, we have obtained the following results of the most significant factors in the work activity of furniture industrial enterprises in the Voronezh Region. Analysis of wide range of managers and employees of furniture industry enterprises, from small to large ones, has been conducted. The analysis has shown that their indicators differ incomparably.

Labor efficiency (LE) is a function that establishes a relationship between input and output values through parameters. Input value parameters (x) make production output: x_1 – financial resources spent on material incentives; x_2 – cost of production; x_3 – level of motivation of top, middle and lower managers (from 0 to 1); x_4 – level of workers' motivation (from 0 to 1); x_5 – number of motivated workers; x_6 – number of unmotivated workers; x_7 – wages fund; x_8 – wages fund of motivated workers. Input value parameters (a) make an assessment of the enterprise activity, i.e. profit: a_1 – labor efficiency of motivated workers; a_2 – labor efficiency of unmotivated workers; a_3 – percent of defective goods (level of complaints).

It is reasonable to start with correlation analysis and use the data to create an optimization model of the motivation process on the example of furniture industry enterprises.

3. Results

Correlation analysis is considered to be the most natural and mathematically sound method for assessing the relationship between the indicators of the studied system. [8]. Pearson correlation coefficients for pairs of indicators of furniture industry enterprises have been calculated using the following formulas:

$$r_{xy} = \frac{\sum_{i=1}^n [(x_i - \bar{x}) \cdot (y_i - \bar{y})]}{(n-1) \cdot \sigma_x \cdot \sigma_y}, \quad (1)$$

Where x_i and y_i – values of indicators of industrial enterprises, between which the correlation for the i -th quarter is determined; r_{xy} – correlation coefficient of x and y indicators (hereinafter r abbreviation is used); n – total number of quarters for all surveyed enterprises for which x and y are known; $\bar{x}$ and $\bar{y}$ – assessments of average values of the indicators determined by the formulas

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i; \quad \bar{y} = \frac{1}{n} \sum_{i=1}^n y_i; \quad (2)$$

σ_x and σ_y – standard deviations of the indicators, calculated as follows:

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}; \quad \sigma_y = \sqrt{\frac{\sum_{i=1}^n (y_i - \bar{y})^2}{n-1}}. \quad (3)$$

Further analysis should take into account that the Pearson correlation coefficient [9] may take values from -1 to 1 . The more pronounced relationship between the indicators, the greater the absolute value of the correlation coefficient is. Nature of relationship indicators can be judged on the sign of the correlation coefficient: when $r > 0$ the relationship is direct one (with an increase in x indicator, y indicator also increases), when $r < 0$ the relationship is inverse one (with an increase in x indicator, y indicator decreases) (formula 4). When calculating the correlation coefficients, their statistical significance is evaluated at the same time, that is, the sufficiency of the initial data for establishing the correlation with a given level of confidence. The condition of the statistical significance of the correlation coefficient with p level is as follows:

$$|r_{xy}| \sqrt{\frac{n-2}{1-r_{xy}^2}} > t_{1-p/2}^{n-2}, \quad (4)$$

Where $t_{1-p/2}^{n-2}$ – critical value of the Student's coefficient which is given for a number of degrees of freedom $(n - 2)$ and level of significance p . Further, only statistically significant correlations with the level $p = 0.05$ (correlations are reliable when the value is not less than 95 %) are considered.

In this paper, the matrix of correlation coefficients and significance levels are calculated using STATISTICA 10 program.

Table 1 has been prepared for the correlation analysis, in which indicators for each of the seven furniture industry enterprises are filled over five years. Thus, the size of the analyzed table is 35 rows (7 organizations $\times$ 5 years) with 16 columns. The correlation coefficients are presented in table 1, where all calculated coefficients are indicated above the main diagonal, and coefficients for only statistically significant correlations are below the main diagonal. The numbers of furniture industrial enterprises of the Voronezh Region which are shown in the cells of the table: 1 - Anstrem, LLC, PC, 2 - Furniture of Chernozemye, LLC, CC, 3 - Somovo-Mebel, LLC, 4 - Gefest-Mebel, LLC, 5 - Lux-Hall, LLC 6 - Furniture for Office, LLC, 7 - Grafskaya Kitchen, LLC, and for which correlation between these indicators is statistically significant. A minus sign is placed after the enterprise number for inverse correlations. Cells are darkened if the most number of enterprises (four or more) have statistically significant correlations of these indicators.

The more numbers in the cells of table 1, the more common is the dependence of the corresponding pair of indicators for furniture industry enterprises. The most common are the correlations that are simultaneously found in five or more of the seven enterprises (the darkened cells in table 1).

From non-obvious correlations (disregarding the effect of time t), the following ones can be distinguished: with an increase in the size of material incentives C_m , revenue R and production cost PC increases; with an increase in the wage fund W_i , revenue R and production cost PC increase; increase in labor productivity of unmotivated workers LE_{uw} leads to an increase in revenue R and the cost of production PC .

