Organizational Factors of Labor Productivity Growth: A Statistical Aspect

Ekaterina Anatolevna Grigoreva[1], Elvira Anasovna Polovkina[2] and Liliya Kabirovna Astafyeva[3]
[1]*Associate Professor, Institute of Management, Economics and Finance/Department of Economic Theory and Econometrics, Kazan Federal University Russia.*
[2]*Institute of Management, Economics and Finance/Department of Economic Theory and Econometrics, Kazan Federal University Russia.*
[3]*Associate Professor, Head University/Institute of Management, Economics and Finance/Department of Economic Theory and Econometrics, Kazan Federal University Russia.*

ABSTRACT: The paper gives an assessment of the influence of organizational factors on labor productivity growth. At the present stage of economic development, the main source of increasing output is the growth of labor productivity. There are two main ways that determine the growth of labor productivity: an increase in the technical level of production; improving the organization of production, labor and management. The aim of the study is to assess the role of organizational factors in labor productivity growth which currently play an important role in increasing production efficiency. This study was conducted with the help of motion studies, the ratio-delay method and stop-watch reading. Correlation dependence of workers' labor productivity on factors of labor organization is revealed. The analysis of the indicators aimed at organizational factors to receive the greatest gain of labor productivity is carried out.

Keywords: labor productivity, working hours, moment observations method, intra replaceable losses, photo of the working day, regression analysis, multiple correlation.

I. INTRODUCTION

In modern conditions there is increasingly serious influence on economic activity of the enterprises and the organizations around the world, the electronic business which is based generally on modern Internet technologies and mobile telecommunication technologies. Electronic business is not limited to purely technological issues; it has significant effect on the strategy of economic activity of any enterprise [1].

Development of electronic business by the enterprise significantly changes business conditions. Development of information technologies stimulated development of rather large number of different type systems of electronic commerce which together with corporate information systems find effective application in a rather wide range of the enterprises' business processes.

At the present development stage of managing the main source of increase in the output labor productivity is growth. In many spheres of economic activity increase in labor productivity is inseparably linked to the use of electronic business technologies. In this regard the comprehensive analysis of the factors forming labor productivity level, and allocation of them, which in the conditions of the separate enterprises or branches are decisive [2], is necessary.

It is possible to allocate two main directions causing labor productivity growth: increase in technological level of production; improvement of the production organization, work and management. The factors expressing impact of scientific and technical progress are decisive. Other analysis direction is connected with assessment of the labor productivity growth role in organizational factors [3, 4].

Currently organizational factors take an important role in the production efficiency increase. Improvement of the work organization assumes improvement of work rationing and forms of material and moral incentive, training qualified personnel, strengthening labor discipline [5, 6].

Practice of planning needs assessment for quantitative influence of separate factors on labor productivity growth. The first stage in the solution of this task is developing the system of the indicators characterizing the level of various labor productivity factors [7].

In the field of information support for calculations of the corresponding groups of organizational factors indicators, there are a lot more unresolved questions. If, for example, the indicators characterizing technological level can be generally calculated on the basis of information, which is contained in the statistical reporting or in primary registration documents, then the information which can be received only according to specially organized observations [8] is often necessary for calculation of the indicators characterizing the level of the production organization, work and management.

II. METHODS

Depending on the levels of management, the analysis of labor productivity factors is carried out, the maintenance of the indicators characterizing various factors can change.

According to the reporting, the following system of indicators can be calculated:

1. Indicator of jobs service (K_1) :

$$K_1 = \frac{N_0}{N_{wor}}$$

Where N_0 – number of the workers serving jobs;
N_{wor} – average number of workers.

2. Indicator of receptions development and methods of work (K_2) :

$$K_2 = \frac{N_6}{N_{wor}},$$

where N_p – the number of the workers who met the norms.

