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ECONOMIC AND MATHEMATIC MODELS FOR STAFF PLANNING AT ENTERPRISES OF ALL OWNERSHIP FORMS

The article defines the basic requirements to planning and composition of staff basing on the forecast demand for company's products. The offered system of assessment would minimize the subjectivity in evaluating the employees' performance effectiveness at enterprises of all forms of ownership.
Keywords: planning methods; education and competence of personnel; rating assessment.

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ВИКОРИСТАННЯ ЕКОНОМІКО-МАТЕМАТИЧНИХ МОДЕЛЕЙ ПРИ ПЛАНУВАННІ ЧИСЕЛЬНОСТІ ТА СКЛАДУ ПРАЦІВНИКІВ НА ПІДПРИЄМСТВАХ УСІХ ФОРМ ВЛАСНОСТІ

У статті визначено основні вимоги до планування чисельності та складу персоналу на основі запрогнозованого попиту на продукцію. Запропоновано систему оцінювання, яка надасть можливість мінімізувати суб'єктивізм при оцінюванні ефективності діяльності працівників підприємств усіх форм власності.
Ключові слова: методи планування; освіта та компетенції персоналу; рейтингова оцінка.
Форм. 5. Табл. 4. Літ. 10.

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ИСПОЛЬЗОВАНИЕ ЭКОНОМИКО-МАТЕМАТИЧЕСКИХ МОДЕЛЕЙ ПРИ ПЛАНИРОВАНИИ ЧИСЛЕННОСТИ И СОСТАВА ПЕРСОНАЛА НА ПРЕДПРИЯТИЯХ ВСЕХ ФОРМ СОБСТВЕННОСТИ

В статье определены основные требования к планированию численности и состава персонала на основе спрогнозированного спроса на продукцию. Предложена система оценки, которая позволит минимизировать субъективизм при оценке эффективности деятельности работников предприятий всех форм собственности.
Ключевые слова: методы планирования; образование и компетенции персонала; рейтинговая оценка.

Problem setting. The process of personality formation is ongoing, that's why the problem of effective administration of people at enterprises is constantly rising. Its organization depends on different factors, among which the very system of administration is the key element. It is necessary to mention that in today's conditions of society and economy's development, knowledge becomes obsolete every 4–6 years. This should be taken into account in labour laws, in contents of educational courses, and also in staff training. People must be ready to work with new information, new means of automatization and mechanization of its search.

Recent research and publications analysis. In numerous works of foreign and Ukrainian scientists the greatest attention is paid to specific features of economic and mathematic modelling of economic processes (Babenko, 2014; Kobets, 2014; Makarkina, 2008; Tsay, 2010; Vitlinskij and Babenko, 2012) and to peculiarities of personnel management (Holod and Volovych, 2011; Stetsyuk, 2011; Zayarna and

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Karelyus, 2011). In spite of considerable results, there are still some problems which need additional scientific analysis, inter alia, concerning the use of expert methods of investigation and application of economic and mathematic models. Many working enterprises have serious problems with subjectivism while solving personnel problems, especially when it comes to stuff reduction or career promotion choices.

The research objective is to elaborate and verify the use of economic and mathematic models while planning the amount of personnel with minimization of subjectivizm in solving personnel problems and providing appropriate conditions for labour productivity at enterprises of all forms of ownership.

Key research findings. Planning of enterprises activity is realized via different methods. While choosing methods of planning it's necessary to take into consideration certain requirements. The methods of planning are to be: adequate to external conditions, taking into account the specifics of market development; the type of object activity and variety of tools and methods in reaching the main entrepreneurial aim — increasing income.

Today the absence of administrative instruments adequate to industrial programs and market conditions is typical for the majority of Ukrainian enterprises. The necessity of modelling enterprise's functioning, especially under crisis conditions, is predetermined by the problems with effective administration and industrial program optimization. Introduction into enterprises' administrative practice of new methods of personnel management will give additional possibility to unite the teams of professionals at enterprises.

To our mind, while planning the volume of industrial and labour resources, it is reasonable to use the following information:

- prediction of demand for enterprises' output, on the basis of researching the market changes in terms of time, prices, offers, quantity of competitors etc.;
- prospect(s) for products and service output;
- results of research on current circulation of products;
- agreement on goods production and distribution in the wholesale sector;
- measures increasing the industrial capacities of enterprises;
- measures increasing specialization and cooperation of enterprises;
- data on unrealized production in the previous period.

It is necessary to note that formation of an optimal industrial program is impossible without taking into account industrial criteria, in particular, industrial capacity, material and technical potential, personnel factor.