However, statistically significant correlations of the total correlation matrix (table 2) are in good agreement with general correlations in table 1.

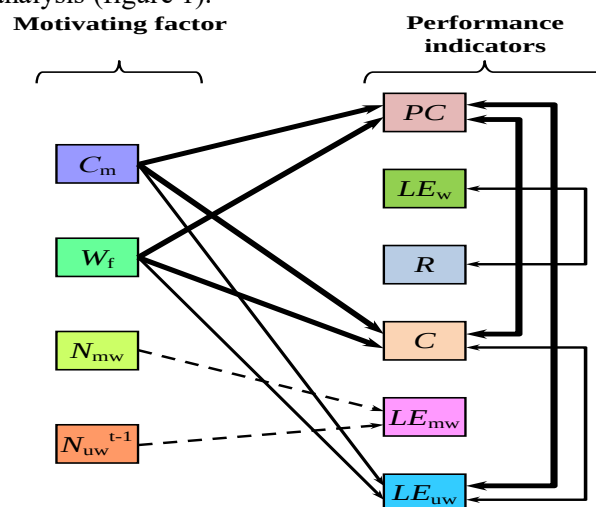
Table 1. General correlations for the analyzed furniture enterprises.

Indicators	Indicators														
	<i>t</i>	<i>R</i>	<i>LE_w</i>	<i>N_w</i>	<i>R</i>	<i>C_m</i>	<i>PC</i>	<i>K_m</i>	<i>K_w</i>	<i>N_{mw}</i>	<i>N_{uw}</i>	<i>W_f</i>	<i>W_{fmw}</i>	<i>LE_{mw}</i>	<i>LE_{uw}</i>
<i>t</i>	1.00														
<i>R</i>	1-, 5-, 7-	1.00													
<i>LE_w</i>	4	3	1.00												
<i>N_w</i>	3-, 7-	4, 7		1.00											
<i>R</i>	7-	3, 6-	1, 2, 3, 7		1.00										
<i>C_m</i>	1-, 3-, 4-, 5-, 6-, 7-	1, 4, 5, 6, 7		1, 3, 4, 7	6-	1.00									
<i>PC</i>	1-, 5-, 7-	1, 2, 3, 4, 5, 6, 7	3	4, 7	3, 6-	1, 4, 5, 6, 7	1.00								
<i>K_m</i>	5-, 6	7		3, 7	5	3, 7	7	1.00							
<i>K_w</i>			1		1			5	1.00						
<i>N_{mw}</i>	5-, 7-	4, 5, 7	1	2, 4, 7		4, 7	4, 7	3, 5, 7	1, 5, 6	1.00					
<i>N_{uw}</i>	1-, 3-, 7-	1, 4, 7	5-	3, 4, 7		1, 3, 4, 7	1, 4, 7	7		4, 7	1.00				
<i>W_f</i>	1-, 3-, 4-, 5-, 6-, 7-	1, 4, 5, 6, 7		1, 3, 4, 7	6-	1, 0	1, 4, 5, 6, 7	3, 7		4, 7	1, 3, 4, 7	1.00			
<i>W_{fmw}</i>	4-, 5-, 7-	4, 5, 7		2, 3, 4, 7		2, 3, 4, 7	4, 7	3, 5, 7	5	3, 4, 5, 7	4, 7	2, 3, 4, 7	1.00		
<i>LE_{mw}</i>		4, 6, 7-		4, 5, 7-	6-	4, 6, 7-	4, 6, 7-	1-, 3-	1-	1-, 3-, 4, 7-	4, 7-	4, 6, 7-	3-, 4, 7-	1.00	
<i>LE_{uw}</i>	5-	2, 4, 5, 6, 7-		4, 7-	6-	4, 5, 6, 7-	2, 4, 5, 6, 7-		5	4, 5, 7-	3-, 4, 7-	4, 5, 6, 7-	4, 5, 7-	4, 6, 7	1.00

Table 2. Correlation matrix for the seven analyzed enterprises.

