V.I. VERNADSKY TAURIDA NATIONAL UNIVERSITY

INNOVATIVE MECHANISMS FOR MANAGING THE ECONOMIC DEVELOPMENT OF UKRAINE

Collective monograph

Lviv-Toruń
Liha-Pres
2019

Reviewers:

Prof. nadzw., dr hab. ***Stanislaw Kunikowski****, Rektor of Cuiavian University in Wloclawek (Republic of Poland);*

Prof. dr hab. ***Joanna Marszalek-Kawa****, Uniwersytet Mikolaja Kopernika w Toruniu / Nicolaus Copernicus University (Republic of Poland);*

Dr ***Henryk Stępień****, Associate prof. of the Faculty of Social and Technical Sciences, Rector's representative for Development of Cuiavian University in Wloclawek (Republic of Poland).*

Innovative mechanisms for managing the economic development of Ukraine : collective monograph / P. I. Bezus, K. S. Demenska, Y. V. Grudtsyna, I. S. Kocharian, etc. – Lviv-Toruń : Liha-Pres, 2019. – 172 p.

ISBN 978-966-397-123-0

Liha-Pres is an international publishing house which belongs to the category „C" according to the classification of Research School for Socio-Economic and Natural Sciences of the Environment (SENSE) [isn: 3943, 1705, 1704, 1703, 1702, 1701; prefixMetCode: 978966397]. Official website – www.sense.nl.

The monograph studies the main aspects of innovative mechanisms for managing the economic development of Ukraine. The current state of public administration of the socio-economic development of the regions of Ukraine is analysed. Problems that prevent economic growth, improvement of social development indicators, and formation of an effective system of regional development management are distinguished. Directions of improvement of the mechanism of state regulation of the socio-economic development of Ukrainian regions are substantiated.

ISBN 978-966-397-123-0

CONTENTS

DOI https://doi.org/10.36059/978-966-397-123-0/4-25

PROCESS MODELING OF MAKING THE OUTPUT OF PRODUCTS

Bezus P. I.

INTRODUCTION

The imperfection of the structural restructuring of the Ukrainian economy, the unsatisfactory investment climate and the poor level of market relations have led to the fact that today the gross domestic product (GDP) has not reached even 60% of the 1990 level of GDP[1]. This situation is complicated by the fact that specific microeconomic units (producers of gross domestic product) are in a state of limited resources and, in turn, limits their ability to increase production. Therefore, providing limited resources, special attention should be paid to methods of increasing productivity output by business entities without attracting investments by identifying and optimizing the use of reserves for each production factor.

Determining the dynamics of changes in each studied production factor based on the manufacturing simulation makes it possible to timely identify reserves and on this basis to determine a way to increase production efficiency and achieve the desired output of products with optimal costs.

1. Forecasting production reserves

The identification of production reserves is carried out both by enterprise units and by production factors (material resources, labor, energy, financial resources, fixed assets).

If the need for the costs of the studied factors and their proportions for the production of a unit of production are unchanged, it is possible to forecast production reserves for each factor.

To simulate the behavior of the production system in time, it is necessary to construct a mathematical forecast function *f(t)*[2,3]. If we

[1] Статистичний щорічник України за 2016 рік. Державна служба статистики України. Київ : ТОВ «Август Трейд», 2017. 552 с.

[2] Безус П.І. Моделювання нарощування обсягів виробництва. *Економіка та підприємництво* : Збірник наукових праць. 2007. Вип. 18. С. 307–312.

analyze the volume of production, then in a certain time interval t it will change in accordance with the forecast function:

$$Z_p^t = f_p(t); \quad p = \overline{1,m}; \quad t = \overline{1,T}, \qquad (1)$$

where Z_p^t – the gross output of type p in the time interval t.

To ensure the necessary volume of production, it is necessary to use a certain amount of each type of resource in certain proportions. In this regard, the amount of the resource should not be less than the value determined at a fixed point in time corresponding to its share in units of production (coefficient of expenditures of a certain resource).

To ensure the predicted volume of this type of product (p) for the considered period of time t (f.1), the required amount of the resource is calculated by the formula:

$$\overline{Y_{rp}^t} = v_{rp} \cdot Z_p^t, \qquad (2)$$

where v_{rp} – resource consumption rate r ($r = \overline{1,g}$) per unit of product type p, $p = \overline{1,m}$;

Based on the predictive function to ensure the production process, you can determine the amount of this resource for the manufacture of products of type p for each time interval:

$$Y_{rp}^t = f_r(t); \quad r = \overline{1,g}; \quad p = \overline{1,m}; \quad t = \overline{1,T} \qquad (3)$$

When comparing the required amount of a resource (f.2) with the forecasted amount of the same resource (f.3), it is possible to determine its reserves at each time interval in the future:

$$\Delta Y_{rp}^t = Y_{rp}^t - \overline{Y_{rp}^t} \qquad (4)$$

Given that under the influence of the external environment, the proportions defined between resources cannot remain constant, their changes must be taken into account when identifying production reserves in the future. Based on changes in the respective proportions in the past, the prognosis of the proportions of the amount of the attracted resource for production is carried out according to the following formula:

---

[3] Скурихин В.И., Шифрин В.Б., Дубовский В.В. Математическое моделирование. Київ : Техніка, 1983. 270 с.

$$v_{rp}^{t} = f^{rp}(t), \quad t=\overline{1,T}; \quad p=\overline{1,m}; \quad r=\overline{1,g} \quad , \qquad (5)$$

where v^t_{rp} – the predicted proportion of the amount of resource *r* to the number of products of the *p*- type in a period of time *t*; $t=\overline{1,T}$.

To ensure the volume of production (Z^t_p), which is predicted for a certain time interval *t* and taking into account the forecast of the proportion of the amount of resource to production (v^t_{rp}), it is necessary to use the following amount of resource *r*, which is:

$$\tilde{Y}_{rp}^{t} = v_{rp}^{t} \cdot Z_{p}^{t} \quad , \qquad (6)$$

where v^t_{rp}, Z^t_p – are determined by the corresponding forecasting functions according to formulas (5) and (1).

Then the reserves of this resource for each future point of time:

$$\Delta\tilde{Y}_{rp}^{t} = Y_{rp}^{t} - \tilde{Y}_{rp}^{t} \quad . \qquad (7)$$

In addition to forecasting reserves for production resources, it is necessary to apply forecasting of production reserves by its divisions for the intensive development of an enterprise. The forecasting of reserves by enterprise units is carried out similarly with the forecasting of reserves for each type of resource involved in production. The need of process simulation for individual divisions of the enterprise, due to the variety of processes that take place in different divisions, the variety of products that they produce, and the different functions they perform, while forecasting the total volume of production does not provide the opportunity to fully analyze the activities of the enterprise.

To determine the production reserves for a certain period, it is necessary to correlate the actual value of the sought indicator with the potential (the maximum possible value that it could achieve under the most favorable conditions). So, the production reserves of any enterprise for a certain period can be determined by the formula:

$$\Delta V = P - V, \qquad (8)$$

where *P* – potential capacity of the enterprise (potential);

V – actual production volumes for the study period.

Potential production capacity is determined by the formula[4]:

$$P = P_0 + \frac{1}{T}\sum_{t=1}^{T} \Delta P_t (T - t) \ , \qquad (9)$$

where P_0 – standard production capacity;

t – appropriate planning period interval, $t=\overline{1,T}$;

ΔP_t – change in the capacity (potential) of the enterprise in the time t.

Given that the production potential of an enterprise depends on many factors, each of which has its own reserve of power, each factor has an impact on production capacity and is an integral part of the production process. It has a throughput capacity, ensures the implementation of production capacity at the level of the calculated potential value. If for the production potential we take the maximum possible production capacity taking into account all factors, then the reserve calculated by the formula (8) can be called full. To realize the full reserve, it is not necessary to increase the capacity for any factors, but only create favorable conditions for the use of the existing capacity factors. When determining the reserves of any factors, as a rule, the normative method for calculating the capacities of the studied factors is used, when using which there are significant inaccuracies, as a result of which the average value of the power is underestimated by 20%[5,6]. The application of the proposed method for calculating will reveal additional reserves of the analyzed factors.

Reserves for increasing production over the study period can be analyzed by component intervals. For this, it is necessary to consider changes in a certain indicator for the study period, consisting of a specified number of time intervals (T). For the analysis of reserves, the symbols is introduced where: P_t – the production potential of the enterprise for the time interval t, and V_t – is the actual volume of production of the enterprise for the interval t. Thus, the analysis of the production reserve ΔV_t by the components of the time intervals makes it possible to identify reserves for each time interval:

$$\Delta V_t = P_t - V_t, \ t=\overline{1,T} \qquad (10)$$

[4] Безус П.І. Моделювання процесу економічного розвитку виробничого підприємства : автореф. дис. на здобуття наук. ступеня канд. екон. наук : спец. 08.00.11 «Математичні методи, моделі та інформаційні технології в економіці». Київ, 19 с.

[5] Крамаренко В.І. Управління ресурсами підприємства. Київ : ЦНЛ, 2004. 288 с.

[6] Антоненко Г.Я., Клименюк Н.Н., Калишук Д.А. Производственный потенциал предприятий сборного железобетона. Київ : Вища школа, 1982. 132 с.

After determining the reserves for each time interval for their practical use, it is necessary to sort the values of the reserves in descending order, identify the causes of their underutilization, develop and implement measures to eliminate them. The calculation of the total production reserves represented by equations (8), (10) is the simplest, but their practical use is difficult due to insufficient specificity. In this regard, practical interest appears in the analysis of identified production reserves for each factor separately. Factors include both production resources and production units.

To analyze production reserves for each individual factor, the following symbols is introduced:

i – factor number; $i=\overline{1,n}$;

n – number of considered factors;

P_i, P_{it} – the production potential of factor i for the entire studied period and, accordingly, for the compound time interval t ;

V_i, V_{it} – actual parameters (volumes) of factor i for the entire study period and, accordingly, for the intervals of which it consists t.

The subsequent analysis of production reserves for the study period and each component time interval makes it possible to determine the reserves for individual time intervals for each of the analyzed factors.

The absolute reserves of factor i for the studied period of time are:

$$\Delta V_i = P_i - V_{i,}, \; i=\overline{1,n} \; . \qquad (11)$$

The relative reserves of factors can be determined by the following formula:

$$\Delta V_i = \frac{P_i - V_i}{P_i} \; , \; i=\overline{1,n} \; , \qquad (12)$$

An analysis of an enterprise’s reserves by production factors in some cases may reveal additional reserves. This is possible when favorable conditions have led to the fact that the actual value of the indicator of the studied factor exceeded the previously fixed value of the indicator of this factor. Thus, the total reserve will be:

$$\sum_{i=1}^{n} \Delta V_i = \sum_{i \in \{\overline{1,n}\}: V_i < P_i} (P_i - V_i) \; , \qquad (13)$$

In this case, the total reserve exceeds the value of the reserve of the enterprise, i.e. $\sum_{i=1}^{n} \Delta V_i > \Delta V$.

Based on the analysis of the company's reserves by production factors, it becomes possible to identify additional reserves of this production as a whole:

$$\Delta V_{\partial} = \sum_{i=1}^{n} \Delta V_i - \Delta V \qquad (14)$$

If a production unit is considered as a factor, then, by analogy, an analysis of the enterprise’s reserves by units may reveal additional production reserves when the actual output exceeded the previously recorded value of production potential in at least one of the enterprise’s units.

Compared with the analysis of reserves for production units, the analysis of the enterprise’s reserves for production resources, such as labor, raw materials, material resources, fixed assets, energy resources, is the most difficult. Production reserves for each of certain factors are partial, since only their joint use will lead to an increase in production. The complexity of the analysis lies in the fact that to determine the reserves for these production factors, it is necessary to obtain information on the actual state of use of each factor for a certain period of time and their maximum throughput (potential). To compare these two values for each of the factors, they must be expressed as the number of units of products that can be made from the existing volume of this factor. The value of the indicator of the actual use of the factor of production is determined on the basis of information on the volumes of manufactured products, and the calculation of the potential or maximum possibility of this factor is carried out according to the normative method.

In almost every enterprise there are significant imbalances in the use of the main factors – resources, leading to a significant decrease in the productivity of enterprises and a decrease in their economic indicators. Numerous factors affecting the production of finished products lead to uneven development of production units of the enterprise. On this basis, the company has bottlenecks that do not allow to use the potentials of other production units to a sufficient extent. A certain increase in production under such conditions is not provided, and therefore the economic efficiency of the enterprise is reduced. Thus, the identification of those divisions and factors whose carrying capacities in the future may hamper the development of the entire enterprise, the determination of the period of occurrence of imbalances and their values will make it possible to take timely measures to increase the proportionality of the development of production divisions and production factors.

The most important among the production factors can be identified such integrated groups of resources as material, labor, energy resources. If the throughput of at least one of them is lower than the production capabilities of the enterprise unit, the volume of output will be constrained by the throughput of this component.

It is quite difficult to establish an unambiguous correspondence of production capabilities for the listed components of the production process in production due to its dynamic nature associated with constant changes in the number of employees, in the number and nomenclature of products, in the amount of raw materials involved, etc. every fixed point in time.

At the first stage, it is necessary to consider the ratio at the moment in time of the production capabilities of labor, material, energy resources and equipment. The established proportions of the production capabilities of these factors can be presented in the form of a diagram (Fig. 1), where, respectively, M_1, M_2, M_3, M_4 – are the production capabilities of labor, material, energy resources and equipment; ΔM – the value of increasing the production capabilities of factors. The production capacity of the enterprise, in accordance with the regulatory method for its determination, is always equal to the production capacity of the equipment: $M=M_4$. In fact, the production capacity of the enterprise does not correspond to this equation. This is due to the fact that the volume of production even with the assumption of the full use of the capabilities of each of the factors is defined as:

$$V = \min \{M_i, i = \overline{1,n}\}, \tag{15}$$

where i – process factor number.

Analyzing the ratio of production capabilities of factors, which is reflected in the diagram, it can be concluded that to increase production to the level of installed production capacity, it is enough to take measures to increase the production capabilities of labor and material resources, where increase of the production capabilities of material resources will be ΔM_2, and increase of production capabilities labor resources will be ΔM_1. Thus, this will ensure an increase in output by a significant amount equal to the largest of the two named values of the build-up, that is, $\Delta M^{'} = \Delta M_2$. With the possible implementation of the necessary measures, it is envisaged to increase production volumes to the level of production capacity *M*.

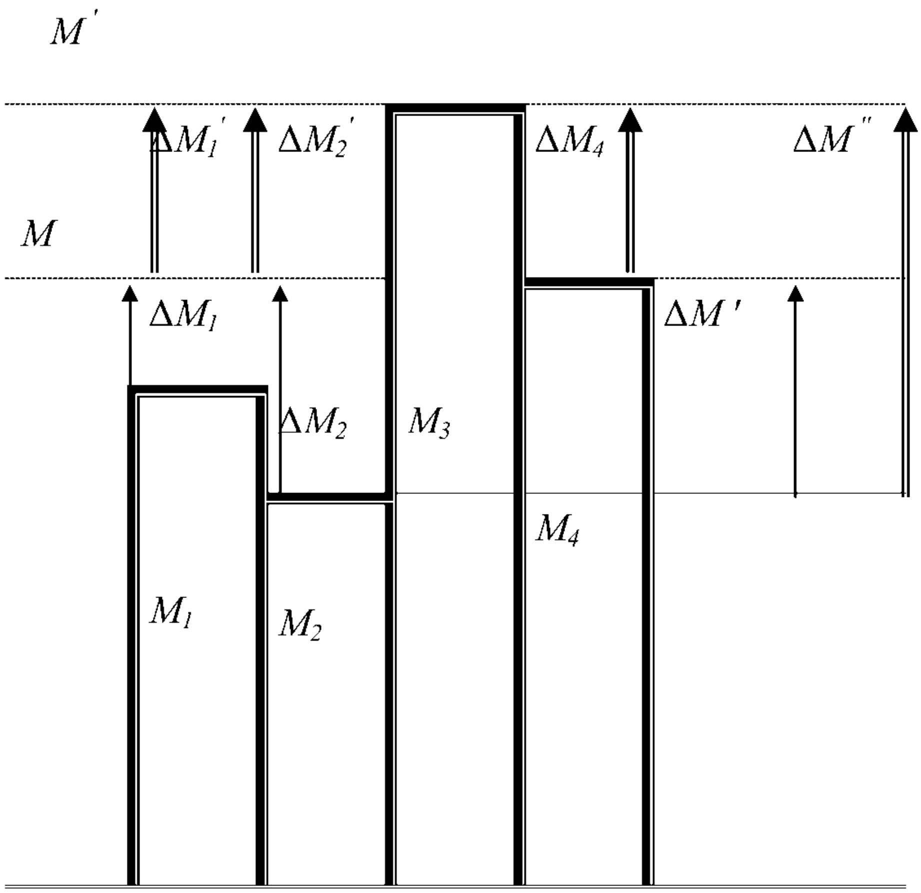

Fig. 1. The diagram of the ratio of production capabilities of factors

But it is possible to further increase production volumes due to the identified reserves of all factors (fig. 1). To further increase production to the level of production capacity $M^{'}$ it is assumed that measures should be taken to increase the production capabilities of labor, material resources and equipment. Due to the fact that at the first stage these values reached a level that can provide the same volume of output (level *M*), their increase at this (second) stage will be ΔM_4, which will be equal to the value of $\Delta M_2^{'}$ and also to $\Delta M_1^{'}$ ($\Delta M_4 = \Delta M_1^{'} = \Delta M_2^{'}$). Thus, having achieved the implementation of all the above measures, we will ensure an increase in output by an amount equal to the sum of two stackable quantities in the first and second stages

$$\Delta M'' = \Delta M' + \Delta M_4.$$

In general, provided that all stages of production increase are fully implemented, it is possible to provide for an increase in production volumes to the level of production capacity M'.