3. Indicator of division and labor co-operation (K_3) :

$$K_3 = \frac{N_c + N_m + N_c}{N_c^v + N_m^v + N_c^v},$$

Where N_c, N_m, N_c – number of the workers captured by the collective work organization, multimachine service, combination of professions.

4. An indicator of labor discipline (loss of working hours because of workers) (K_4).

5. Indicator of the jobs organization (K_5) :

$$K_5 = \frac{N_m}{N},$$

Where N_m and N and – quantity of jobs according to standard projects and in the analyzed division.

6. Work rationing indicator (K_6):

$$K_6 = \frac{N_n}{N_{wor}},$$

Where N_n – number of workers whose work is normalized.

7. Indicator of qualified workers use (K_7):

$$K_7 = \frac{R}{R'}$$

Where R and R' – the average category of workers and the performed works.

If we have results of special observations of working hours use by means of the working day photo or a moment observations method and results of the made time observations, then indicators of job service, rationality of receptions and methods of work, indicators of labor division and labor discipline can be calculated as follows:

1. Indicator of job service (K_1):

$$K_1 = \frac{t_{idle.}}{T_{sh} \cdot n},$$

Where t_{idle} – the total time of intra replaceable idle times caused by shortcomings of providing with materials and tools (hour);

$\quad T_{sh}$ – shift duration (hour);

$\quad n$ – number of workers.

2. Indicator of receptions rationality and methods of work (K_2):

$$K_2 = 1 - \frac{\sum_1^k (t_i^a - t_i^n) Q_i^a}{T_a},$$

where t_i^a and t_i^n – the actual and standard costs of time for performance of i operations (hour);

Q_i^a – the actual volume of the performed work;

K – number of the operations which are carried out in a workplace;

T_a – actually spent time (hour).

3. The indicator of labor division (K_3) characterizing extent of workers specialization according to qualification and know-how:

$$K_3 = 1 - \frac{t_{u.w.}}{T_{sm}n},$$

Where $t_{u.w.}$ – total expenses of time for performance by workers of unusual works during change (hour).

4. An indicator of labor discipline (K_4) (a share of losses because of workers):

$$K_4 = 1 - \frac{t_w}{T_{sm}n},$$

where t_w – losses of working hours because of workers (hours).

If one considers forming the average level of labor productivity at the enterprise, then the indicators calculated according to the reporting can estimate a role of organizational factors in forming the average level of

labor productivity. If it is about the analysis of the factors forming labor productivity level of certain workers, then the majority of indicators of the reporting loses the analytical functions (an exception indicators make K_4 and K_7) [9]. Indicators which can be calculated according to observations of intra replaceable time of workers are better suitable for these purposes. It must be kept in mind that indicators on each worker of the studied set will be required that will cause entering of some changes into the indicators calculation method. Taking into account the told indicators of the work organization forming labor productivity level of certain workers of the site, we will count thus:

$$K_{1j} = 1 - \frac{t_{idle.j}}{T_{sm}},$$

Where j - the indicator and the corresponding elements belong to specific j worker.

$$K_{2j} = 1 - \frac{\sum_i^k (t_{ij}^a - t_{ij}^n) Q_{ij}^a}{T_{aj}},$$

$$K_{3j} = 1 - \frac{t_{u.w.j}}{T_{sm}},$$

$$K_{4j} = 1 - \frac{t_{wj}}{T_{sm}},$$

Where t_{pj} – intra replaceable losses of working hours by fault j of the worker.

$$K_{7j} = \frac{R_j}{R_j'},$$

Where R_j – the category j of the worker;

R_j' – the average category of the works performed j by the worker.

According to the photo of the working day by means of a moment observations method, it is possible to calculate for each examined worker the indicators of job service, extents of labor division and labor discipline. Using data of technological documentation and primary account in the course of observation, it is possible to calculate also an indicator of qualified workers use [10].

Results of time observations are necessary for definition of an indicator of receptions rationality and work methods.