In the process of our research it has been defined that majority of enterprises in the Kherson region ignore planning of personnel quantity, as well as the influence of current changes, occurring in business environment. At the same time, while managing and planning the needs in labour resources, enterprises managers, first of all, must take into consideration actual and forecasted production volumes. Having reliable information on the volume of production, administration can carry out strategic planning of labour resources and define the expediency of personnel employment, transfer and other measures of personnel administration.

Today, there are a lot of models of forecasting production, but none of them is trustworthy enough when it comes to the influence of changes that occur in political, economic and social life of the state and in particular regions. Taking into considera-

tion the current financial position of subjects in the wineproducing sector of the Kherson region, the lack of funds for buying particular program provision and lack of skillful specialists in forecasting, it is reasonable to use the plural linear regression of two factors. For instance, for the join-stock company "Tsurupinskiy" it will be represented by the following formula:

$$X_0 = A_0 + A_1 \times X_1 + A_2 \times X_2, \tag{1}$$

where X_0 — the volume of run, ths dal; X_1 — average price of realization of UAH/dal; X_2 — the level of average monthly income of population in a region, UAH; A_0, A_1, A_2 — coefficients.

Using data, on wine output at "Tsurupinskiy" during 2008−2014 in its original form (ths decalitres), we have proposed the function for run forecast in wine production: $X_0 = 66.2 − 0.0186 \times X_1 + 0.0273 \times X_2$.

With the average level of price being 1300 UAH per 1 dal and the average monthly wage of 2743 UAH (according to the Program of economic, social and cultural development in Kherson region for 2015, adopted by the decision of region council session, 30.01.2015, # 1176) the predicted volume of production at "Tsurupinskiy" will be: $X_{2015} = 66.2 − 0.0186 \times 1300 + 0.0273 \times 2743 = 117$ ths dal.

These calculations confirm that under the influence of economic and political crisis in the country on the background of reducing population purchasing capability, wine production will not change much. So, taken into account that in 2014, for the production of 120 ths dal of wine at "Tsurupinskiy" 93 persons were drawn to work, then with the average annual rate of growth of work productivity (in 2010−2014 — about 110%) and under unchangeable conditions of company development, the planned needs in personnel for the company in 2015 will reach: $Pn = (93 / 120) \times (117 / 1.1) = 83$ persons.

The suggested methodology helps not only plan the demand in personnel, but also define the volume of enterprise's production and also forecast the commitment to suppliers for providing raw materials into production, that will help realize more effective logistic operations at the enterprise.

At the same time, in case of using the suggested propositions concerning personnel quantity for 2015, the enterprise administration may come across some difficulties, connected with cutting 10 working placing.

According to current labour laws in Ukraine, job contract, signed on undertermined term and fixed-date contract till dead-line term of its salidity may be broken by the owner or his representative in the following cases:

- exposure of person's inconsistency with the position or fulfilled work because of low level of professional skills or health conditions that impede to continue this work;

- systematical unreasonable nonfulfilment of duties by a worker, entrusted with job contract or rules of inner labour order, in case if the worker was under chastisement;

- in other cases, stipulated by effective current legislation.

For solving the problem of personnel optimization at enterprises attestation once in 3−5 years is carried out by the owner (according to current legislation). Attestation is reasonable to be held in the case of inconsistency with appointment or fulfilled

work, of insufficient professional skills. So, enterprise administration has the task to carry out the objective rating of workers effective job, that is finding congruence between professional and individual competences of employees and requirements to their positions according to set criteria.

The important problem with personnel rating is the exactness of results, that cover to general moments, same for all workers, but also particular labour standards for a certain job or position. In the first case rating results define the way workers belong to certain organization and social system, in the second one − congruence of worker's activity to his professional requirements.

While defining the first group it is necessary to take into account that first of all administration of the explored enterprise, is interested in the growth of work productivity. That's why the importance of each factor that influences on work productivity must be fixed by the expert commission, members of which are enterprise representatives and, in case of necessity − with the involvement of external experts.

To calculate the coefficient of experts' competence we suggest to use the formula:

$$C = \frac{C_1 + C_2 + \ldots + C_n}{n}, \tag{2}$$

where C − the coefficient of experts' competence; C_1 − the coefficient, assigned in accordance to a position; C_2 − the coefficient, assigned in accordance to a certain education level; C_n − the coefficient, assigned in accordance to n-factor; n − the number of factors due to which the experts' professional level is rated.

Depending on expert commission members, particular gradation is held while calculating the coefficient, which is assigned in accordance to position taken and other factors due to which the expert qualification level is rated. So, the expert, who has the lowest level of education is assigned the minimal grade (for example, 1 g), the expert, who has the best level of education is assigned the maximum grade, defined depending on the quantity of experts and the average grade, taking into account the potentially changing level of education in the group of experts. The same actions are hold with other factors. The coefficient, assigned due to n-factor is calculated as the ratio of certain expert rating, expressed in grades, to the general sum of grades in this expert group.