Each production process can only be carried out in accordance with the proportions for the use of various types of resources defined for a given production. Therefore, the volume of production is limited to that resource, the production capacity of which is the smallest. If the production capabilities for each of the factors are used in full, the production volumes of the enterprise (*V*) are determined by the production factor that has the minimum throughput. This value is called the production potential of the enterprise[7,8]. The production potential of the enterprise is associated with the actual production of such a condition:

$$V \le P = \min \{P_i, i = \overline{1,n}\}, \qquad (16)$$

where *P* – production potential of the enterprise;

P_i – production potential of the factor *i*;

n – number of factors i.e. components of the production process.

The cases considered above that made it possible to assess the capabilities of the enterprise by its production capacity differ from the methods for assessing the capabilities of the enterprise by production potential.

When analyzing the production activity of an enterprise at a certain point in time, its capabilities in terms of labor, material, energy resources and equipment are unequal and are equal to P_1, P_2, P_3, P_4, the values of which are shown in the diagram (fig. 2).

As can be seen from the diagram, the production potential of the enterprise is equal to the lowest value of the potential of one of the factors ($P=P_1$).

Based on the accepted conditions, the value of production potential characterizes the value of the productivity of the enterprise as a whole and coincides with it. The volume of output depends on the production potential of

[7] Антоненко Г.Я., Клименюк Н.Н., Калишук Д.А. Производственный потенциал предприятий сборного железобетона. Київ : Вища школа, 1982. 132 с.

[8] Гавва В.Н. Потенціал підприємства: формування та оцінювання. Київ : ЦНЛ, 2004. 224 с.

the enterprise and therefore, to increase production, it is necessary to increase production capacity. To build capacity, let's say from level P to level P' (aig. 2), it is necessary to increase the production potential of labor, material resources and equipment by appropriate values, which is ΔP_1, ΔP_2 i ΔP_4.

The production potential for various types of resources at each enterprise and in each individual time interval can vary. The proportions of the production potentials of these resources also change, and in connection with this, the production potential of the entire enterprise changes.

The analyzed situation is fixed in time and does not reflect the influence of constantly acting random factors arising in the course of production processes. In real conditions, the task of increasing productivity is different in that its performance indicators cannot be indicated by a single number due to the constant influence of random factors. Thus, a factor with a minimum value of performance is a constraining factor at a given time.

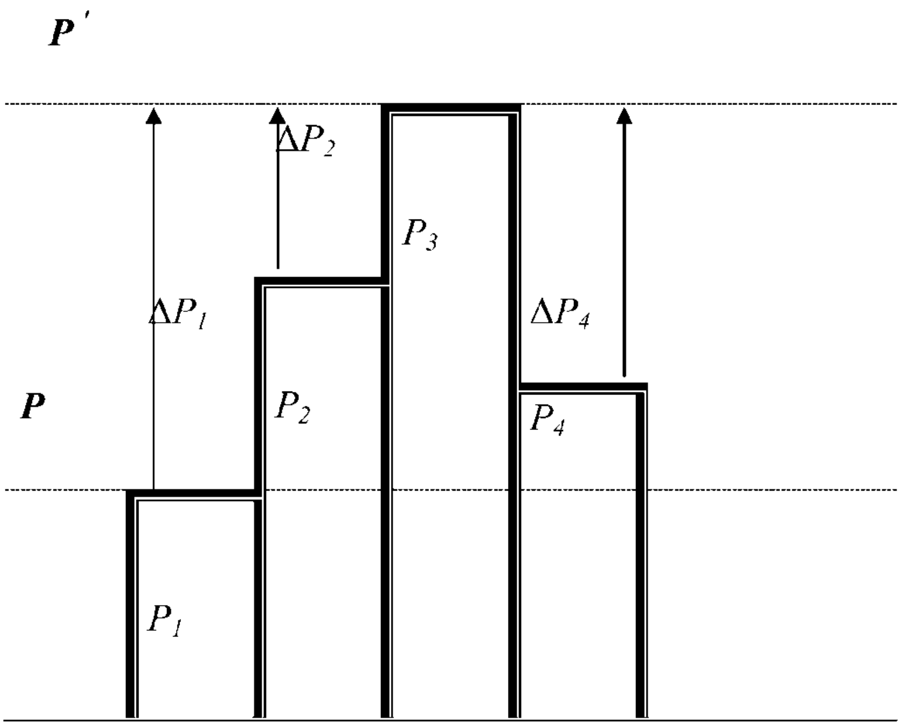

Fig. 2. The diagram of the ratio of production potentials of the studied factors

In addition to the influence of all existing factors on the production volume of the enterprise, for the most detailed analysis of production, we can study the dynamics of changes in the productivity indicator for each individual production factor. A detailed study of the dynamics of changes in the performance indicator for each factor of production over a long period makes it possible to establish the corresponding limits of changes in this indicator. The volume and nature of changes in productivity for each factor of production over time are determined by the relevant laws. After establishing the maximum and minimum boundaries of the indicator of production capabilities of the studied factor, you can set the average value of this indicator for a certain period of time using the following formula:

$$\overline{V} = \frac{\sum_{t=1}^{T} V_t}{T}, \qquad (17)$$

where V_t – indicator of production capabilities of the factor, which is analyzed in the time interval t ;

t – number of the investigated moment of time, $t = \overline{1,T}$.

In the process of research, the nature of the corresponding changes in productivity indicators for each production factor over time is determined and the boundaries of their deviations are compared and their average values are determined by the formula (17), (fig. 3).

M – enterprise production capacity;

$\overline{V_1}$, $\overline{V_2}$, $\overline{V_3}$, $\overline{V_4}$ – average production capabilities of factors.

If during the analysis, when comparing the average values of the indicators of production capabilities of factors, a factor appears that has a significantly lower indicator among them, then a further solution to the problem of increasing production volumes of the enterprise is directed to taking measures to increase average production capabilities for this factor of production.

However, there are cases when the average values of production capabilities of various factors are close to each other. Let us suppose that when analyzing the production activity of an enterprise over a certain period of time, the average values of production capabilities of various factors are equal. Then, in accordance with the above, the increase in the average value of one of the factors will not lead to an increase in the volume of production. Because, as noted, to increase the volume of production of the enterprise, in this case, can only lead to an increase in production capabilities for all factors. But taking into account the peculiarities of changes in production factors and their interaction, we can conclude that even with equal average values of indicators of production capabilities of the studied factors, an increase in any of them will lead to an increase in the productivity of the entire enterprise.

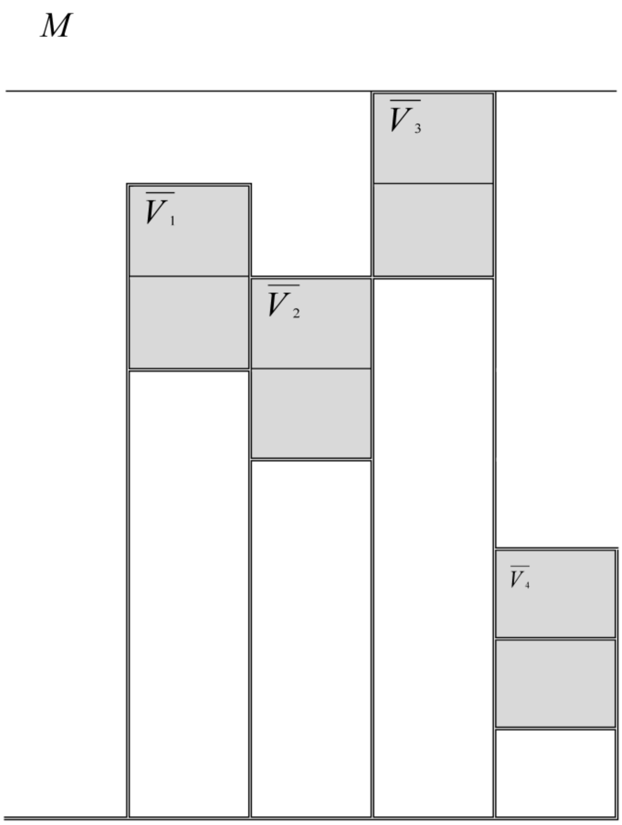

Fig. 3. The nature and boundaries of changes in the production capabilities of factors of production

In general, the dependence of increasing the production volume of any enterprise on increasing the production capabilities of a single factor, the average value of which is the smallest among the factors, depends on the conditions prevailing in this enterprise. The dependence of increasing the production volume of the enterprise on one factor is carried out according to the dependence characteristic of the enterprise (fig. 4). The initial increase in the enterprise's production by increasing the average indicator of the studied factor can be carried out according to a linear relationship, but its further increase begins to be reproduced in accordance with the dependence described by the nonlinear function.

Analyzing the graph, it can be noted that an increase in enterprise production due to an increase in the average indicator of the studied factor in the section from V_{i0} to V_{i1} is displayed by a linear relationship.

This happens because this dependence at a given time reflects such production conditions when other factors do not have a negative effect and an increase in production volumes, that is, the average value of the production capabilities of the concidering factor is much less than the productivity of other factors of this production.

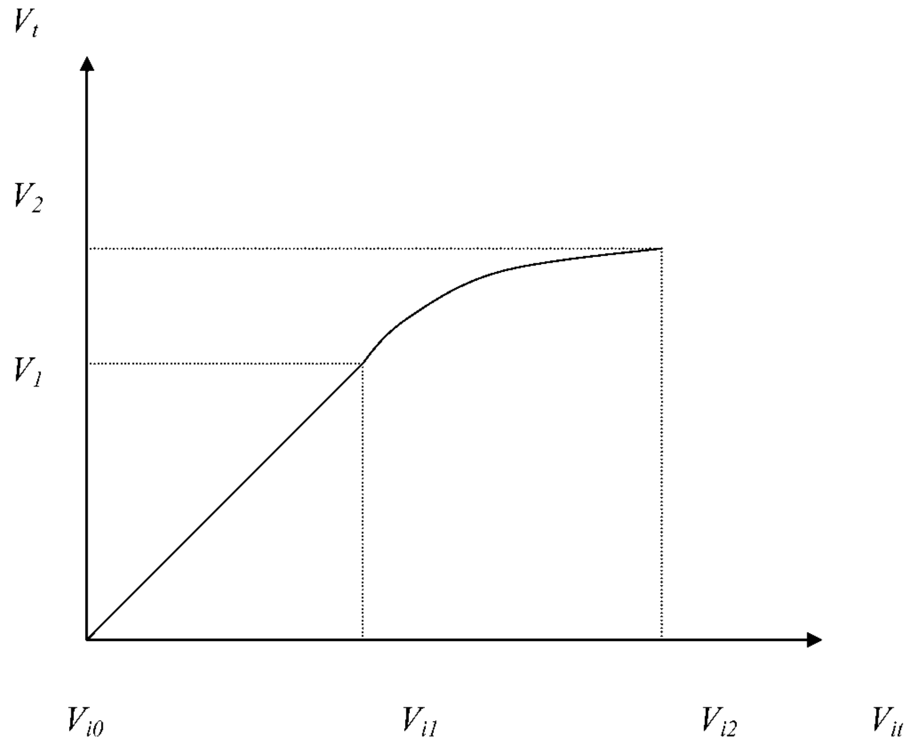

Fig. 4. The dependence of the increase in the volume of production of the enterprise (V_t) on the increase in production capabilities of the factor *i* (V_{it}).

This situation will be observed until the upper boundary of the production capabilities of this component reaches the lower boundary of the production capabilities of any of the other factors of production and, therefore, from this stage, at some points in time, the constraining factor will be the production factor that has the smallest of production capabilities in a given time interval.

Upon further analysis of the graph, it can be noted that in the area of increasing the indicator of production capabilities of factor *i* from V_{i1} to V_{i2}, changes in production volumes of an enterprise from increasing volumes of only this component begin to be described by a nonlinear dependence arising between them. And this happens because a further increase in the production capabilities of this factor can no longer lead to a proportional increase in the productivity of the enterprise as a whole due to the influence of other factors of production, that is, with their deterrent effect.

2. The model of optimal production growth

The considered methods of increasing production volumes can influence the increase in production efficiency. But in order to develop the best option for increasing production volumes, to determine the groups of factors affecting changes in production volumes of an enterprise, it is necessary to carry out a correlation and regression analysis. According to its results, there is a need to clarify the magnitude of the influence of these factors on production volumes since the above analysis establishes only a general view of the dependence of factors.

Due to the complexity that may arise when constructing a function that should reflect the dependence of changes in production volumes on increasing volumes of each of the factors, taking into account their mutual influence, it becomes necessary to apply process modeling to determine these dependencies.

To determine the parameters of changes in each of the factors, it is necessary to use data that characterize the dynamics of production and provide an opportunity to obtain the existing regularity of changes in these factors. Based on these data, for constructing models, it is necessary to apply the values behind the studied dependencies using time series. Before building models of the dependences of the volume of production on each of certain factors, it is necessary to find out the mechanism of influence of each factor on production[9]. To identify at each analyzed point in time the potential value of output by the studied factor, it is necessary, taking into account the actual value of the volume of output, to determine the amount of underutilization of this factor through the deterrent effect of other factors.

[9] Безус А.М., Безус П.І. Управління розвитком підприємства: моделі та методи : монографія. Київ : ВПЦ АМУ, 2008. 152 с.

The size of the underutilization of the studied factor due to the impossibility of implementing other factors at a given time is the value of exactly that additional production volume that could be produced at this enterprise in the absence of restrictions on other production factors.

To determine the volume of underutilization of the studied factor over any period of time (for example, a 24-hour period), it is necessary to take into account the total amount of all downtime due to a lack of other resources. Thus, the existence of data on actual volumes of production and on volumes of products that are not manufactured due to limited opportunities for other components of production, provide an opportunity to determine the potential output with the full implementation of the studied factor:

$$V_{it} = V_t + \Delta V_{it}, \quad i = \overline{1,n}; t = \overline{1,T} \ , \qquad (18)$$

where V_t – indicator of the volume of production of the enterprise in the time interval t ;

V_{it} – potential production volume of the enterprise, which can be obtained in the time interval t with the full realization of the factor$i$;

ΔV_{it} – the size of the unfinished volume of production in the time interval t due to limited capabilities in other components of production except for the factor i ;

i – considering factor number, $i = \overline{1,n}$;

t – number of the investigated moment of time, $t = \overline{1,T}$.

So, having determined the volume of output shortage of products that could be manufactured under the condition that the investigated factor is fully realized, it becomes possible to determine the potential output for a given period of time. Based on the obtained data, it becomes possible to determine the type of predictive function that will allow you to predict the necessary trend of a number of dynamics:

$$V_{it} = f_i(t) \ , \quad i = \overline{1,n}; \ \ t = \overline{1,T} \ , \qquad (19)$$

Thus, the obtained functions for each production factor make it possible to study the effect of each of them on the production process and to establish the dependence of changes in production volumes on the increase in the volumes of the studied factors.

To establish the dependence of changes in production volumes on the degree of increase in the magnitude of the investigated factor, it is necessary, based on actual data, to determine the potential production volumes per day for each of the studied factors. Then, based on these data, determine the production volumes of the enterprise (unit) per day, based on the fact that $V_t = \min_i \{V_{it}\}, \ t = \overline{1,T}$. The annual production volume consists of the daily values of this indicator, i.e. $V = \sum_{t=1}^{T} V_t$.

Based on the size to which this factor will increase, a certain interval of its changes, or step, is taken. The number of intervals is determined depending on the characteristics of the factor, that is, if the growth of the factor leads to a nonlinear dependence, it is advisable to take about ten intervals of gradual changes in the values of the studied factor, if this dependence approaches linear – the number of intervals can be reduced.

Having determined the volume of the buildup of the studied factor and the number of intervals, the value of the interval equal to l_m, $m = \overline{1,L}$ is taken.

After accepting the value of the interval, that is, determining the value by which you can increase the value of this factor, for example (l_1), you need to adjust the initial function by this factor, and for this you need to increase the free term of the function by the value $l_1\overline{V}_i$, where $\overline{V}_i$ is the average value of the production capabilities of the *i*-factor. In this regard, replace the initial function for this factor with the adjusted one and then, on the basis of this, determine new values of the enterprise (unit) production volumes per day and for the whole year.

After the calculations performed in two stages, it is possible to obtain the first point of dependence of the increase in production volume on the factor increase, which is determined on the one hand by the parameter of the factor increase, that is, l_1, and on the other hand, the increase in annual production volume (ΔV_1), which is calculated by determining the difference between the last adjusted value of the volume of production of the enterprise and its initial value.

