Секция: Современные математические методы, модели и информационные технологии в экономике

Lebedev S. S., PhD Student,
Simon Kuznets Kharkiv National University of Economics,
Kharkiv, Ukraine

MODELING OF COMPREHENSIVE INDEX OF CAPITALIZATION OF HUMAN POTENTIAL OF THE INDUSTRIAL ENTERPRISE STAFF

One of the basic assumptions of modern economic theory is the assertion of the leading role of human capital in the implementation of the transition to the post-industrial stage of development. At the stage of the knowledge economy human capital is precisely the factor that determines the development of not only society as a whole, but also each company separately. Humankind has entered the information age where wealth has become a product of knowledge [1]. That's why education and training are considered as the most important investments in the company's development [2]. In this context, knowledge is seen as an economic good, because it gives a unique opportunity to gain a competitive advantage. But training provides increasing of human potential only. It is essential that the knowledge which employee acquired during training would be implemented in its work, namely that the capitalization of accumulated human capital would take place [3]. Accordingly, there is a need to develop methods of evaluation of the efficiency of the implementation of human potential, which was accumulated during the training.

The aim of this paper is to construct a mathematical model of a complex system, which is a combination of knowledge, skills and abilities of managers of industrial enterprise.

The development of human potential is one of the most important business management objectives. In accordance with the recognition theory [4 et al.], a mathematical model for the evaluation of human potential capitalization can be seen as identifying of this process. The mathematical formulation of the problem of recognition is as follows. Let the inverse image X is the totality of all the attributes that characterize the image of the subject to recognition (including qualitative characteristics). Then the image Y is the totality of all classes of images. The challenge is that the observed value $x \in X$ would be put into accordance with the characterization $y \in Y$. Recognition process model describes the dependence of the estimate $\hat{y}$ on the number of class samples y of observed values x of the random variable X. Construction of the mathematical model is reduced to the description of this dependence. This raises two problems: formalization of the subject field and selection of function by which the recognition will be done. Let us consider these two aspects.

One of the modern methods of business management is management by objectives [5], the implementation of which involves the use of key performance indicators (KPI). KPI are defined by the strategic and tactical objectives of the company as a whole. They help to assess the extent to which company reached the target. The author suggests using KPI for evaluating the effectiveness of the using of human potential, formed in the course of industrial training that is degree of its capitalization [6]. For building the KPI system we were used a functional approach: the mission of the company $\Rightarrow$ company structure $\Rightarrow$ job responsibilities $\Rightarrow$ the purpose of training $\Rightarrow$ KPI.

It is clear that key performance indicators of the workers and service staff should be built according to labor productivity, which is essential in the performance of new manufacturing operations. Since all of these indicators are quantitative and are determined by technological requirements, the difficulty in choosing them does not arise. As usual, several different indicators would be

used to reflect all the features of technology process. As a unit of measure for all key performance indicators we can use the time which is necessary to perform these technology operations. Thus, the problem of formalization of the subject field is solved. Let us proceed to the construction of the function by means of which recognition will be done.

Since the comprehensive characterization of the quality of the acquired skills requires the use of multiple KPI, that's why we need to build a comprehensive index, which characterizes the effectiveness of capitalization of the human potential of every worker. This comprehensive index is a weighted average cost of the KPI and the weight of each KPI is determined by an expert method. Thus, the identification function $X \xrightarrow{f} \hat{Y}$ has the form:

$$I = \sum_{i=1}^{n} w_i \cdot KPI_i, \quad \sum_{i=1}^{n} w_i = 1,$$

where KPI_i – is the KPI, which characterizes the i th technology operation; w_i – the weight, which determines the proportion of the KPI_i as part of the comprehensive index; n – the number of technology operations, which are taken into account in the construction of the comprehensive index.

Expert method for calculating the weighting factors for each KPI is advisable to realize as follows. A group of m experts is elected to carry out the ranking of n key performance indicators that will be included in a comprehensive index. Weighting factor of KPI which characterizes the i th technology operation is determined by the formula:

$$w_i = \sum_{j=1}^{m} r_{ij} \Big/ \sum_{i=1}^{n} \sum_{j=1}^{m} r_{ij},$$

where r_{ij} – is the rank, which assigns the j th expert ($j = \overline{1, m}$) to i th factor ($i = \overline{1, n}$).

However, in the construction of model evaluation of human potential capitalization for managers we have a problem and at the stage of formalization

of the subject field, and at the stage of selection of function by which the recognition will be done. The difficulty of formalizing of the subject field is due to the fact that the manager's work is determined by the effectiveness of the work of the production division, which he manages. In this case, the efficiency of the production division as a whole is only a part of the key performance indicators that characterize the work of the manager. As with the definition of the KPI for the workers, this key performance indicator is quantitative. It can be measured, for example, in the amount of output per unit of time (if that production division makes the finished products) and in the time required to perform the operations process (if that production division realizes only the individual process steps).

Quantitative characteristics of productivity of production division are a mandatory component of the system of evaluation of capitalization of human capital of manager. But their part in the comprehensive index is determined by what kind of training the manager had. It can be even 100% if the training was, for example, in the development of new technological processes. But it is not more than 70%, if the manager took the training of personal growth. In this case, the comprehensive index must contain key performance indicators which characterize the personal qualities of the manager and his ability to organize the work of production division. These include such personality traits as organizational skills, leadership skills, communication skills and attention to subordinates, professional authority, and the like.

Thus, the comprehensive index is composed of the two parts. One part of the KPI, which characterize the performance of production division, contains quantitative indicators. The magnitude of this type of the CPI is determined by the formula:

$$KPI_i = \frac{x_i - x_0}{x_{\max} - x_0},$$

where x_i – is the value of factor X_i obtained by estimating; x_0 – base value of factor X_i; $x_{\max}$ – the desired value of the factor X_i.

All key performance indicators, which are included in the second part of the comprehensive index, characterized the personal qualities of the manager. These KPI are qualitative and they need to be digitized in relative units. For this purpose let us use the Harrington desirability function [7]. For each indicator, all its possible values are divided into 5 ranges: [0, 0.2] – very bad; (0.2, 0.37] – bad; (0.37, 0.63] – fine; (0.63, 0.8] – good; (0.8, 1] – excellent. According to this scale, the experts carry out evaluation of the personal manager qualities acquired through personal growth training. Finally, a comprehensive index is created taking into account the weight of each KPI.

Thus, the proposed method of construction of the comprehensive index allows to objectively evaluating the degree of transition of human potential, acquired through training in human capital.

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