In our case for JSC "Tsurupinskiy" the coefficient of each expert competence is suggested to be determined on the basis of educational level and occupied position. It is also necessary to take into account the conditions of enterprise's production and products' specificity. Taking into account the current legislatia on protection of personal data, we suggest the following naming for expert commission, which will − includes: the director of the enterprise − Expert 1, doctor of sciences in "economies and management of enterprises"; the director assistant on economic matters − Expert 2, master in "management and administration"; the director assistant in technical issues − Expert 3, master in "economy and administration of enterprises"; the head of personnel staff − Expert 4, master in "management and administration"; the leading engineer − Expert 5, specialist in technical science. Taken into account that each respondent within the commission has different education, experience and as a result, different position at the enterprise, it is suggested to calculate the coefficient of competence for each member. For calculating this coefficient, which is assigned

corresponding to taken position and taken into account the aim of this research, we divide the experts into 4 groups: 1 − director (4 points), 2 − director assistants (3 points), 3 − head of personnel (2 points), 4 − the leading engineer (1 point). For calculating the coefficient, assigned in accordance to actual educational level, we divide the experts into 4 groups: 1 − Doctor of Science (4 points); 2 − Candidate of Science (3 points); 3 − Master of Science (2 points); 4 − specialist (1 point).

We present calculations of the experts' competence coefficients in Table 1.

Table 1. **Experts' competences' coefficients,** *authors'*

Expert	Grade	C_1	Grade	C_2	C
Expert 1	4	0.30769	4	0.36364	0.335665
Expert 2	3	0.23077	2	0.18182	0.206295
Expert 3	3	0.23077	2	0.18182	0.206295
Expert 4	2	0.15385	2	0.18182	0.167835
Expert 5	1	0.07692	1	0.0909	0.083910

It was determined that on wine-producing enterprises the main strategic factors in staff potential management must include: professional education of workers, working experience relevant to profession, time and quality of decisions made; complexity of functional duties; initiative at work; the style of leadership; accidents prevention etc. (depending on additional factors that influence enterprise functioning).

Table 2 shows the results of the questionnaire and the list of benefits for each expert in the commission concerning the influence of each criteria: education (Ed), experience (Exp), timeliness and quality of decisions made (Tq), complexity of functional duties (Cf), initiative at work (Ac), leadership style (Ls), accidents prevention (Ap). While determining the significant value of influence, produced by each factor on the general result we will take into account that the first place in the row − 7 points, 2 − 6 points, 3 − 5 points, 4 − 4 points, 5 − 3 points, 6 − 2 points, 7 (last) − 1 point.

Table 2. **Rating of criteria's importance,** *authors'*

Expert	Rating
Expert 1	Exp > Ed > Tq > Cf > Ac = Ls = Ap
Expert 2	Ac > Exp > Cf > Tq > Ed > Ls = Ap
Expert 3	Tq > Cf > Ac > Exp = Ed > Ls > Ap
Expert 4	Ed > Exp > Tq = Ac > Ls > Cf > Ap
Expert 5	Exp > Ap > Tq > Cf > Ac = Ls = Ed

In Table 3 the significance coefficients for criteria in correspondence with the experts' competences is calculated.

The result of our research helps define that the most significant influence on the competitive ability of JSC "Tsurupinskiy" have such criteria: work's experience (21.1%), timeliness and quality of decisions made (17.9%).

The next step is rating of personnel by the given group of criteria taking into account the significance of their influence on to performance results.

For rating another group of criteria is chosen (labour norms for certain working places or positions, the criteria of output of certain type of production or realization of certain functions). For maximum objectivity of rating it is necessary to realize this

process through 10 technical criteria (functions), and take into account the workers' wage. Exact and reliable information must be given for each of these criteria. To set all technical criteria into one scale of calculation we suggest to use the author's methodology, which consists of 3 stages.

Table 3. **Calculation of significance criteria for experts' competences,** *authors'*

Criteria	Grade corresponding to the coefficient of experts' competence	Significance
Work experience	7 x 0.3357 + 6 x 0.2063 + 3.5 x 0.2063 + 6 x 0.1678 + 7 x 0.0839 = 5.904	5.904 / 28 = 0.211
Education	6 x 0.3357 + 3 x 0.2063 + 3.5 x 0.2063 + 7 x 0.1678 + 2 x 0.0839 = 4.698	4.698 / 28 = 0.168
Timeliness and quality of decisions made	5 x 0.3357 + 4 x 0.2063 + 6.5 x 0.2063 + 4.5 x 0.1678 + 5 x 0.0839 = 5.019	5.019 / 28 = 0.179
Initiative at work	2 x 0.3357 + 7 x 0.2063 + 5 x 0.2063 + 4.5 x 0.1678 + 2 x 0.0839 = 4.07	4.07 / 28 = 0.145
Leadership style	2 x 0.3357 + 1.5 x 0.2063 + 2 x 0.2063 + 3 x 0.1678 + 2 x 0.0839 = 2.065	2.065 / 28 = 0.074
Accidents prevention	2 x 0.3357 + 1.5 x 0.2063 + 1 x 0.2063 + 1 x 0.1678 + 6 x 0.0839 = 1.858	1.858 / 28 = 0.066
Complexity of functional duties	4 x 0.3357 + 5 x 0.2063 + 6.5 x 0.2063 + 2 x 0.1678 + 4 x 0.0839 = 4.386	4.386 / 28 = 0.157
$\sum$	28	1.0