Thus, we obtained the first dependence point with the following coordinates (l_1; ΔV_1).

To obtain other dependency points under construction, it is necessary to repeat the chain of the described calculations, starting with a twofold increase in the value of the studied factor, i.e., up to $l_2 = 2\, l_1$.

So, after calculating all the necessary parameters, using the developed method, you can get a set of points (l_m; ΔV_m), that form the desired dependence of increasing the volume of production on increasing the volume of the studied production factor[10].

In the same way, after appropriate calculations for each of the factors selected during the analysis of production, the dependences of increasing production on the changes in each of these factors are obtained. For the task of optimally increasing the production volumes of an enterprise by identifying and using existing production reserves, it is necessary, first of all, using correlation and regression to determine the group of factors that are most influential on the production process and to build an economic-mathematical model of the optimal increase in production volumes.

To realize an increase in production volumes by the indicated value, it is necessary to influence the group of the most influential factors determined by preliminary analysis in order to increase their production capabilities or volume. But you need to take into account the fact that each of the factors has a certain area of its growth. Introducing into the model the value of the limiting value of growth, set restrictions on each of the factors.

Let us suppose that in the course of the correlation and regression analysis, the group of the most influential results of the production of factors is determined consisting of the number of industrial production personnel (K), total volumes of raw materials received (L), the active part of fixed assets (M).

To determine the limitations, the above factors are introduced into the mathematical model of the problem with the indication of those quantities that are limiting for each of the factors in accordance with the capabilities of the enterprise. Thus, the following values acquire a restriction for each of the factors: $0 \leq \Delta K \leq a$; $0 \leq \Delta L \leq b$; $0 \leq \Delta M \leq c$, where a, b, c – limiting values of the buildup of each factor.

But specifying the areas of change of factors is not enough to fully formulate the limitations of the model of this problem. It is also necessary to determine the effect of the growth of each of the factors on the change in the indicator of the volume of products manufactured by this enterprise.

In general, they can be displayed as follows:

[10] Безус А.М., Безус П.І. Управління розвитком підприємства: моделі та методи : монографія. Київ : ВПЦ АМУ, 2008. 152 с.

– the dependence of production on the number of personnel – $V=f_1(K)$;

– the dependence of production on the supply of raw materials – $V=f_2(L)$;

– the dependence of production on the active part of fixed assets – $V=f_3(M)$.

After defining these functions, we can formulate in the final form the necessary limitation for this model, which should provide a given increase in production volume (ΔV), in which case it can take the following form:

$$f_1(K)+ f_2(L)+ f_3(M)\geq \Delta V.$$

The next step is to determine the type of each of the functions that describe the nature of the changes occurring in a given production, and to determine the values of the buildup of selected factors at which a given increase in production will be achieved.

In addition to the limitations in the mathematical model, it is necessary to determine the objective function. Due to the fact that an economic and mathematical model is being created for the task of optimally increasing the production volume of an enterprise by increasing the volume of production factors, exactly this task is the basis for the formation of the objective function of the model. Given that increasing the indicator of each of the factors requires different unit costs for the production of additional products, it is necessary to compare all possible options for further changes in factors to select the optimal development option for this enterprise. In this regard, it is necessary to determine such a combination of selected factors and the buildup of each of them that, with an increase in production by a given amount, will lead to minimum total costs of the enterprise, and will be the optimal solution to this problem. Thus, the objective function reflects the goal of reducing production costs while increasing the volume of all influential factors of production. But before formulating the objective function, it is necessary to determine the dependence of production costs on the buildup of each factor. To do this, it is necessary to determine the function of cost changes from increasing its volume that is suitable for each factor. So, the change in costs from increasing the number of industrial production personnel (ΔK) reflects the function $U= u_1(K)$; the function $U= u_2(L)$ reflects the production costs from increasing the total volumes of raw materials (ΔL); the function $U= u_3(M)$ reflects production costs from building up the active part of fixed assets (ΔM).

The objective function of the formulated problem model reflects the main goal – the optimal increase in the enterprise's production by increasing factors and is expressed through minimizing the total costs, which can be represented in the following form:

$$u_1(K)+u_2(L)+u_3(M)\rightarrow \min.$$

In general, the task of optimally increasing production volumes due to production factors is to find such unknown values of increasing the factors identified during the analysis that will provide a given level of increasing the volume of production, while the restrictions for each factor will be met, and the total cost of increasing these factors will be minimal[11].The general view that the mathematical model of this problem acquires is as follows:

Target function:

$$u_1(K)+u_2(L)+u_3(M)\rightarrow \min; \tag{20}$$

Limitation:

$$\left.\begin{array}{c} f_1(K)+f_2(L)+f_3(M)\geq \Delta V; \\ 0\leq K\leq a; \\ 0\leq L\leq b; \\ 0\leq M\leq c, \\ a\geq 0,\ b\geq 0,\ c\geq 0, \end{array}\right\} \tag{21}$$

where ΔV – increase in production volume;

a, b, c – limit values of the buildup of each factor, in accordance with the capabilities of the enterprise.

After determining the boundaries of the growth of factors, it is necessary to determine the influence of the growth of the values of each of the factors on the subsequent increase in production volumes. To determine the described dependencies, it is advisable to use simulation.

To reproduce the predicted values for each of the dependencies, time series are constructed. To determine the parameters of time series in the form of input information, empirical data are introduced that characterize the current production and reflect the patterns of changes and random fluctuations of each factor.

[11] Безус П.І. Моделювання процесу економічного розвитку виробничого підприємства : автореф. дис. на здобуття наук. ступеня канд. екон. наук : спец. 08.00.11 «Математичні методи, моделі та інформаційні технології в економіці». Київ, 19 с.

In the case of construction, the time series should reproduce the value of potential production volumes, which will be due to adjustments in the process of increasing the volume of a certain factor. To build the dependence of production volume on the factor buildup, it is necessary to note all the equal empirical time series for each of the factors and determine the indicators of possible output volumes for each factor. The obtained functions for each production factor $(V_{it} = f_i(t))$ provide an opportunity to establish the dependence of changes in production volumes on increasing volumes of the studied factors. But the dependence of increasing production volumes on an increase in any factor can acquire intensive growth only at the initial stage of increasing the volume of this factor. At the next stages, there will be a decrease in the proportional increase in production volumes with the same increase in the amount of this factor. This is due to the fact that at the next stages, an increase in the volume of the analyzed factor begins to negatively affect the growth in the volume of production of the deterrent effect of other factors. Thus, the dependencies that are determined are approximated by a staircase dependence[12]. To determine the parameters of the staircase dependence, the least squares method is used, but the linearization of the curve is also used. After determining the parameters of the time series of the dependencies of indicators of potential production volumes for each of the production factors, an economic-mathematical model is created. Due to the fact that the established dependences of changes in production volumes on the buildup of each factor, taking into account their mutual influence, are presented in the form of nonlinear functions, the constructed model belongs to the class of nonlinear programming problems of a separable form and in this case does not have an exact solution method. For practical implementation, one of the known methods can be applied with the help of which this task will be transformed into a linear programming task[13].

CONCLUSIONS

Ukraine's GDP growth is extremely low. One of the reasons is that manufacturers of gross domestic product are in a state of limited resources and that, in turn, limits their ability to increase production. Therefore,

[12] Швачич Г.Г. Сучасні інформаційні технології в математиці для економістів. Київ : ЦНЛ, 2003. 236 с.

[13] Кузнецов Ю.П., Кузубов В.И., Волощенко А.Б. Математическое программирование. Москва : Высшая школа, 1980. 224 с.

under such a condition, methods of increasing production volumes by business entities without attracting investments deserve special attention due to the determination and optimal use of reserves for each production factor. The proposed model of optimal increase in production volumes allows us to provide a given level of increase in production volume with minimal costs for building up production factors defined in the process of analysis.

SUMMARY

The work explores a method of increasing production volumes due to production reserves. The total reserves of production are determined, for which the actual value of the indicator under study is correlated with its potential. The dependences of changes in production volumes on increasing volumes of each of the factors are determined taking into account their mutual influence. An economic-mathematical model of the optimal increase in production volumes is proposed.

REFERENCES

1. Статистичний щорічник України за 2016 рік. *Державна служба статистики України.* Київ : ТОВ «Август Трейд», 2017. 552 с.
2. Безус П.І. Моделювання нарощування обсягів виробництва. *Економіка та підприємництво* : Збірник наукових праць. 2007. Вип. 18. С. 307–312.
3. Скурихин В.И., Шифрин В.Б., Дубовский В.В. Математическое моделирование. Київ : Техніка, 1983. 270 с.
4. Безус П.І. Моделювання процесу економічного розвитку виробничого підприємства : автореф. дис. на здобуття наук. ступеня канд. екон. наук : спец. 08.00.11 «Математичні методи, моделі та інформаційні технології в економіці». Київ, 19 с.
5. Крамаренко В.І. Управління ресурсами підприємства. Київ : ЦНЛ, 2004. 288 с.
6. Антоненко Г.Я., Клименюк Н.Н., Калишук Д.А. Производственный потенциал предприятий сборного железобетона. Київ : Вища школа, 1982. 132 с.
7. Гавва В.Н. Потенціал підприємства: формування та оцінювання. Київ : ЦНЛ, 2004. 224 с.

8. Безус А.М., Безус П.І. Управління розвитком підприємства: моделі та методи : монографія. Київ : ВПЦ АМУ, 2008. 152 с.

9. Швачич Г.Г. Сучасні інформаційні технології в математиці для економістів. Київ : ЦНЛ, 2003. 236 с.

10. Кузнецов Ю.П., Кузубов В.И., Волощенко А.Б. Математическое программирование. Москва : Высшая школа, 1980. 224 с.

Information about the author:
Bezus P. I.
PhD in Economics, Associate Professor,
Associate Professor Department of Management and International Economic Relations,
V. I. Vernadsky Taurida National University
33, John McCain str., Kyiv, 02000, Ukraine

DOI https://doi.org/10.36059/978-966-397-123-0/26-44

THE CONCEPT OF ENTERPRISE SECURITY MANAGEMENT

Demenska K. S.

INTRODUCTION

The security of the enterprise (firm) should be understood as the state of its stable activity, in which programs are implemented, profit and protection against external and internal destabilizing factors are provided.

The main aspects of the concept "security":

• external and internal threats;

• existence of vital interests of the objects of protection;

• balance of interests between them.

The presence of threats is primary in these definitions. And this is natural, because if they are not there, what then to defend from? The secondary aspect is the existence of vital interests, i.e. those interests, the implementation of which determines the existence of security objects and without which objects cease to exist as a whole. For example, for the state it is sovereignty and integrity of borders, economic growth; for the enterprise – effective current activity and stable tendencies of development[1].

1. Concepts and types of enterprise security

The purpose of ensuring the security of an enterprise (firm) should be a comprehensive counteraction to potential and real threats, the elimination or minimization of which should guarantee the economic entity the success of functioning in unstable conditions of the external and internal environment.

The security of the enterprise can be divided into the following types (Fig. 1).

The central element of ensuring the enterprise security in general is the economic security of the entity.

[1] Користін О.Є., Чернявський С.С. Протидія відмиванню коштів в Україні: правові та організаційні засади правоохоронної діяльності : навчальний посібник. Київ, 2009. 612 с.

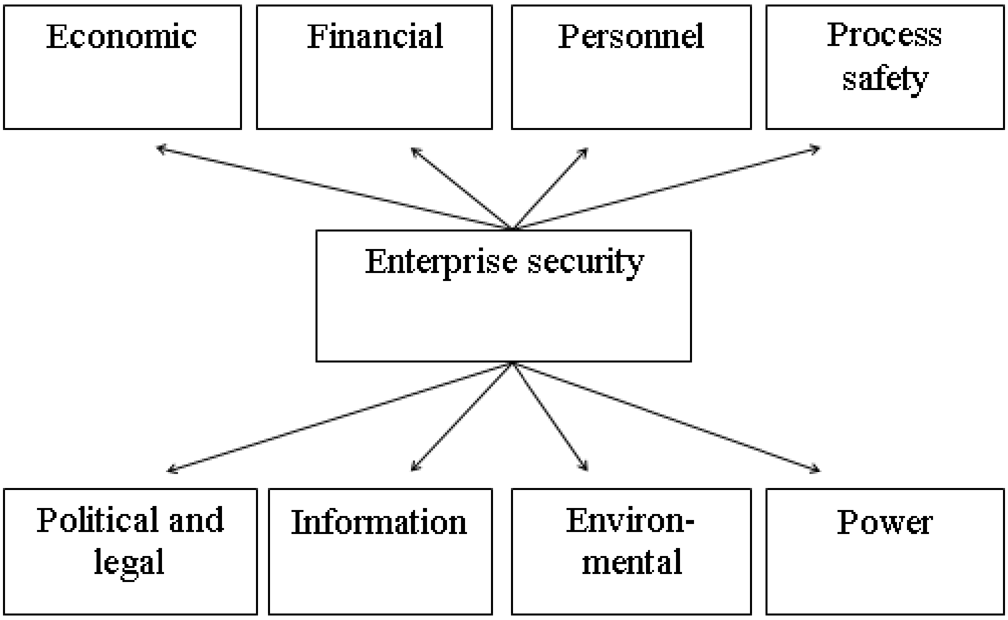

Figure 1. Types of enterprise security

The concept of economic security has undergone a lot of rethinking in economic theory due to changes in environmental conditions and taking into account the factors that determine management processes. In the modern scientific literature, the term "economic security" is often derived directly from the more general category of security (from Greek means "to control the situation"). The professional literature provides a definition of security as a condition in which any object is in a position of reliable protection and is not exposed to the negative influence of any factors. In a general scientific sense, security means the protection of natural-physiological, socio-economic, ideal-spiritual and situational needs for resources, technologies, information and moral ideals necessary for the life and development of the population[2].

Another important component of enterprise security is financial security. Without ensuring sustainable financial security, it is almost impossible to solve any of the tasks facing the enterprise.

The concept of financial security is as broad as the interpretation of finance as an economic category. Today there is no one well-established definition of "financial security". The existing wording reflects only certain aspects of financial security and cannot claim its unambiguous and

[2] Ігнашкіна Т.Б. Економічна безпека підприємства та її трактування у праць. ПДТУ. Маріуполь, 2011. Т. 2. С. 204–207.

full interpretation. Financial security as a definition is viewed from different angles, in particular:

– resource and functional approach determines financial security as protection of financial interests of business entities at all levels of financial relations; security of households, enterprises, organizations, institutions, regions, industries and sectors of the state's economy with financial resources sufficient to meet their needs and fulfill their obligations;

– in terms of statistic, financial security is a state of financial, monetary, currency, banking, budgetary, tax, investment, customs, tariff and stock systems characterized by balance and resistance to internal and external negative impacts, ability to prevent external financial expansion to ensure the effective functioning of the national economic system and economic growth;

– in the context of legal regulation, financial security provides the creation of such conditions for the functioning of the financial system, in which, firstly, there is no possibility to direct financial flows to the areas of their use that are not protected by legislative acts, and, secondly, the possibility of abuse of financial resources has been reduced to a minimum[3].

Thus, from the standpoint of a multifaceted approach, financial security is the protection of financial interests at all levels of financial relations; a certain level of independence and stability of a country's financial system under external and internal destabilizing factors that threaten its financial security; the ability of the financial system of the state to ensure the effective functioning of the national economic system and sustainable economic growth.

One of the most important aspects of the organization of enterprise security is work with personnel. Personnel security is the process of preventing the negative impact on the enterprise security due to the risks and threats related to the personnel, its intellectual potential and labor relations in general.

Personnel security plays a dominant role in the security system of the company, as it is the work with human resources, and they are the primary in any organization.

In fact, in addition to external threats to the security of the company, there are internal, arising from its own personnel. Here we are not even talking about the economic threat that may arise due to someone's negligence,

---

[3] Фінанси : Підручник. 4-те вид. Київ : Центр учбової літератури, 2009. 312 с.

incompetence or mere accident. We mean quite deliberate theft, sabotage, bribery, disclosure of trade secrets and other unfair actions of employees.

Therefore, an important component of enterprise security is personnel security. It is a process of preventing negative impacts on the enterprise security because of the risks and threats related to the personnel, its intellectual potential and labor relations in general [4].

Enterprise process safety is the level of conformity of the technologies applied at the enterprise to the best analogues in the world for cost optimization. The negative effects on this component include:

actions aimed at undermining the technological potential of the enterprise;

violation of technological discipline;

obsolescence of the used technologies.

A lack of external and internal investment can be considered as external threats to the weakening of process safety. Difficulties in obtaining long-term loans from banks make it impossible to replenish the working capital of the enterprise and direct them to the equipment fleet.

All this leads to the use of outdated equipment, technology and a significant threat to process safety of the enterprise.

Increasing energy prices, the absence of long-term supplier contracts, supplier failure are external security threats that are quite high. Ukraine purchases more than half of the required energy resources abroad, which is why rising energy prices leads to an increase in the cost of production [5].

Political and legal security of the enterprise is protection against excessive tax pressure, unstable legislation, and inefficient work of the legal department of the enterprise. It defines the environment in which businesses operate as well as the “rules of the game for them”.