By results of the working day photo it is possible to receive coefficient of workers employment (K_{8j}) which characterizes employment of workers and a possibility of professions combination and is defined by the relation of working hours to change duration.

Information obtained as a result of carrying out the photo of the working day allows calculating some indicators characterizing the level of the production and management organization in the studied production division.

For example, indicator of administrative functions performance quality:

$$K_y = 1 - \frac{t_{a.l.}}{T_{sm}},$$

Where $t_{a.l}$ – losses of working hours because of the administrative functions untimely performance.

This value is meant as idle times due to the lack of materials, tool, expactation of the equipment repair.

It is possible to define one of level indicators for the production organization as well:

$$K_0 = 1 - \frac{t_n}{T_{sm}m},$$

Where t_n – total costs of all readjustments during the

shift;

m – number of units of actually working equipment.

III. RESULTS AND DISCUSSION

The scientific analysis of the existing approaches of statistical studying of labor productivity allowed us to find out that among economists there is no uniform methodology of a research of this category as labor productivity represents a difficult, multidimensional concept of economic science. To disclose economic essence of the labor productivity analysis, it is necessary to mark out the main aspects of a research as labor productivity is a component of any economic problem, whether it be industrialization or research works [11].

Let's consider organizational factors influence on development of workers in a local control link - on the production site. The system of indicators of the work organization and their calculation for this level of management are given by us earlier.

For calculation of job service level indicators, labor discipline and extent of skilled workers it is possible to recommend using results of periodic moment observation. Extent of working hours expenses elements specification has to correspond to research objectives [12].

The size of necessary number of the moments at which the condition of the worker is fixed depends on the minimum share of the allocated elements of the working hours expenses in replaceable fund and is determined by a formula:

$$n = \frac{t^2(1-p)}{\Delta^2_{rel.}p} \cdot 100^2,$$

Where p- a share of the smallest element of expenses in replaceable fund of time;

$\Delta_{rel.}$ – relative size of a limit error of share;

t – the coefficient corresponding to the accepted level of confidential probability.

It is inexpedient to allocate as a part of classification elements of expenses with the specific weight less than 5% as the volume of necessary observations will be too big. Even if to recognize that the smallest specific weight of expenses elements for working hours will make 5%, then at a relative error in 10% and confidential probability 0,954 necessary number of the moments of observation will be equal to 7600.

Depending on number of workers on the surveyed site and duration of one shift the number of changes throughout which it is necessary to make observation is defined.

Results of observations were presented in the table in which reflected: number of moment observations (on average for change), the average duration of an element of expenses (hour) and average development for change (norm-hour).

The equation of correlation dependence for labor productivity (development) of the production site workers on factors of the work organization will be written down so:

$$\hat{y} = b_0 + b_1x_1 + b_2x_2 + b_3x_3,$$

Where x_1 – an indicator of labor division;
x_2 – indicator of labor discipline;
x_3 – indicator of job service;
$\hat{y}$ – replaceable development of workers.

Degree of workers development dependence on the corresponding factorial signs was estimated by means of pair correlation coefficient which values turned out to be following:

$$r_{yx_1} = 0,30, \quad r_{yx_2} = 0,42, \quad r_{yx_3} = 0,48.$$

At the same time, the degree of mutual correlation of factors made:

$$r_{x_1x_2} = 0,50, \quad r_{x_1x_3} = 0,36, \quad r_{x_2x_3} = 0,36$$

It is not necessary to speak about high degree of narrowness of communication between productive and factorial signs here. Of course, the level of workers development is not formed under the work organization factors influence entirely.

We do not consider influence of distinctions in an experience, age and qualification of each worker. Nevertheless in value of pair coefficients of correlation it is possible to judge that factors of the work organization play a part in forming the level of replaceable development of workers. The greatest impact on development of workers of this site is exerted by level of job service (the coefficient of correlation made 0.48).