Indicators	Indicators														
	t	R	LE_w	N_w	R	C_m	PC	K_m	K_w	N_{mw}	N_{uw}	W_f	W_{fmw}	LE_{mw}	LE_{uw}
t	1.00	-0.12	0.12	-0.15	0.08	-0.22	-0.14	-0.09	0.00	-0.05	-0.20	-0.28	-0.16	-0.14	-0.11
R		1.00	0.61	0.62	0.43	0.73	0.99	0.39	0.29	0.56	0.70	0.69	0.57	0.80	0.85
LE_w		0.61	1.00	0.28	0.87	0.31	0.57	0.20	0.23	0.27	0.31	0.28	0.24	0.39	0.60
N_w		0.62		1.00	0.16	0.84	0.66	0.45	0.32	0.81	0.86	0.88	0.81	0.30	0.38
R		0.43	0.87		1.00	0.25	0.40	0.36	0.41	0.25	0.14	0.16	0.22	0.20	0.48
C_m		0.73		0.84		1.00	0.79	0.67	0.58	0.93	0.81	0.94	0.96	0.35	0.53
PC		0.99	0.57	0.66	0.40	0.79	1.00	0.44	0.33	0.62	0.74	0.74	0.63	0.77	0.83
K_m		0.39		0.45	0.36	0.67	0.44	1.00	0.93	0.74	0.33	0.51	0.72	0.08	0.48
K_w					0.41	0.58		0.93	1.00	0.70	0.19	0.38	0.67	-0.01	0.43
N_{mw}		0.56		0.81		0.93	0.62	0.74	0.70	1.00	0.71	0.85	0.98	0.11	0.40
N_{uw}		0.70		0.86		0.81	0.74			0.71	1.00	0.94	0.72	0.46	0.44
W_f		0.69		0.88		0.94	0.74	0.51	0.38	0.85	0.94	1.00	0.89	0.36	0.44
W_{fmw}		0.57		0.81		0.96	0.63	0.72	0.67	0.98	0.72	0.89	1.00	0.13	0.39
LE_{mw}		0.80	0.39			0.35	0.77				0.46	0.36		1.00	0.84
LE_{uw}		0.85	0.60	0.38	0.48	0.53	0.83	0.48	0.43	0.40	0.44	0.44	0.39	0.84	1.00

A diagram of the mutual influence of indicators of furniture industry enterprises has been built based on the correlation analysis (figure 1).

**Figure 1.** Diagram of the influence of motivating factors on the performance indicators of furniture industry enterprises

Correlations of indicators provide information about the nature of management of furniture industry enterprises [10], which may be the initial data for building an optimization model of the motivational process as the basis of management decisions.

Table 1 and table 2 have been used in scheme construction, summarizing information on the mutual influence of indicators for various enterprises.

Figure 1 shows thick and thin lines, which, respectively, show strongly and weakly expressed relationships. Solid and dashed lines show direct (with an increase in one indicator - the second also increases) and reverse (with an increase in one indicator - the second decreases) interrelations.

This scheme of interconnection can be taken as the basis for developing an optimization model of the motivational process as the basis of management decisions. With an increase in the share of motivated workers among all workers, an increase in the efficiency of the enterprise can be expected.

4. Conclusions and recommendations

With the increase in the number of motivated workers N_{mw} revenue R and labor efficiency LE of motivated workers LE_{mw} increase according to the square law.

Thus, the increase in the share of motivated workers leads to a significant square growth of the financial results of the furniture industry enterprise as an effective basis for taking right management decisions.

Matrix to assess motivation and incentives is built based on the developed optimization model, and then the following management solutions are offered (table 3).

Table 3. Management decisions depending on the degree of motivation and incentives

Management decision	Actions depending on the degree of effectiveness of the system of motivation and incentives
Management decision 1.	Ineffective motivation This combination of factors indicates critical state of the enterprise The following set of measures is recommended: 1) To improve the system of motivation and incentives 2) To introduce motivation criteria
Management decision 2.	Weak motivation This combination of factors indicates insufficiently developed system of motivation and incentives at the enterprise The following set of measures is recommended: 1) Maintenance and improvement of the current system of motivation and incentives 2) Product-line expansion
Management decision 3.	Effective motivation This combination of factors indicates the accuracy of enterprise performance The following set of measures is recommended: 1) Maintenance and improvement of the current system of motivation and incentives
Management decision 4.	Highly effective motivation This combination of factors indicates absolutely accurate and well-built system of motivation and incentives. No recommendations.

From this the following conclusions can be made:

- It is advisable to motivate the largest possible share of employees to improve the efficiency of the enterprise;
- If some of the workers are already motivated, it is advisable to use motivating measures for

another share of the workers, since financial indicators increase with increasing N_{mw} according to a stronger law than linear one;

- If the number of motivated employees is small (less than 20%), the company's financial indicators are extremely low or negative.

Increase in the number of motivated workers N_{mw} linearly leads to an increase in the cost of production PC. A non-obvious pattern has been found: with an increase in the share of motivated workers, starting from 10-20%, the productivity of unmotivated LE_{uw} workers increases significantly according to a square law.

The influence of motivating factors on management decisions has been revealed using correlation analysis.

Correlation analysis has led to the following conclusions:

- Revenues and cost of production increase with an increase in the size of material incentives and wage fund;

- Increase in labor productivity of unmotivated workers is directly related to the growth of revenues and production cost.

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