The legal component is the comprehensive legal support of the enterprise, compliance with current legislation. The legal danger is posed by:

insufficient legal protection of the enterprise’s interests in contract and other business documents;

poor qualification of the employees of the relevant economic entity's legal service and mistakes in the recruitment of that entity;

---

[4] Швець Н.Р. Методи виявлення і збереження кадрової безпеки, або Як перемогти зловживання персоналу. Київ : Журнал «Персонал». 2006. № 5.

[5] Іванілов О.С. Економіка підприємства : підручник 2-ге видання Затверджено Міністерством освіти і науки України для студентів вищих навчальних закладів. Київ : «Центр учбової літератури», 2011.

violation of legal rights of the enterprise and its employees;

intentional or unintentional disclosure of commercially important information;

violation of patent law.

The legal patent and licensing service should deal with counteracting these negative impacts; in particular, it should provide legal support for the activity of the enterprise, legal processing of contract documentation, conducting legal and arbitration proceedings, legal training of personnel, control of violations of patent law, etc.

External threat of political and legal enterprise security is frequent changes of the government, instability of the tax system, excessive state interference in business affairs, etc. The lack of legal guarantees in the case of forcible alienation of property, blocking of accounts of enterprises is a serious threat to the activity of the enterprise.

The purpose of the Enterprise Information Security Component is to ensure the continuous working of the organization and to minimize damage from the events containing a security threat.

Information security requires solution to the following issues:

1. Security Policy.
2. Organization of protection.
3. Classification of resources and their control.
4. Personnel security.
5. Physical and environmental security.
6. Administration of computer systems and computer networks.
7. Access control systems.
8. Development and maintenance of information systems.
9. Planning for the continuous working of the organization.
10. Compliance with requirements.

Information security: protection of information; its components:

a) protecting sensible information from unauthorized disclosure or interception;

b) ensuring the accuracy and completeness of information and computer programs;

c) ensuring the availability of information and vital services, when it is required by the user.

Information security management provides a mechanism that enables the implementation of information security.

Risk analysis is a comprehensive term that includes:

– identifying and analyzing the potential threats to computer systems and their vulnerabilities;

– providing management with the information needed to make decisions related to the optimization of investment in information security measures.

Security incident is an event that resulted (or could have resulted) in the loss or damage of an organization's information resources, or an action that violates the organization's security rules.

It is also necessary to consider the enterprise security in the environmental sphere. Environmental enterprise security is protection against the destructive influence of natural, man-made factors and the consequences of the enterprise's business activity. Floods, earthquakes, tornadoes, landslides, avalanches can cause enormous damage to the property of the enterprise and the health of workers. It is impossible to predict natural disasters in practice, but every effort must be made to minimize the consequences of natural disasters for the enterprise. Man-made disasters arise from the use of physically worn-out fixed assets, unplanned power outages or because of the poor qualification and irresponsibility of workers. Environmental losses can significantly affect the financial condition of the company. For example, such events as a legal action for violations of environmental legislation, an accident with environmental consequences at the enterprise, cause losses that fall into the financial and environmental category and are measured in monetary form. Environmental losses due to the loss of health of the company’s employees, the reduction of production volumes and sales of products affect the financial position of the company slightly slower. Environmental damage such as human suffering due to loss of health cannot be measured in monetary terms. Compensation for that is determined subjectively. The environmental damages of the company may be uncovered or partially covered. For the organization it is a significant source of danger [6].

Power enterprise security is protection of an individual from threats to his life, health and material welfare, as well as protection of the enterprise’s property from criminal encroachments. The power component is to ensure the physical security of the employees (especially the

---

[6] Ортинський В.Л., Керницький І.С., Живко З.Б. Економічна безпека підприємств, організацій та установ : навчальний посібник. Київ : Правова єдність, 2009. 542 с.

managers) and to preserve property of the enterprise. The main negative impacts on this component include physical and moral influences on specific individuals (especially on management and leading specialists) in order to harm their health and reputation, which threatens the normal activity of their enterprise.

Negative impacts that cause damage to the property of the enterprise, threaten to reduce the value of its assets and loss of industrial independence (misinformation, destruction of information). The causes of these negative phenomena are:

the inability of competitors to achieve the benefits using correct methods of market character, that is, by improving the quality of their own products, reducing current costs of production (activity), improving market research, etc.;

criminal motives for obtaining income by criminal legal entities (individuals) through blackmail, fraud or theft;

non-commercial motives for encroachment on the life and health of managers and employees of the enterprise (organization), as well as on the property of the company.

Ensuring the safety of business entities is a relatively new phenomenon for Ukraine, but at the same time it has acquired a very serious relevance. The formation and development of domestic entrepreneurial business was influenced by various factors, mostly negative ones.

The lack of proper protection of business activities by the state, the imperfection of legal regulation of relationships in the field of business security did not create preconditions for its effective development, which in turn forced entrepreneurs to seek ways of survival, focusing on their own opportunities. During more than 20 years of existence of an independent Ukraine, the activity of domestic entrepreneurial business not only gained certain economic development and experience, but also steeled itself in the constant fight against all kinds of dangers and threats. For such a struggle, domestic entrepreneurs have created a powerful system of their own security, which has been hindered by unfair and criminal activity in the sphere of business, and protects the interests of business entities in their relations with competitors, counterparties, clients, and the state.

An analysis of recent studies and publications has shown that many works by both Ukrainian and foreign scientists are devoted to the issue of security. There are many different approaches to determining the enterprise security, but as a rule, they are subjective and do not cover the main issues of the topic. Therefore, for further research it is advisable to improve the concept of enterprise security, as well as to identify and motivate such an important type of security as process security.

The main purpose of security management is to ensure the efficient functioning of the economic use of all enterprise resources (capital, labor force, information, technology, equipment, rights), and sufficient skill level of personnel that gives the opportunity to use them most effectively for stable functioning and dynamic scientific, technical and social development, as well as for constant increase of the existing enterprise's potential and its stable development.

2. Factors affecting enterprise security

Security of the enterprise as an economic entity includes its security at all stages of the enterprise operating cycle. Therefore, security should be understood as the ability of the enterprise to resist and function normally under the influence of internal and external threats that can negatively affect its work and development. In order to maintain a stable level of security, it becomes expedient to identify these threats and determine their impact on the production process. For this purpose it is necessary to classify the main factors that can interfere with the normal functioning of the enterprise into groups and to carry out their analysis (Fig. 2).

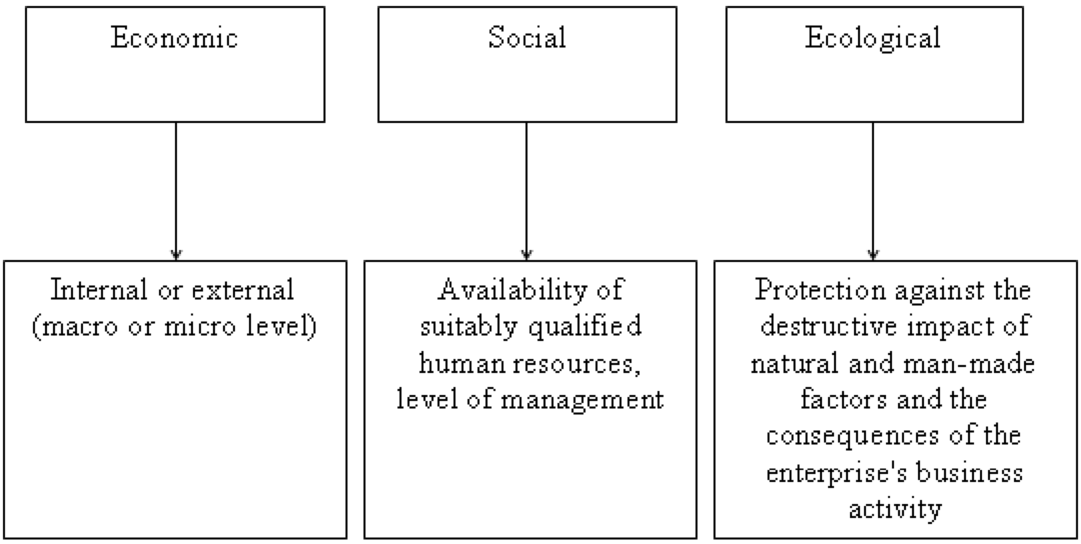

Figure 2. Classification of factors that cause production failure

There are two types of economic factors: external and internal. External factors include:

Table 1

Classification of external economic factors

External factors	Opportunities and threats
Economic	economic situation in the country
	monetary policy
	distribution of state budget funds
	inflation rate
	increase (or decrease) in production volumes
	consumer activity
	degree of consumer satisfaction
	the attitude of consumers to the quality of goods and services
	price level for the supplied products
	the quality of the supplied products
	supplier reliability
	fairness of the competition
	level of goods competitiveness
Social labor	income level of the population
	unemployment rate
	demographic situation
Political	political stability (or instability)
	legislative and regulatory frameworks
	the nature of recent reforms
Scientific, technical and innovative	development and introduction of new technologies
	state support in scientific, technical and innovative sectors
Legal	nature and level of implementation of legislative acts
	changes in tax legislation
	legislative regulation of social and labor issues
Natural and geographic	availability of natural resources
	geographical location of the enterprise
	state of the enterprise environment

Internal factors include:

Table 2

Classification of internal economic factors

Internal factors	Opportunities and threats
Financial factors	general financial and economic potential of the company
	product cost
	profit (loss) of the enterprise
	financial stability
Process and technological	enterprise availability with the basic means of production
	behavior of the productivity growth curve
	flexibility of the production process
	perfection of production technologies
	smooth production flow
	qualified service of the technological equipment
	violation of technological process
Marketing	level of goods competitiveness
	breadth of the product range
	production quality
	effectiveness of pricing policy
	quality of customer service

The social factors affecting the enterprise security should be identified as follows (table 3).

Environmental factors include: the impact of natural and man-made factors on the economic activity of the enterprise (floods, earthquakes, tornadoes, landslides, avalanches, epidemics).

Identification and elimination of economic, social and environmental factors in a certain period of time will allow to increase the level of safety at the enterprise and to improve the course of the production process, which ensures maximum economic effect for a given economic unit in a certain branch of economy.

Identification and elimination of economic, social and environmental factors will allow to increase the level of enterprise security and to improve the progress of production process, which ensures maximum economic effect for a given economic unit in a certain branch of economy.

Table 3

Classification of social factors

Social factors	Opportunities and threats
Organizational and management	compliance of the organizational structure with the enterprise needs
	level of managers competence
	management efficiency
Human	availability of personnel
	level of personnel professional training
	opportunity for career advancement
	providing conditions for the realization of labor potential
	satisfaction of employees' needs
	normal working conditions of workers in production shops and workplaces

The purpose of ensuring the enterprise security should be a comprehensive counteraction to potential and real threats, the elimination or minimization of which should guarantee the entity the success of operation in unstable conditions of the external and internal environment.

As pointed out above, for the normal operation of the enterprise it is necessary to be able to counteract threats. These threats can come from different ways and the main ones are selected in groups and defined as types of security.

Among the list of types of enterprise security, precious little attention is paid in literature to such an important type of security as process safety. Its main point, basis, organization, formation and action of the concept are not described. Therefore, it is necessary to define and analyze the process safety of the enterprise and to find its connection with other types of security.

Therefore, process safety is a state of the enterprise that ensures the normal functioning of production processes and the ability to counteract the impacts of negative threats that cause production failure. A production failure is an event that involves the loss of an object's ability to carry on the required function, that is, a disturbance of the capable state of the object. If we consider the relationship of process safety with other types of security, it must be said that process safety directly contributes to the economic effect of the operating activities of the enterprise, and as a result generates a net cash flow. In case of negative situations related to the business processes, the further functioning and implementation of measures for other types of security loses any substance, as all units that try to maintain economic, financial and other types of security without the normal course of the manufacturing cycle are inappropriate.

Disturbance of the normal operation can be influenced by external and / or internal factors. Regardless of these factors, the enterprise's reserves are an important lever of influence on the process safety.

The reserve is a part of the production potential, which is not used in normal conditions for the enterprise. The reserve is estimated as the difference between the maximum capabilities (capacity) of the process under favorable conditions and its actual use. In order to ensure the stability of the enterprise, it is necessary to identify and use reserves of production potential.

Production stocks are raw materials, materials, semi-finished products, unfinished goods and products for industrial purposes, which are at different stages of production, spare parts and other goods suitable for industrial consumption.

There are two main groups of these reserves: enterprise production potential reserves and management potential reserves. The structure of reserves that affect the process safety of the enterprise is shown in Fig. 3.

Depending on the processes that take place in the enterprise and affect the efficiency of its activities, they can be structured as follows:

– production potential – characterized by the maximum volume of products (services) that can produce an enterprise in favorable conditions;

– management potential – characterized by the maximum amount of management information that can be processed by a management body, which is necessary for the smooth and efficient operation of the management object.

It is the production potential reserves that can increase process safety and neutralize any factors that negatively affect the operation of the enterprise. One of the purposes of enterprise safety management is to identify and increase the capacity of the enterprise and its reserves.

Therefore, the larger the reserves are, the greater abilities to influence process safety the enterprise has.

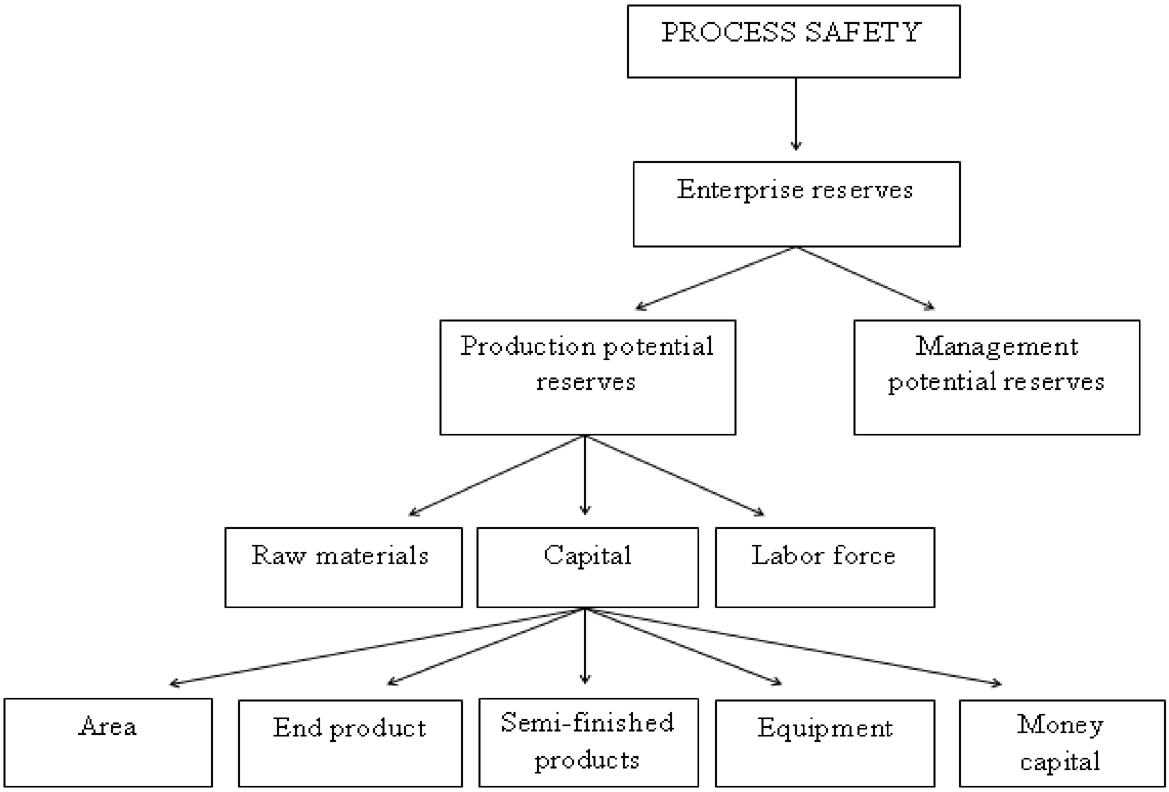

Figure 3. Factors of influence on process safety

In terms of enterprise security, it is advisable to increase capacity reserves. But the increase in these reserves is associated with additional costs, freezing of capital. On this point, the company is interested in creating minimum capacity reserve. The existing contradictory tendency in the management of productive capacity reserve leads to the need to formulate and solve an optimization problem to find such a level of production capacity at which the total costs of freezing idle (reserve) capacity and losses of the company from stoppage associated with the impact of various negatively directed at the enterprise factors will be minimal.

The method of searching for production reserves should be considered as part of a dynamic system that must be created at the enterprise to receive information about additional capabilities of the enterprise and its business units.

It is possible to influence process safety performance by changing these factors. Improving security can be ensured by the mentioned factors.

Increasing the enterprise capacity, production, stocks of raw materials and semi-finished products can increase the level of security. Due to this, the company requires some additional costs.

The nature of this reliance is shown in Fig. 4.