On the first stage rating is held on the basis of calculating the relative error of technical criteria of each worker from the best results of such criteria of other workers in this industrial department by the formula:

$$R_j = \sum_{i=1}^{n} \frac{X_{max} - X_{ij}}{X_{max} - X_{min}} + \sum_{i=1}^{n} \frac{X_{ij} - X_{min}}{X_{max} - X_{min}}, \qquad (3)$$

where R_j — the sum of rating results for each worker according to each criteria, that characterize particular technical aspect; X_{ij} — the results of *i*-criteria of *j*-worker; X_{max} — max results of *i*-criteria; X_{min} — min results of *i*-criteria.

The first part of the formula is used for testing the criteria, the growth of which has positive effect on worker's competitive ability (e.g., work productivity per hour etc.), the second part — for rating the criteria, the growth of which produce negative effect (e.g., duration of deadline time, use of raw materials in industrial processes etc.).

On the second stage the average arithmetical results of rating are calculated for each worker by all criteria, which characterize the technical sphere, according to the formula:

$$R_{avj} = \frac{R_j}{n}, \qquad (4)$$

where R_{avj} — the average arithmetical sum of rating of a particular worker by all technical criteria; n — the quantity of criteria, used for calculation in technical sphere.

In accordance with the results of calculation, the position of each worker on the rating scale in technical sphere is determined. The best worker in technical sphere is considered to the one, whose average arithmetical results have the lowest grade.

Table 4. **The definition of the most productive service worker in the bottle department of JSC "Tsurupinskiy"**, *authors'*

Service workers of the bottle department	Average duration of current repair of equipment, min	Coefficient	Position	Average duration of fundamental repair of equipment, hours	Coefficient	Position	Period between previous and following repair, days	Coefficient	Position	Sum of rating	Average arithmetic of sum in rating	Position
Worker 1	60	$(60-50) / (65-50) = 0.667$	3	5	$(5-4.5) / (5.5-4.5) = 0.5$	2	40	$(50-40) / (50-40) = 1$	4	$0.667+ 0.5+1 = 2.167$	$2.167/3 = 0.722$	3
Worker 2	55	$(55-50) / (65-50) = 0.333$	2	5.5	$(5.5-4.5) / (5.5-4.5) = 1$	4	45	$(50-45) / (50-40) = 0.5$	2	$0.333+ 1+0.5 = 1.833$	$1.833/3 = 0.611$	2
Worker 3	50	$(50-50) / (65-50) = 0$	1	4.5	$(4.5-4.5) / (5.5-4.5) = 0$	1	50	$(50-50) / (50-40) = 0$	1	$0+0+ 0 = 0$	$0/3 = 0$	1
Worker 4	65	$(65-50) / (65-50) = 1$	4	5	$(5-4.5) / (5.5-4.5) = 0.5$	2	42	$(50-42) / (50-40) = 0.8$	3	$1+0.5 +0.8 = 2.3$	$2.3/3 = 0.767$	4
	max = 65			max = 5.5			max = 50					
	min = 50			min = 4.5			min = 40					

On the third stage the comparison with workers' wages is carried out − for each worker it is necessary to calculate the coefficient of competitive ability according to the criteria as quality-appreciation as in the formula:

$$K_k \frac{1/R_{avj}}{C_j}, \tag{5}$$

where R_{avj} − average arithmetic sum of rating for j-worker by all technical criteria sphere; C_j − the average monthly fund of j-worker's payment.

The best and competitive according to the criteria quality-appreciation is considered to be the worker, whose coefficient of competitive ability has the highest grade. As an example, in Table 4 the description of the most productive service worker in the bottle department of "Tsurupinskiy" is given in correspondence with 3 technical characteristics. If the wage in the explored group of workers is equal, the best worker then is Worker 3.

Conclusions and prospects of further research. The use of economic and mathematical models in economic activity of industrial enterprises of all forms of ownership allow not only plan the run on certain production, but also determine the quantity of personnel, define the optimal staff volumes and build an objective rating of personnel in accordance with their quantitative and qualitative level. At the same time further research should be focused on the determination of experts' competence level and their gradation.

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