The coefficient of multiple correlation (narrowness of communication of all factors with indicators of replaceable development) made 0.6. It indicates close dependence of a productive indicator on the factors entered into model. The coefficient of multiple determination made 0.36, therefore, the variation of replaceable development of workers on the site for 36% is caused by fluctuation of the work organization factors.

The equation of multiple dependence of replaceable development of workers at the level of the work organization will be written down as follows:

$$\hat{y} = -13,25 + 13,03x_1 + 12,06x_2 + 1,94x_3$$

IV. SUMMARY

In parameters of the received equation we can estimate a role of each factor in change of level of replaceable development of workers. For these purposes we will use the analysis of coefficients of regression at each of factors, coefficients of elasticity $\left[E_i = b_i \dfrac{\overline{x_i}}{\overline{y}}\right]$ and the standardized private coefficients of regression $\left[\beta_i = b_i \dfrac{\sigma_{x_i}}{\sigma_y}\right]$ (Table 1).

Table 1: Statistical characteristics of factors.

Factor	Average level	Average quadratic deviation	Deviation coefficient, %	Elasticity coefficient, %	< -coefficient
x_1	0,92	0,14	15,22	1,06	0,91
x_2	0,93	0,14	15,05	0,99	0,84
x_3	0,68	0,20	29,41	0,12	0,12
y	11,3 n/h.	2,6 n/h.	23,01	-	-

On regression coefficients in the equation of multiple dependence, one may say that increase in level of labor

division on 0,1 allows one to increase replaceable development for 1,303 norm-hours, and increase by 0,1 levels of job service and the level of labor discipline will increase replaceable development respectively for 0,194 and 1,206 norm-hours.

Coefficients of elasticity allow to establish the size of the replaceable development gain at increase in values of each indicator of the work organization by 0,01 within a certain interval. Due to increase in the level of labor division by 1%, replaceable development can be increased by 1,06%, and at increase in the level of labor discipline and job service respectively by 0,99 and by 0,12%.

Values of β - coefficients show on what part of an average quadratic deviation the indicator of replaceable development with change of this or that indicator of the work organization at a size of its average quadratic deviation will change.

The greatest values of β- coefficient correspond to factors x_1 and x_2. It means that during the change of indicators of labor division and labor discipline at the value of an average quadratic deviation replaceable development will change respectively by 0,91 and 0,84 in average quadratic deviations, i.e. by 2,366 and 2,184 norm-hours $(0{,}91 \times 2{,}6$ and $0{,}84 \times 2{,}6)$.

V. CONCLUSIONS

Thus, the analysis of all listed indicators specifies the directions of impact on organizational factors for the purpose of receiving the greatest gain of labor productivity.

In our opinion, the indicators of the production organization level, work and management calculated on the basis of data on distribution of replaceable fund of working hours correspond to a task of the analysis of the organizational factors role on the specific site, in the shop and at the enterprise more. When carrying out the intra-branch analysis it is possible to use also the system of the indicators based on the workers given about the total number and their coverage by the scientific work organization, production and management [13].

As the indicators of the organization of production and management applied in the analysis at the branch level, the following can be used.

I. For the characteristic of the level of the production organization:

1) Production specialization coefficient. This direction of the production organization can be presented by an indicator of specific weight of the main production in a total amount of finished goods or an average indicator for various production works performed during the reporting period in one workplace in one change.

2) The cooperation coefficient representing the specific weight of costs of the cooperated deliveries in product cost.

II. For the characteristic of the management level:

1) Coefficient of management personnel profitability:

$$K_E = \frac{N_n}{M_m} : \frac{N_a}{M_a},$$

Where M_m and M_a - the number of structural divisions, according to the structure and actual standard provided; N_n and N_a - respectively the standard and actual number of employees in these divisions.

As the generalizing indicators of organizational factors level, the rhythm coefficients, percent of losses from faulty production and an indicator of specific weight of the highest quality production can be used.

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