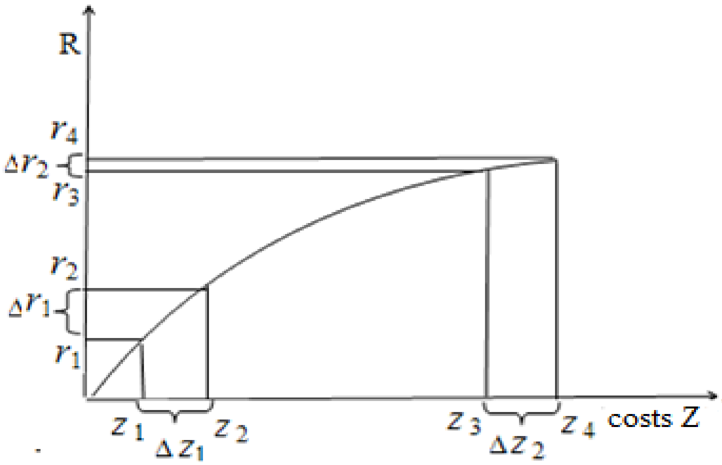

Figure 4. Reliance of the level of process safety on the costs for increasing production factors

Let us set:

R – level of process safety;

Z – costs for increasing the factors that affect security level.

The peculiarity of this reliance is its nonlinear nature, that is, the necessary costs for increasing security rise as it increases. As costs rise from the level z1 to z2, that is, by the value of Δz_1 (z2 – z1), the security level increases by the value of Δr_1 (r2 – r1). If process safety rises to the level of r3, such growth is associated with an increase in costs. Suppose that the security level is equal to R = r3, and the increase in the cost of production factors by the same amount, that is, from z3 to z4 ($\Delta z_2 = z_4 - z_3 = \Delta z_1$), will increase the security level from the level of R = r3 to the level of R = r4, that is Δr_2, which is much smaller than Δr_1.

The analysis of the above reliance leads to the conclusion that increasing the level of security by the same amount is associated with different specific costs of production factors (Fig. 5).

So increasing the level from r1 to r2 by the value of Δr_1 requires additional costs Δz_1 ($\Delta z_1 = z_2 - z_1$). Increasing the security level by the same value of $\Delta r_2 = \Delta r_1$ from the level r_3 to r_4 requires Δz_2 cost which is much higher than the cost of Δz_1.

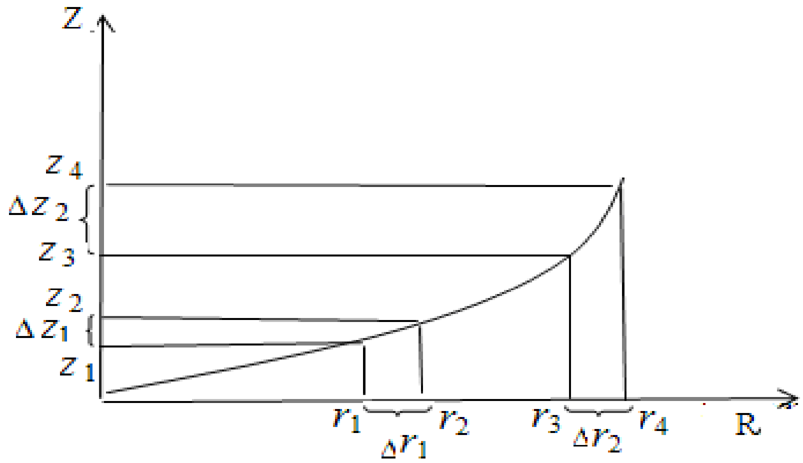

Figure 5. Reliance of the amount of costs for increasing production factors on the level of process safety

The above features of the reliance of process safety on production factors and the cost of their implementation makes it advisable to determine optimal level of process safety rather than considering the problem of improving its level.

Process safety of the enterprise depends to a great extent on such properties of the system as risk and reliability of production processes.

According to [7] at risk we will understand the feature of the system under the influence of external and / or internal factors to change from a state of normal functioning (performance capability) to a state of failure. In this case, the reliability of the system can be taken as a feature of the system to maintain a state of normal functioning (performance). Functioning state is the state in which the system enforces specified functions (goal achievement).

The level of reliability can be measured by the probability of maintaining the functioning state.

According to[7] lets determine the reliability of the system at a finite time interval (0,L). During this time, the system may be in working E1 or non-working E0 states.

Determination of the system reliability assessment over a period of time (0,L):

$$H(1, L) = \frac{r \times m}{L} \quad (1)$$

where r – the number of cases when the system is in working order;

[7] Клименюк М.М., Брижань І.А. Управління ризиками в економіці : навчальний посібник. Київ : Просвіт, 2000. 256 с.

m – the average duration of the system in working condition, days;
L – the time interval during which the study took place, days.

The reliability of the system depends on a large number of production factors, among which is the reserve of productive capacity reserve.

Here is an example of the impact of the productive capacity reserve on the system reliability. We provide the initial data in the form of table 4.

Let us set:

H – level of reliability;

ΔN – productive capacity reserves.

Table 4

Data on the reliance of reliability on productive capacity reserves

№	ΔN %	H
1	2	0,25
2	5	0,43
3	10	0,6
4	20	0,76
5	30	0,85
6	40	0,9
7	50	0,92

The graph is based on the data (Fig. 6).

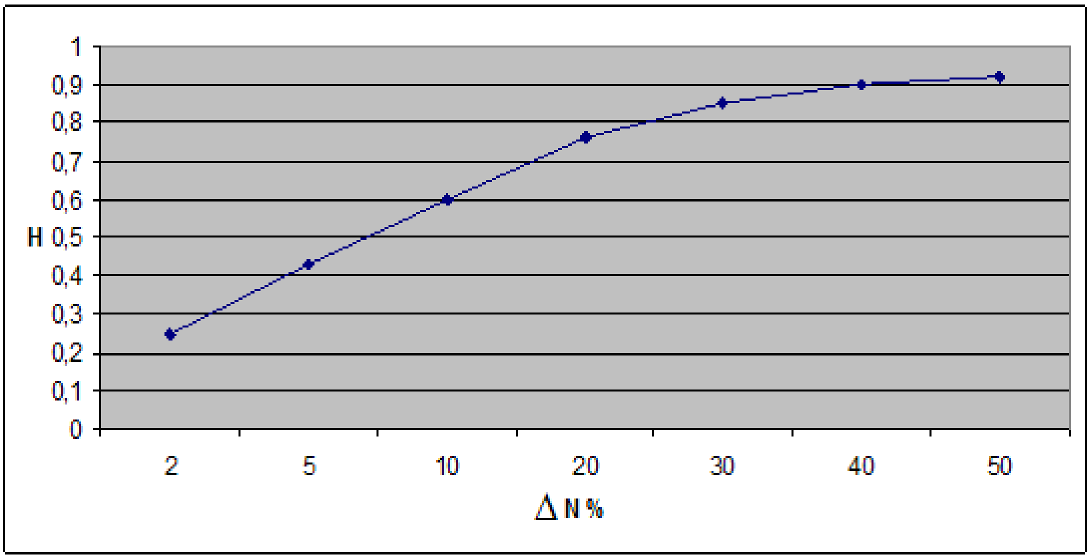

Figure 6. Reliance of reliability on productive capacity reserves

CONCLUSIONS

In order to determine the optimum level of reliability, it is necessary to build, in addition to certain reliance of reliability on productive capacity reserves, a function of costs and losses associated with insufficient reliability of production processes. The nature of these reliance is shown in Fig. 7.

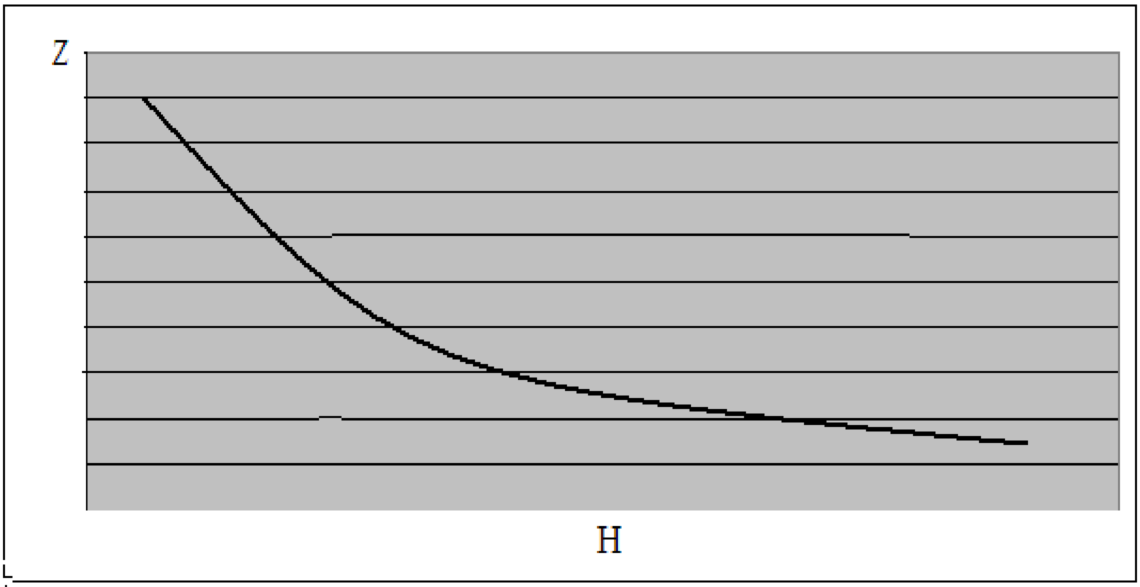

Figure 7. Reliance of costs and losses of the enterprise, connected with stoppage of production processes, on the level of reliability

SUMMARY

Therefore, the production reliability and the process safety are related to the costs and losses of the enterprise, which have opposite tendencies. On the one hand, improving the production reliability by reserving production capacity entails additional costs. On the other hand, increasing reliability leads to reduced production stoppage and consequently a reduction in costs and losses.

Taking into account two trends allows us to form the concept of determining the optimal level of security. The joint consideration and resolution of the costs reliance function on reserving and increased reliability, as well as the costs and losses of system failures from insufficient reliability, are the basis for determining such a level of enterprise process safety, with which these total costs will be minimal.

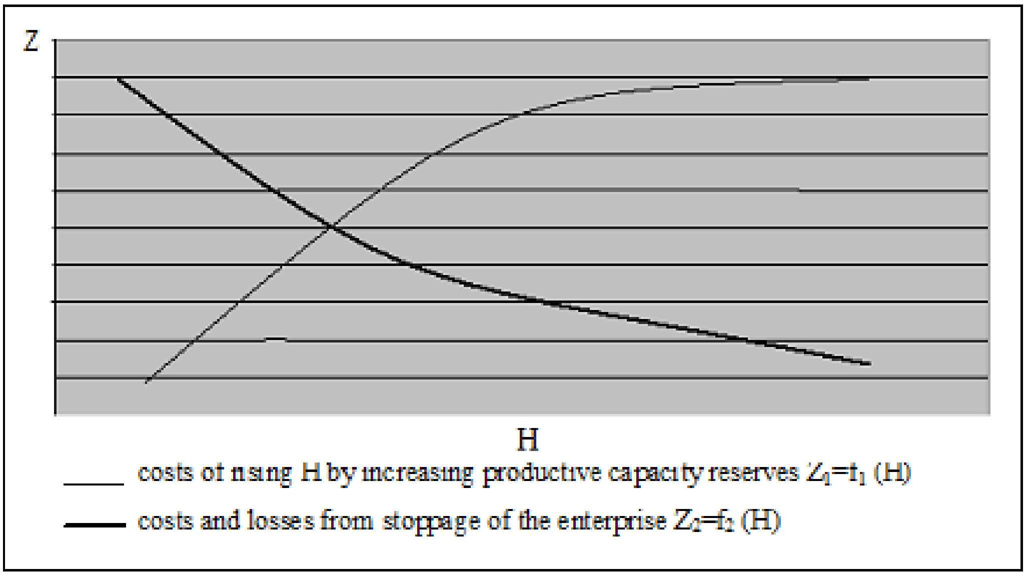

Figure 8. Reliance of costs and losses of the enterprise on the level of reliability

The dependence of costs on the level of reliability is the basis for constructing the objective function on min total costs for the production conditions of a particular enterprise.

REFERENCES

1. Користін О.Є., Чернявський С.С. Протидія відмиванню коштів в Україні: правові та організаційні засади правоохоронної діяльності : навчальний посібник. Київ, 2009. 612 с.
2. Ігнашкіна Т.Б. Економічна безпека підприємства та її трактування у праць. ПДТУ. Маріуполь, 2011. Т. 2. С. 204–207.
3. Фінанси : Підручник. 4-те вид. Київ : Центр учбової літератури, 2009. 312 с.
4. Швець Н.Р. Методи виявлення і збереження кадрової безпеки, або Як перемогти зловживання персоналу. Київ : Журнал «Персонал». 2006. № 5.
5. Іванілов О.С. Економіка підприємства : підручник 2-ге видання Затверджено Міністерством освіти і науки України для студентів вищих навчальних закладів. Київ : «Центр учбової літератури», 2011.

6. Ортинський В.Л., Керницький І.С., Живко З.Б. Економічна безпека підприємств, організацій та установ : навчальний посібник. Київ : Правова єдність, 2009. 542 с.

7. Клименюк М.М., Брижань І.А. Управління ризиками в економіці : навчальний посібник. Київ : Просвіт, 2000. 256 с.

Information about the author:
Demenska K. S.
Lecturer, Department of Management
and International Economic Relations,
V. I. Vernadsky Taurida National University
33, John McCain str., Kyiv, 02000, Ukraine

DOI https://doi.org/10.36059/978-966-397-123-0/45-67

RELIABILITY MODELING AS PRODUCTION QUALITY EVALUATION METHOD INTRODUCTION

Grudtsyna Y. V.

INTRODUCTION

The quality problem is relevant for all goods and services, and the problem of improving the quality of production takes a leading place in ensuring its competitiveness in the developed countries of the world. Production quality is an important indicator of an enterprise’s activities, and improving production quality largely determines the ability of an enterprise to survive in a market. For the Ukrainian economy, the release of high-quality products is a strategic task. Only the release of high-quality products will ensure the country's success in both the domestic and foreign markets.

A thorough study requires a quantitative evaluation of production quality, because quality evaluation is an inseparable element of any quality management system, since to control any process, first of all, it is necessary to be able to measure and evaluate its parameters. Among the variety of quality indicators by which it is evaluated, special attention is required to the reliability indicator that characterizes the production in terms of storing its properties over time, because for any consumer it is important how long the product be in use. A particularly important indicator of reliability is for industrial production, in particular industrial equipment, because the reliability of the equipment, that is, work with the least number of failures and consequently inactive time, is one of the elements of the smooth operation of the entire enterprise. Therefore, the issue of evaluating reliability over time is of particular relevance and requires careful study.

Analysis of research and publications. The problem of production quality evaluation has been and remains the object and subject of scientific research. To the study of problematics of production quality evaluation has been given a lot of attention by domestic and foreign experts. Foreign experience in managing and evaluating product quality is reflected in the works of A. Shewhart, K. Ishikawa, G. Taguchi, J. Juran, E. Deming etc. Among domestic scientists were A.M. Krylov, P. Bridgman, G.G. Azgaldov, Z.N. Krapyvensky, A.V. Glychev, V.P. Panov, Yu.P. Adler and many other scientists and specialists. In Ukraine, T. Bubela, T. Boyko, P. Stolyarchuk, L.I. Bozhenko, P.Ya. Kalyta, A. Yu. Chorny, G.G. Ushakov, V.R. Kutz, B. Stadnyk, V. Motalo are handling production quality evaluation problems.

Paying tribute to the scientific and practical significance of the works of the above authors, it should be noted that the problems associated with the evaluation of production quality are not fully understood and require further development.

1. Analysis of the quality evaluation methods and identification of deficiencies

The purpose of the article is to identify indicators and methods for product quality evaluation, to show their relationship with the needs of consumers and to identify the shortcomings of a modern system of product quality evaluation. As part of the study, the task was set to simulate reliability as the main indicator in the system of quality evaluation indicators.

The solution to the problem of improving product quality requires a clear vision of the understanding of the essence of the concept of "quality". Based on the fact that quality is a capacious and complex category, it has a number of aspects in the literature, you can find many of its formulations. Let's consider the definition of the concept of quality by foreign and domestic scientists, as well as regulatory documents. It is worth noting that the category "quality" was analyzed by Aristotle in the 3rd century BC., saying "what exists by itself, already forms a quality", then in research in the category of "quality" was engaged the philosopher Hegel[1]. A lot of scientific research is devoted to questions of evolution of the development of the concept of production quality. The work of Soviet economists A.V. Glycheva, V.P. Panova, G.G. Azgaldova "What is quality?" is devoted to the research on the essence of quality[2]. In the process of evolution, the concept of quality has undergone changes in the understanding of its essence. In modern conditions, production quality is directly related to meeting the needs of society. That is, the term "quality" has a whole range of interpretations, which is associated with its multi-aspect. From a philosophical point of view, quality is understood as a set of properties, thanks to which one object can be distinguished from another.

[1] Гегель Г.В.Ф. Логіка. В кн. : Гегель Г.В.Ф. Твори. Т.І.М. – Л.: Держвидав, 1929.

[2] Гличев А.В., Панов В.П., Азгальдов Г.Г. Что такое качество? Москва : Экономика, 1968. 135 с.

In the social aspect, quality is associated with the study of consumer relations to the object, his perception, thoughts and reviews. So, the qualitative properties of products can depend on various factors: cultural (level of education, customs, traditions, fashion) and demographic (gender, age), from changes in supply and demand, from the level of consumer income. It is worth agreeing with the opinion of Soboleva M.A., who notes, that "Direct compliance with the standards provides only a minimum level of product quality"[3], that is, compliance only with existing drawings, standards, regulatory documents is only one of the signs of product quality and does not conclude the entire content of this the concepts. Economist Syskov V. I. notes that "product quality should be understood as the degree, measure of meeting the demand for this type of product under fixed consumption conditions, which are determined by the totality of characteristics created in the production process in accordance with the requirements of standards"[4].

J. M. Juran, a well-known American specialist in quality, speaking about the definition of quality, writes: "The concept of product quality differs from the concept of quality of construction, technology. The first means only the degree of compliance with the drawings, regulations and standards, and the second – the characteristics of the raw materials used, the method of production and control, etc. But compliance with the drawings, specifications and standards characterizes not only the quality of the product as such, but how much the quality of work to achieve it". J. Juran distinguishes among the concepts of quality, product, design, technology and considers quality as suitability for use, that is, compliance with the purpose and degree of customer satisfaction, which cannot be disagreed with in today's conditions[5].

The views of the scientist Feigenbaum A. regarding the concept of quality also come from the fact that there is a direct relationship between quality and meeting the needs and expectations of consumers. The concept of "quality" is interpreted by scientists from the point of view of full satisfaction of consumer needs[6].

---

[3] Соболева М.А. Роль стандартизации в решении проблем качества промышленной продукции в США. Экономические проблемы повышения качества продукции. Москва, 2006. С. 148–152.

[4] Сиськов В.И. Статистические измерения качества продукции. Москва : Статистика, 1966. 167 с.

[5] Джуран Дж.М. Ответственность руководящих работников промышленности за качество продукции. *Стандартизация и качество*. Москва : Комитет стандартов, 1966. С. 30–32.

[6] Фейгейбаум А. Контроль качества продукции. Москва : Экономика, 1986. 471 с.

Other researchers, such as Zykov Yu.A., Matvieiev L.A., Polyshko S.P., Kozlov A.L., Arystov A.V., Mishyn V.M., define quality as "a set of properties that determine the degree of their compliance with a given specific need in fixed conditions of consumption"[7]. The most important criterion is to take into account the manifestation of product properties in specific consumption.

The ISO 8402-86 standard considers quality "as a combination of properties and characteristics of a product or service that give them the ability to satisfy specified or anticipated needs" [8].

The identified needs are fixed in legal norms, standards, contracts, technical conditions of supplies and other documents. It is advisable to note that the above requirements are: requirements that are specified at the conclusion of the contract, requirements of regulatory documents for the implementation of environmental conditions. Failure to comply with most of the established requirements leads to administrative or legal liability. Estimated needs should be identified and determined (results of market research, new developments, consumer demand formation, etc.). It can be aesthetic requirements, the accordance of products to fashion, consumer preferences, national and cultural characteristics[9].

In accordance with the international standard ISO 9000: 2000, quality is "the degree to which the totality of the characteristics of a product, process or system meets needs or expectations that are established, predictable or required". According to the standard DSTU ISO 9000: 2007, quality is "the degree to which the set of characteristics of an object meets the requirements of interested parties"[10].

So, speaking about the concept of quality, it is necessary to note that the main place is given to needs. It should not be forgotten that the needs of consumers are unstable and constantly changing. Even when the product parameters can clearly correspond to the normative and technical documentation, however, the requirements of consumers change and the quality with constant parameters become worse or be completely lost.

But almost all authors in today's conditions emphasize that quality is the property of products to satisfy consumer needs.

---

[7] Аристов О.В., Мишин В.М. Качество продукции : Учебное пособие. Москва : Издательство стандартов, 1982. 142 с.

[8] Управление качеством продукции. ИСО 9000-9004, ИСО8402. Москва : Изд-во стандартов, 1988.

[9] Шаповал М.І. Менеджмент якості : підручник. Київ : Т-во «Знання» КОО, 2001. 475 с.

[10] ДСТУ ISO 9000:2007 Системи управління якістю. Основні положення та словник термінів (ISO 9000:2005, IDT). Чинний від 01.01.2008. Київ : Держспоживстандарт України, 2008. 28 с.

That is, product quality is directly related to customer satisfaction. In the conditions of market relations, the value of needs and their research should take a central place, because it is impossible to study the quality of products outside of existing social needs due to the fact that there is a close relationship between these two categories.

The state of needs or their satisfaction is closely related to quality indicators that quantitatively characterize the properties of products, therefore, when classifying needs, we can rely on the classification of indicators of production quality. Existing consumer needs Rebryn Yu.I. "classifies into several categories that differ from each other by temporary factors of action: basic, which are the main and objective when choosing a product, and additional ones that reflect the subjective desires of consumers"[11].

Speaking about the current state of the interdependence of such concepts as product quality and need, it is worth noting that quite often an insufficiently high level of production quality depends on unexplored needs both in assortment and in the saturation of demand with specific goods. Therefore, the study of the today's and future needs is the first step in solving the problem of improving production quality.

From the various characteristics of product quality, a set of properties that determine its suitability to satisfy certain needs is distinguished. Each individual property of a product is an objective feature that can show itself in its creation, turnover and consumption, and is characterized by certain indicators. That is, product quality is evaluated on the basis of a quantitative measurement of its defining properties, and modern science and practice have developed a system for the quantitative evaluation of product properties and have given quality indicators[12].

The quality indicator according to DSTU 2925-94 is interpreted as "a quantitative characteristic of one or more properties of products that make up its quality, which is considered relative to certain conditions of its creation and usage or consumption". The property of a production is "an objective feature of a product that may show itself during its creation, usage or consumption"[13].

---

[11] Ребрин Ю.И. Управление качеством : Учебное пособие. Таганрог : Изд-во ТРТУ, 2004. 174 с.

[12] Боженко Л., Гутта О.Й. Управління якістю, основи стандартизації та сертифікації продукції : навчальний посібник. Львів, 2001. 176 с.

[13] ДСТУ 2925-94. Якість продукції. Оцінювання якості. Терміни та визначення. Чин. від 01.01.1996. Київ : Держстандарт України, 1995. 25 с.

Depending on the characteristics qualities, the indicators are divided into: goods purpose indicators, reliability indicators, indicators of productibility, indicators of standardization and unification, ergonomic indicators, aesthetic indicators, indicators of transportability, patent and legal indicators, environmental indicators, safety indicators [12].

By the methods of determining the values of indicators, the authors-scientists distinguish: measuring, based on information obtained using technical measuring instruments; registration, based on the use of information obtained by counting the number of specific events; a calculation method in which the values of quality indicators are found using calculations with formulas, models, and other mathematical dependencies; the organoleptic method – is a method where instead of measuring tools are used the senses of experts; survey method, which can be applied in various forms: sociological and expert. The sociological method consists in using mass surveys of consumers or users of products and processing of their results by experts. An expert method of measuring quality indicators is to determine the quality indicators of products by experts.

Production quality can be evaluated by determining the level of quality. According to DSTU 2925-94 "Product quality. Quality evaluation" terms and definition of production quality level are defined as "relative characteristics of production quality, based on a comparison of the values of estimated indicators of production quality with the basic values of the relevant indicators."[12]. Quality evaluation is a systematic examination that allows you to understand how the object is able to fulfill the established requirements. Failure to comply with established requirements is a noncompliance. To eliminate the causes of the existing noncompliances, organizations carry out corrective actions.

So, each product has a set of properties, their combination determines quality indicators, that is, quality indicators consist of quantitative characteristics of product properties.

Modern science has identified the following methods for evaluating the level of production quality – differential, complex, mixed, which allow us to evaluate the quality of products by comparing the measured values of quality indicators with basic indicators. The differential method of determining the level of product quality is to find individual unit indicators of its quality with the corresponding set of values of the corresponding basic quality indicators. A comprehensive method for determining the level of production quality is to compare the so-called complex indicators of the quality level instead of single ones, as in the differential method. The statistical method for determining the level of product quality, which is used in serial and mass production, is distinguished by periodically selecting a certain group of products, measuring their quality indicators and based on processing the results of the development of measures to ensure the product quality level specified in the technical requirements.[14]

It is worth noting that the disadvantage of the differential method of evaluating the quality level is the difficulty in deciding on the values of many individual quality indicators, since there can be an infinitely large number of these quality indicators. It is also difficult to evaluate the overall level of quality, since with the differential method it can only be confidently asserted that a baseline level has been achieved for some quality indicators and for others are not.

The disadvantage of the complex method is that a generalized quality indicator may not fully take into account all the essential properties of the product. The methodology of a comprehensive evaluation of the quality level is based on the condition of the unequal importance of individual useful properties that are compared among themselves. The disadvantage is the difficulty in accurately determining the importance of these properties. Also, to the disadvantages of the complex method can be added the possibility of “covering” a low level of some properties with a higher level of others.

The disadvantages of expert methods include the fact that the objectivity of the expert evaluation and its accuracy depends mainly on the qualifications of the expert. It is also difficult to find an error in the decision of an expert. Expert methods are quite laborious. The disadvantage is also the low recoverability of the results, since the evaluations made by the expert are influenced by a number of factors of an unstable compositions: age, gender, health status, and even part of the day when a decision is made[15].

In product development, great importance is given to optimizing its quality indicators.

Shapoval M.I. determines that “such characteristics of quality indicators are called optimal, when the greatest effect is achieved from the

---

[14] ДСТУ 2925-94. Якість продукції. Оцінювання якості. Терміни та визначення. Чин. від 01.01.1996. Київ : Держстандарт України, 1995. 25 с.

[15] Ткачук Л.М., Калугаряну Т.К. Якість продукції: методологічні та прикладні аспекти. *Ефективна економіка*. 2013. № 5. URL: http://nbuv.gov.ua/UJRN/efek_2013_5_20

usage or consumption of the production at given costs for its creation and usage or consumption, or the desired effect at minimum costs, or the maximum ratio of effect to cost. In the case when at the given costs per unit of production the best characteristic of the generalized quality indicator, which characterizes the maximum effect from the operation or consumption of the product, is determined, it is considered as an optimization criterion, and the specified costs are limitations during optimization. Determining the optimal values of the characteristics of quality indicators makes sense only if the optimization criterion is established and the restriction is indicated"[16].

The optimal values of the characteristics of quality indicators do not necessarily relate to real-life products; they can be determined by calculation for newly developed or even hypothetical production with the value of characteristics of quality indicators that can actually be achieved. In the latter case, such calculated values of the optimal characteristics of quality indicators are used as the basis for comparing with them the corresponding characteristics of the quality indicators of existing product samples. The optimal values of the characteristics of indicators of product quality in the presence of an objective function and restrictions on costs or effect are determined by linear and non-linear programming, dynamic programming, game theory and statistical decisions, optimal-control theory and other mathematical methods described in the special literature.

In a market economy, a system for evaluating production quality should most closely match the characteristics of market relations between producers and consumers. To do this, it is advisable to solve the following issues:

firstly, it concerns an objective evaluation of production quality at various stages of interaction between developers, manufacturers and consumers of products, taking into account the relationship between quality, quantity and price;

secondly, the ability to quickly obtain all the necessary objective data on product quality, its technical level and competitiveness at any stage of the product life cycle.

A modern quality evaluation system at the enterprise, regardless of the form of ownership and scale of production, should optimally combine actions, methods and means that ensure, on the one hand, the manufacture

[16] Шаповал М.І. Менеджмент якості : підручник. Київ : Т-во «Знання» КОО, 2001. 475 с.

of products that meet the needs of the market, and on the other, the development of new products that can satisfy future needs the market.

So that the production have success in the market and can successfully compete in it, it must meet the needs of the consumer. To do this, on the one hand, the state must take into account the needs of the market when developing quality standards, and on the other hand, the manufacturer of the products themselve. Meeting needs requires the manufacture of products of a certain quality and quantity. The gap between needs and manufactured production in terms of quality and market saturation should be the basis for managerial decisions on state management of production quality. In order for a product to be of high quality, the needs of today should be laid in it, however, besides this, the manufacturer should remember that quality is a dynamic concept, it has a change in time, as consumer needs change – so the quality changes. Quality as a degree of compliance with consumer needs is constantly changing over time with the changing requirements and needs of consumers, and what was considered a quality product yesterday may not correspond to a technical innovation that can better satisfy the needs of consumers who have already changed. Quality as an economic category is associated with meeting the needs of consumers, while products have many properties, by measuring which we can evaluate quality. As a review of sources shows, in terms of quality evaluation, that is, indicators and methods are analyzed, today there is no clear concept for quality evaluation.

The modern system of quality evaluation at the enterprise, regardless of the form of ownership and scale of production activities, should optimally combine actions, methods and tools that ensure the manufacture of products that will satisfy the needs of the market, that is, should focus on the needs of consumers and their dynamics.

Improving the level of production quality is an important task of both a single enterprise and the state as a whole. Today, production quality, as already mentioned, is manifested through the properties and level of customer satisfaction.

Product quality is manifested through properties, properties, in turn, can be represented through product characteristics, which can be measured using quality indicators. Each product is described by many quality indicators that characterize it. In addition, modern science has proposed methods for evaluating the level of production quality – differential, complex, mixed, statistical, measuring, expert, organoleptic, sociological, that allow you to evaluate quality by comparing the measured values of quality indicators with basic indicators. So, using the proposed indicators and methods for evaluating them, you can evaluate the quality by comparing its indicators with the baseline. However, they allow you to evaluate quality only now, at the time of manufacture and transfer to operation, but the problem is that quality is not a constant value, and tends to change over time with changing needs and requirements of consumers, which give quality a final evaluation. Therefore, the disadvantage of existing methods is that they do not take into account the time factor in evaluating quality, that is, they do not make it possible to evaluatie the degree of customer satisfaction with products during the time change.

It is worth noting that the reliability indicators (reliability, storage, maintainability, durability) indicate the preservation of properties over time. These indicators characterize the property of the product to perform its functions by maintaining operational indicators within the established limits during the given period of time established in the technical documentation. However, these indicators are not able to comprehensively evaluate the quality, especially since the ability to maintain product properties is carried out within the period established by technical documents.

So, today, firstly, there is no clear concept for evaluating quality, and secondly, these methods and indicators do not allow us to evaluate quality, considering the time factor, therefore, there is a need to develop a method for evaluating quality not only now, but also over time, that is, to find cumulative quality for a certain time interval.

2. Equipment reliability qualification

As already noted, the quality of the object is manifested primarily because of its properties. To the extent that a set of these properties will satisfy the needs of consumers and product quality will manifest itself.

We will consider one of such important properties as reliability and trace how reliability changes over time.

According to the source,[17] as the reliability indicators are taken the probability of uptime, average time between failures and the intensity of failures. Reliability is a quality indicator that requires further research. It is

[17] ДСТУ 2925-94. Якість продукції. Оцінювання якості. Терміни та визначення. Чин. від 01.01.1996. Київ : Держстандарт України, 1995. 25 с.

this indicator that can be considered as a property of the product to maintain its parameters over time, which is the main characteristic for industrial equipment, because for any enterprise it is important that the equipment has as few failures and consequently downtime. So, reliability is the main property of industrial equipment. In this regard, let us dwell on the evaluation of the reliability indicator.

Reliability is one of the properties of the product to keep in time and the specified permissible limits of all parameters of their quality in accordance with the specified conditions for their use, repair, storage and transportation. In other words, reliability includes such product quality indicators as reliability in the performance of its functions, maintainability, in case of elimination of the causes of temporary loss of the specified quality of the products and storage for a given time[18].

Reliability is closely linked to risk. So according to the source[19] in general terms, the risk of a process (system) is defined as the property of a system under the influence of internal and external factors to switch from a state of normal functioning to a state of failure. And reliability is understood as the possibility of failure-free operation of a system (process) for a given period of time. Therefore, according to the methodology for evaluating the reliability and risk of the system described in the work of M. M. Klymenyuk, I.A. Bryzhan “Risk Management in the Economy” we perform calculations to evaluate the reliability of the production process on the example.

So, reliability is the main property of the production process, so its quality must be evaluated precisely by the reliability indicator.

In accordance with the methodology for evaluating the reliability and risk of the system, we perform calculations to evaluate the reliability of the industrial production process.

To determine the reliability of the production process, we consider its functioning on a finite time interval (0,L). During this time, it may be in working – E_1 or non-working – E_0 states.

An estimate of the reliability of the system over the time interval (0,L) is[20]:

[18] Боженко Л., Гутта О.Й. Управління якістю, основи стандартизації та сертифікації продукції : навчальний посібник. Львів, 2001. 176 с.

[19] Клименюк М.М., Брижань І.А. Управління ризиками в економіці : навчальний посібник. Київ : Просвіт, 2000. 256 с.

[20] Клименюк М.М., Брижань І.А. Управління ризиками в економіці : навчальний посібник. Київ : Просвіт, 2000. 256 с.

$$H(1,L) = \frac{r \times m}{L} \qquad (1)$$

r – the number of cases the system was in working condition, pcs;

m – the average duration of the system in working condition, 24-hour periods;

L – time interval during which the study was going, 24-hour periods.

At the same time, we accept that the number of cases the production process has been in working condition coincides with the number of failures since these states interchange. To determine the level of system reliability, it is necessary to collect data on the presence of this system in a state of failure or in operable state.

The calculations will be based on data of the DBK-1 reinforced concrete products factory, which produces reinforced concrete panels for the installation of panel houses. The main production process carried out by the plant is the production, stockpiling and loading of panel carriers with the products necessary for construction and installation departments. The normal course of this process is to load panel carriers with the necessary products as they arrive at the finished goods warehouse of the plant – this is the operating condition of the system. If at the time of arrival of the vehicle in the warehouse there is no product of the necessary nomenclature, then the car is in idle period, that is, the system is inoperative (failure condition).

To evaluate the reliability of the production process, its operation was monitored for the number of failures in work for eight quarters.

After a study conducted in the first quarter, we have the following results (Table 1).

Table 1

Information about the failure of the production process in the 1 quarter

Failure serial number	1	2	3	4	5	6	7	8
Duration of failure, 24-hour period	0,1	0,3	0,2	0,5	0,5	0,2	0,6	1

Source: compiled by the author individually

From the above table it follows that on the time interval (0.90) the production process was in a state of failure 8 times and this state lasts 3.4 24-hour periods.

Duration of system operation is

$$\tau=90-3,4=86,6 \text{ 24-hour period.}$$

The average working condition is

$$m = \frac{86,6}{8} = 10,825 \text{ 24-hour period.}$$

Reliability rating is

$$H\,(1,90) = \frac{r \times m}{L} = \frac{8 \times 10,825}{90} = 0,96$$

So, the reliability of the production process for the study period is 0.96 or 96%.

Information on the downtime of the production process for the second quarter is shown in Table 2.

Table 2

Information about the failure of the production process in the 2 quarter

Failure serial number	1	2	3	4	5	6	7	8
Duration of failure, 24-hour period	0,6	0,3	0,4	0,9	1,6	0,8	0,4	0,7

Source: compiled by the author individually

From the above table it follows that on the time interval (0.90) of the production process it was in a state of failure 8 times and this state lasts 5.7 24-hour periods.

Duration of system operation is

$$\tau=90-5,7=84,3 \text{ 24-hour period.}$$

The average working condition is

$$m = \frac{84,3}{8} = 10,537 \text{ 24-hour period.}$$

Reliability rating is

$$H\ (1{,}90) = \frac{r \times m}{L} = \frac{8 \times 10{,}537}{90} = 0{,}94$$

So, the reliability of the production process for the study period is 0.94 or 94%.

Information on the downtime of the production process for the third quarter is shown in Table 3.

Table 3

Information about the failure of the production process in the 3 quarter

Failure serial number	1	2	3	4	5	6	7	8	9
Duration of failure, 24-hour period	1,2	0,6	0,5	1,3	0,5	0,4	1,7	1	0,7

Source: compiled by the author individually

From the above table it follows that on the time interval (0.90) of the production process it was in a state of failure 9 times and this state lasts 7.9 24-hour periods.

Duration of system operation is

$$\tau = 90 - 7{,}9 = 82{,}1 \text{ 24-hour period.}$$

The average working condition is

$$m = \frac{82{,}1}{9} = 9{,}12 \text{ 24-hour period.}$$

Reliability rating is

$$H\ (1{,}90) = \frac{r \times m}{L} = \frac{8 \times 9.12}{90} = 0{,}91$$

So, the reliability of the production process for the study period is 0.91 or 91%.

Information on the downtime of the production process for the fourth quarter is shown in Table 4.

Table 4

Information about the failure of the production process in the 4 quarter

Failure serial number	1	2	3	4	5	6	7	8	9	10
Duration of failure, 24-hour period	0,3	1,3	0,4	0,6	1,3	0,1	1,6	0,9	1,2	0,8

Source: compiled by the author individually

From the above table it follows that on the time interval (0.90) of the production process it was in a state of failure 10 times and this state lasts 8.5 24-hour periods.

Duration of system operation is

$$\tau=90-8,5=81,5 \text{ 24-hour period.}$$

The average working condition is

$$m = \frac{81,5}{10} = 8,15 \text{ 24-hour period.}$$

Reliability rating is

$$H\ (1,90) = \frac{r \times m}{L} = \frac{8 \times 8.15}{90} = 0,90$$

So, the reliability of the production process for the study period is 0.90 or 90%.

Information on the downtime of the production process for the fifth quarter is shown in Table 5.

Table 5

Information about the failure of the production process in the 5 quarter

Failure serial number	1	2	3	4	5	6	7	8	9	10	11
Duration of failure, 24-hour period	0,7	0,7	1,8	0,8	1	1	0,9	1,3	1,2	1,4	1,5

Source: compiled by the author individually

From the above table it follows that on the time interval (0.90) of the production process it was in a state of failure 11 times and this state lasts 12,3 24-hour periods.

Duration of system operation is

$$\tau=90-12,3=77,7 \text{ 24-hour period.}$$

The average working condition is

$$m = \frac{77,7}{11} = 7,06 \text{ 24-hour period.}$$

Reliability rating is

$$H\ (1,90) = 0,86$$

So, the reliability of the production process for the study period is 0.86 or 86%.

We will carry out similar calculations for following periods. In total for eight quarters we have the following indicators of the reliability of the production process (Table 6).

Table 6

Information on changes in reliability over a period of 8 quarters

Serial number of the quarter	1	2	3	4	5	6	7	8
Reliability	0,96	0,94	0,91	0,9	0,86	0,85	0,84	0,82

Source: compiled by the author individually

So, we found indicators of the reliability of the production process over 8 quarters and we can trace the trend towards a decrease in the values of the reliability indicator from 0.96 to 0.82. We will depict this trend in Figure 8.

Having the above indicators of changes in reliability over time, we make forecast values for 7 periods ahead. To do this, we construct five types of trending models and define the determination coefficients for each of them.

In Figure 9, we build a reliability forecast by constructing a linear trend, we find the value of the coefficient of determination.

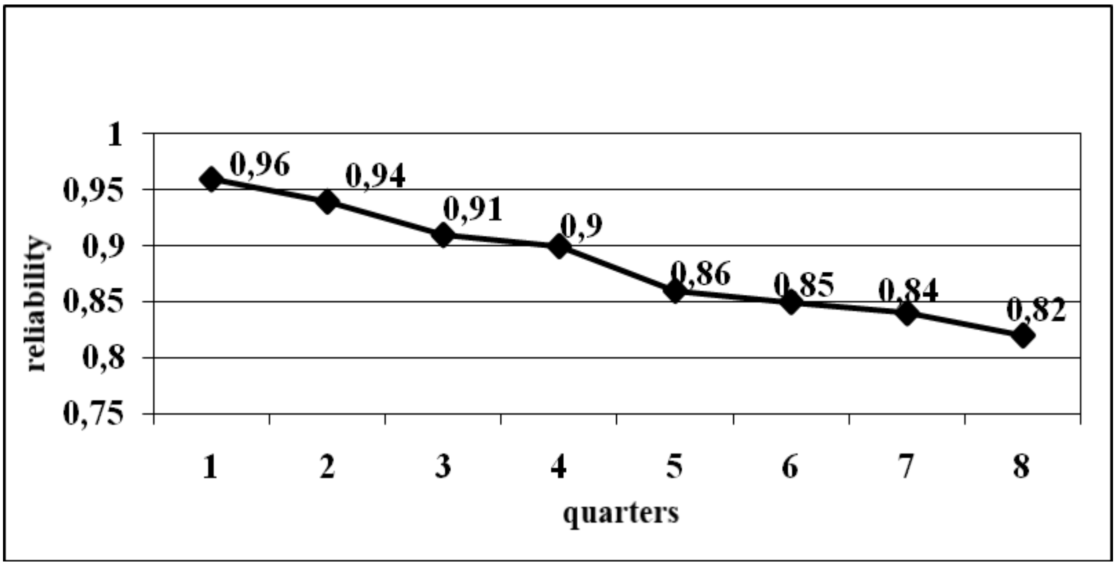

Figure 8. The reliability dynamics of the production process over 8 quarters

Source: compiled by the author individually

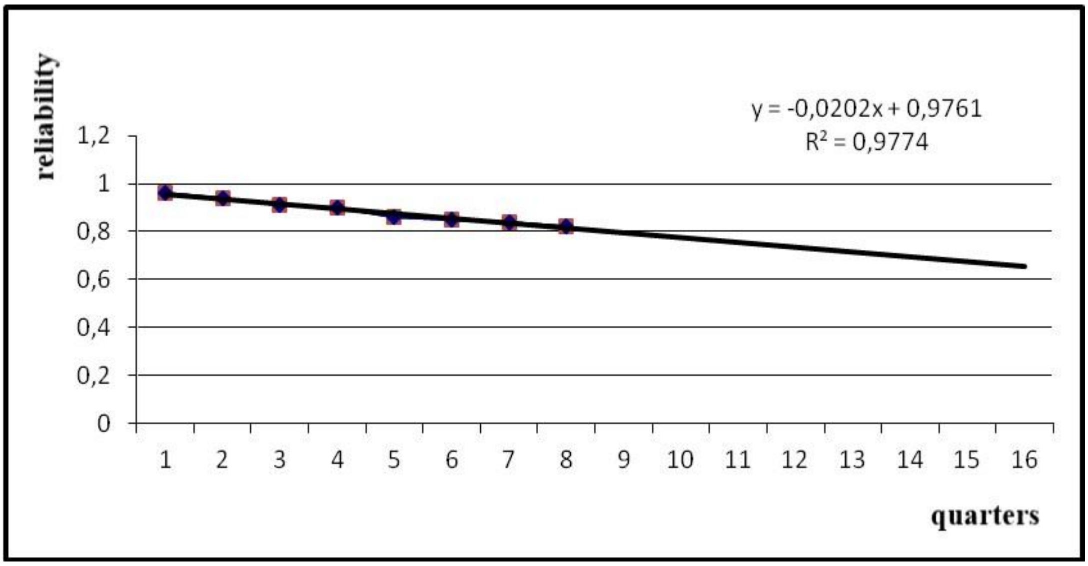

Figure 9. Reliability prediction by building a linear trend

Source: compiled by the author individually

In Figure 10, we build a reliability forecast using a logarithmic trend, we find the value of the coefficient of determination.

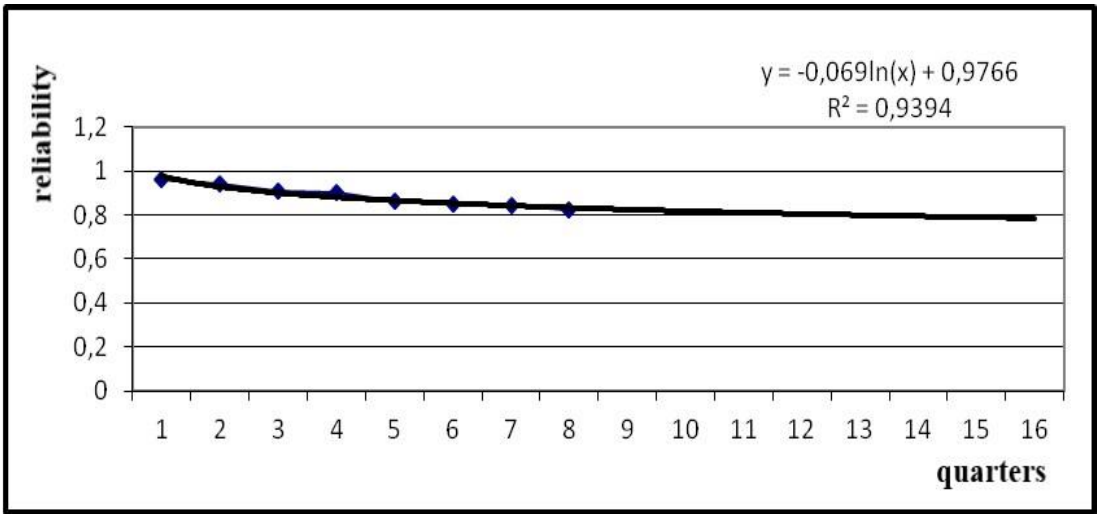

Figure 10. Reliability prediction by building a logarithmic trend

Source: compiled by the author individually

In Figure 11, we build a reliability forecast using a second-order parabola, we find the value of the coefficient of determination.

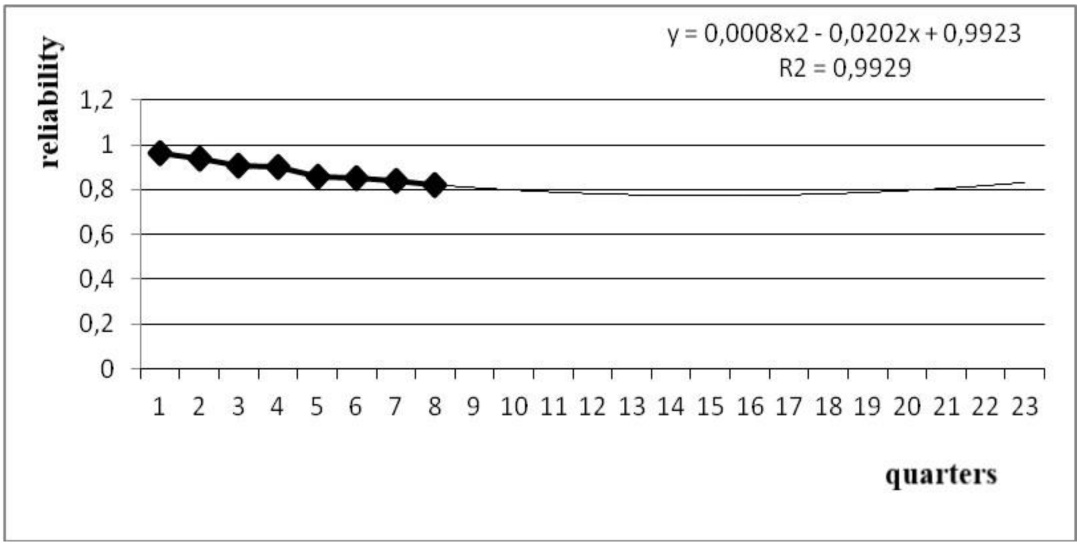

Figure 11. Reliability prediction by parabola of 2 order

Source: compiled by the author individually

In figure 12, we build a reliability forecast using a power-law trend, we find the value of the coefficient of determination.

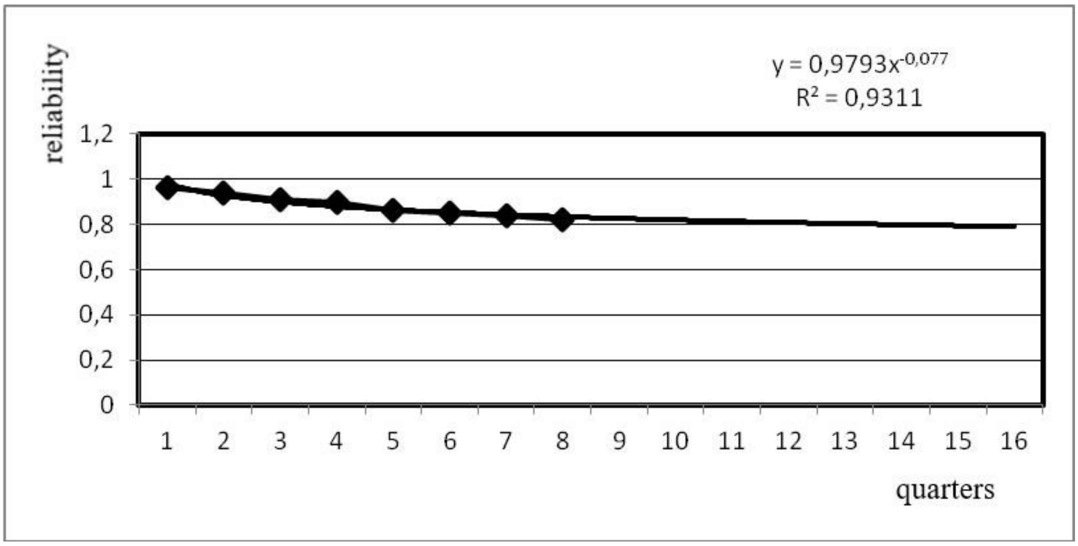

Figure 12. Reliability prediction by building a power-law trend

Source: compiled by the author individually

In Figure 13, we construct a reliability forecast using an exponential trend, we find the value of the coefficient of determination.

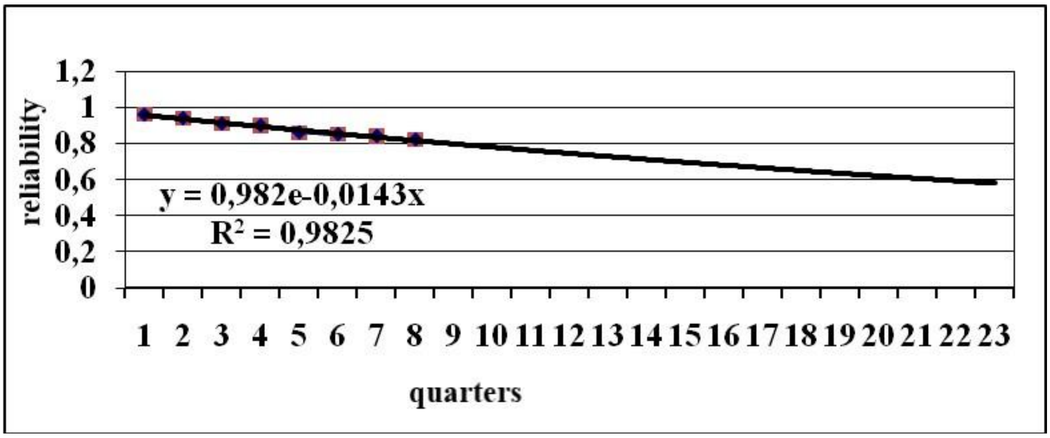

Figure 13. Reliability prediction by building an exponential trend

Source: compiled by the author individually

The construction of trending models of five types and determination of the coefficient of determination for each of them gave the results, which are presented in Table 7.

Based on the value of the determination coefficient for forecasting the reliability indicator, you should choose a trend model in the form of a parabola of 2 order, since this indicator is the highest and is 0.9929. However, when forecasting future values for this model, we observe a significant increase in the reliability indicator, which cannot be in reality (Fig. 11).

Table 7

Information about the constructed trend models for the reliability indicator

Type of trend	Function	Determination coefficient R^2
linear	$y = -0{,}020x+0{,}976$	0,977
logarithmic	$y = -0{,}061\mathrm{Ln}(x)+0{,}976$	0,939
parabola of 2 order	$y = 0{,}0008x^2-0{,}0202x+0{,}9923$	0,9929
exponential	$y = 0{,}982e^{-0{,}0143x}$	0,9825
power-law	$y = 0{,}979x^{-0{,}07}$	0,931

Source: compiled by the author individually

Therefore, we consider it appropriate to use an exponential trend model (Fig. 13).

Having modeled the reliability indicator, the most reliable forecast was found and, accordingly, the function for further reliability studies.

For a better evaluation of reliability, we suggest taking the total (cumulative) reliability indicator for the affected period. Thus, we will have an evaluation of reliability by finding cumulative reliability. Cumulative quality, in turn, is the area from the abscissa axis to the function on a given time interval, or in other words, it is the sum of interval quality levels on a given time interval.

This method can be proposed by the state for both state and other business entities.

CONCLUSIONS

Therefore, quality as an economic category is associated with satisfying the needs of consumers, while products have many properties, by measuring which we can evaluate quality. As a review of sources shows, in evaluating quality, that is, the analyzed indicators and methods, today there is no clear concept for evaluating quality, and these methods and indicators do not allow to evaluate quality, from the perspective of time. Using the proposed indicators and methods for evaluating them, you can evaluate the quality by comparing its indicators with the baseline.

However, they allow you to evaluate quality only now, at the time of manufacture and transfer to operation, but the problem is that quality is not a constant value, and it tends to change over time with changing needs and requirements of consumers, which give quality a final evaluating. Therefore, the disadvantage of existing methods is that they do not take into account the time factor in evaluating quality, that is, they do not make it possible to evaluate the degree of customer satisfaction with products during a time change. So, a method for evaluating quality by modeling a reliability indicator as the main indicator in the system of quality indicators is proposed. At the same time, we note that the time factor occupies an important place in evaluating quality, since quality is not a constant value, and it tends to change over time. For a better evaluation of reliability, we suggest taking a cumulative reliability indicator for the affected period.

A method for evaluating quality by modeling a reliability indicator as the main indicator in a system of quality indicators is proposed. We take into account the time factor, which occupies an important place in evaluating quality, since quality is not a constant value, and it tends to change over time. For a better evaluation of reliability, we suggest taking a cumulative quality indicator for the affected period, which is the area from the abscissa to the function on a given time interval, or in other words, this is the sum of interval quality levels on a given time interval. The use of this method can be proposed by the state for both state and other business entities.

SUMMARY

Quality as an economic category is associated with meeting the needs of consumers, while products have many properties that can be measured by evaluating quality. The state of needs and their satisfaction is closely related to quality indicators that quantitatively characterize its properties. Ensuring the effectiveness of quality management at all stages of the product life cycle is inextricably connected with quality evaluation. Evaluating the level of product quality is the basis for decision-making in the quality management system. It is understood that quality of products under the influence of scientific and technological progress and consumer requirements tends to change over time, in connection with which there is a need to evaluate the quality of products, based on a promising level that takes into account the priority areas and pace of development of science and technology and consumer preferences. The reliability indicator is studied as one of the main indicators of quality evaluation in the system.

REFERENCES

1. Гегель Г.В.Ф. Логіка. В кн. : Гегель Г.В.Ф. Твори. Т.І.М. – Л.: Державидав, 1929.

2. Гличев А.В., Панов В.П., Азгальдов Г.Г. Что такое качество? Москва : Экономика, 1968. 135 с.

3. Соболева М.А. Роль стандартизации в решении проблем качества промышленной продукции в США. *Экономические проблемы повышения качества продукции*. Москва, 2006. С. 148–152.

4. Сиськов В.И. Статистические измерения качества продукции. Москва : Статистика, 1966. 167 с.

5. Джуран Дж.М. Ответственность руководящих работников промышленности за качество продукции. *Стандартизация и качество*. Москва : Комитет стандартов, 1966. С. 30–32.

6. Фейгейбаум А. Контроль качества продукции. Москва : Экономика, 1986. 471 с.

7. Аристов О.В., Мишин В.М. Качество продукции : Учебное пособие. Москва : Издательство стандартов, 1982. 142 с.

8. Управление качеством продукции. ИСО 9000-9004, ИСО8402. Москва : Изд-во стандартов, 1988.

9. Шаповал М.І. Менеджмент якості : підручник. Київ : Т-во «Знання» КОО, 2001. 475 с.

10. ДСТУ ISO 9000:2007 Системи управління якістю. Основні положення та словник термінів (ISO 9000:2005, IDT). Чинний від 01.01.2008. Київ : Держспоживстандарт України, 2008. 28 с.

11. Ребрин Ю.И. Управление качеством : Учебное пособие. Таганрог : Изд-во ТРТУ, 2004. 174 с.

12. Боженко Л., Гутта О.Й. Управління якістю, основи стандартизації та сертифікації продукції : навчальний посібник. Львів, 2001. 176 с.

13. ДСТУ 2925-94. Якість продукції. Оцінювання якості. Терміни та визначення. Чин. від 01.01.1996. Київ : Держстандарт України, 1995. 25 с.

14. Ткачук Л.М., Калугаряну Т.К. Якість продукції: методологічні та прикладні аспекти. *Ефективна економіка*. 2013. № 5. URL: http://nbuv.gov.ua/UJRN/efek_2013_5_20

15. Клименюк М.М., Брижань І.А. Управління ризиками в економіці : навчальий посібник. Київ : Просвіт, 2000. 256 с.

Information about the author:
Grudtsyna Y. V.
PhD, Associate Professor,
Department of Management and International Economic Relations
V. I. Vernadsky Taurida National University
33, John McCain str., Kyiv, 02000, Ukraine

DOI https://doi.org/10.36059/978-966-397-123-0/68-88

CONCEPTUAL APPROACH TO FORMING ADMINISTRATIVE DECISIONS ON THE STATE REGULATION OF THE REGIONAL HIGHER EDUCATION SYSTEM OF UKRAINE

Кocharian I. S.

INTRODUCTION

The future of Ukraine, the rise of its economy and culture, the development of democratic principles of the organization of society directly depends on the efforts of the regions. Achievement of the goals determined by the strategies of development of the regional higher education system should be based on creating conditions for solving existing problems in the system of planning and development of the region.

Such an approach, based on science and backed up by historical experience, should become the basis of the current regional policy of Ukraine.

The introduction of political reform in Ukraine fundamentally changed the format of the management system of regional and local development, the division of powers and responsibility for the development of territories.

The accession of Ukraine to the Bologna process objectively requires a more specific direction of the policy of developing the national system of higher education for joining the European space. Regional higher education institutions (HEI) play a leading role in this task, as one of the requirements of the Bologna Declaration is the independence and autonomy of universities in the processes of adaptation of higher education and research systems.

It should be noted that the existing research does not solve the problem of evaluating the links between economic and education development, the adaptive characteristics of education have not been studied, there are no models for education planning, taking into account the lack of training specialists and the needs of employers, there are no adequate models for calculating and forecasting the need for specialists that connect the regional education system and the region's economy, the dynamics of demand in the market of educational services is not investigated[1].

Thus, it can be stated that currently methods and techniques of predicting the labor market and evaluating the needs of participants of the regional labor market in the form of requirements to competences of future specialists are not developed enough. In addition, there is no conceptual scheme according to which the decision-making support system can be implemented with the interaction of the regional education system and the labor market[2].

New pro-European directions of the development of educational area of Ukraine require the transformation of both the mechanisms of state administration of regional education and the reform of the activities of higher education institutions. Consideration of the situation at the regional level of higher education shows that there are a large number of problems of different nature: state-management, financial, organizational, etc.[3].

In Ukraine, there is a need to ensure the reality and implementation of the identified goals of strategic development of the regions, using the newest tools of strategic planning and forecasting, as well as to link target strategic milestones to optimization of the costs of resources to achieve them[4].

1. Formation of the need of the national economy for specialists with higher education

Let us analyse some of the main parameters of the type of economic activity "Education" in relation to the HEI of III-IV accreditation levels, listed in Table 1.

The analysis shows that during the period from 1990/91 to 2005/06, the number of HEIs increased by 2.3 times, the number of students – by 2.5 times, and the admission to the first year – by 2.88 times.

---

[1] Мазалова О.Г. Формування системи моніторингу управлінської діяльності органів управління освітою як основи ефективної діяльності регіональної системи управління освітою. URL: http://revolution.allbest.ru

[2] Рамазанов С.К., Крупський К.Л. Розробка концептуальної схеми прийняття рішень при взаємодії регіональної системи освіти та ринку праці. *Бізнесінформ.* 2012. № 4. С. 154–157.

[3] Щербакова Г.О. Проблеми і особливості державного управління вищою освітою в контексті адаптації діяльності регіональних вищих навчальних закладів до Болонського процесу. URL: http://www.nbuv.gov.ua/e-journals/dutp/20062/txts/GALUZEVE%5C06sgozbp.pdf

[4] Стратегії розвитку регіонів: шляхи забезпечення дієвості : Збірник матеріалів «круглого столу» / за ред. С.О. Білої. Київ : НІСД, 2011. 88 с. URL: http://www.niss.gov.ua/content/articles/files/Broshura_Bila-a47aa.pdf

Table 1

Main indicators of higher education institutions of III–IV accreditation levels[5]

Period (e.y.)	Amount of institutions	Amount of students in institutions, thousand.	Students accepted, thousand.	Specialists graduated, thousand.
1	2	3	4	5
1990/91	149	881,3	174,5	136,9
1992/93	158	855,9	170,4	144,1
1993/94	159	829,2	170,0	153,5
1994/95	232	888,5	198,0	149,0
2000/01	315	1402,9	346,4	273,6
2002/03	330	1686,9	408,6	356,7
2003/04	339	1843,8	432,5	416,6
2004/05	347	2026,7	475,2	316,2
2005/06	345	2203,8	503,0[1]	372,4[2]
2006/07	350	2318,6	507,7[1]	413,6[2]
2007/08	351	2372,5	491,2[1]	468,4[2]
2008/09	353	2364,5	425,2[1]	505,2[2]
2009/10	350	2245,2	370,5[1]	527,3[2]
2010/11	349	2129,8	392,0[1]	543,7[2]
2011/12	345	1954,8	314,5[1]	529,8[2]
2012/13	334	1824,9	341,3[1]	520,7[2]
2013/14	325	1723,7	348,0[1]	485,1[2]
2014/15[*]	277	1438,0	291,6[1]	405,4[2]
2015/16	288	1375,2	259,9[3]	374,0[4]
2016/17	287	1369,4	253,2[3]	318,7[4]
2017/18	289	1330,0	264,4[3]	359,9[4]

[*] Data for 2014-15 academic year does not take into account the indicators of the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and parts of the zone of ATO.

[1] Persons accepted to the initial cycle of study (excluding those accepted for continuing education with a goal of obtaining a higher degree of higher education).

[2] Specialists graduated (excluding those graduated from the relevant cycle of study, in particular Bachelor studies, and continuing their education in order to obtain a higher degree of higher education).

[3] Persons accepted to the initial cycle of study (excluding those accepted for continuing education in order to obtain a higher educational degree (educational qualification level).

[4] Specialists graduated (excluding those who have completed the appropriate cycle of study, in particular Bachelor studies, and continue their education in order to obtain a higher educational degree (educational qualification level) are issued).

[5] Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf

At first glance, these cardinal changes are positive. But the question arises whether these changes were substantiated, could it be possible to increase the training potential of HEI in such a relatively short period in 2.5-2.88 times without losing the quality of education; Was there a need to increase the academic capacity of admission in 2005/06 e.y. up to 503 thousand students, if already in 2011/12 e.y. its use decreased to 314.5 thousand, in 2014/15 e.y. to 291.6 thousand, and in 2017/18 e.y. to 264.4 thousand, largely due to the demographic crisis. The same can be said about the number of universities that in 2017/19 e.y. decreased by 60 institutions in relation to 2010/11 e.y.

Since the admission of students in amount of 392 thousand (2010/11 e.y.) was supported by a licensed volume, HEIs were equipped with the necessary basic means. This means that in 2017/18 e.y. there was a mismanagement of fixed assets in the amount corresponding to 127.6 thousand of students (392-264.4). With an average financial strength of one student, 12.7 thousand UAH (72520/5730), where 72520 million UAH. is the fixed assets of the type of economic activity “Education”[6]; 5730 – the number of people who studied in educational institutions in 2017/18 e.y., thousand people[7], the cost of fixed assets with forced simplicity, makes 1614 million UAH (assuming the solution of task of evaluating the relation of economic development with the specific capital coefficient of all persons who studied in educational institutions). However, when making the planned decisions on training specialists in 2010/11 e.y., the impact of the demographic crisis has not been taken into account, which has caused negative consequences in higher education.

The negative consequences of rapid, extensive development of the higher education system include:

– the partial use by HEI of the educational capacity in a number of specialties, primarily engineering;

– tendency for the absolute absence of the first-year admission program for licensed specialties of HEI;

– a significant discrepancy between the demand for specialties that are widely popularized or presented to the population as the most “modern”, trendy, and capacities of the HEI, in which the training of

[6] Статистичний щорічник України за 2013 рік. Державна служба статистики України. URL: http://ukrstat.org/uk/druk/publicat/Arhiv_u/01/Arch_zor_zb.htm

[7] Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf

specialists in these specialties is carried out. Because of this discrepancy, HEI failure to fully meet the economic needs for professionals and the social need of the population in higher education is emerging, and, on the one hand, there is a shortage of educational capacities in such specialties and, on the other, significant volumes of "frozen" fixed assets and human resources of HEI, which carry out training in specialties not in demand in the education market;

– overloading the infrastructure of social services of individual cities and the need for additional investments due to the lack of a well-founded state strategy of regional development of the potential of higher education and the choice of applicants for the place of higher education.

The described situation regarding the planning of training of specialists with higher education makes it possible to distinguish the following factors, which significantly influence the efficiency of the system of higher education:

1) additional investment in increasing the educational capacity;

2) additional investments in the development of the infrastructure of the region related to the provision of educational services to residents from other regions during their training in the HEI;

3) additional investments in the basic means of the region related to student training and employment of specialists from other regions.

From the point of view of the state budget, it is more profitable for the state to choose such approaches to macroeconomic planning of specialists training that will ensure, with a certain quality of specialists, the least cost of investment, but with observance of the established standard of living of both permanent residents of the region and students during training and their employment after obtaining higher education.

The main purpose of state planning of training specialists is to ensure the needs of economic entities, organizations of various forms and levels for specialists of all specialties. However, apart from ensuring this, other conditions and restrictions, including financial and social ones, should be taken into account when planning a state order.

For example, if the educational capacity of higher education institutions in a certain region of Ukraine is not enough to meet the needs of this region for the specialists of a specific specialty, then the plan offices face the question of choosing a rational variant: to increase the capacity of the HEI of the region at the expense of investments or to use free capacities for the training specialists of HEI of other regions.

The choice of the second option ensures savings in investment, but generates a social problem of additional burden on the city's infrastructure due to the additional influx of young people to study in its educational institutions.

It also should be taken into account that some graduates of the HEI remain at permanently residence in the city after graduation, become its full rights residents, and therefore needs the appropriate quality of services for all social systems. Among them, production, trade, transport, communications, education, health care and social assistance, provision of communal and individual services, cultural and sporting activities, and more.

In this case, it is not about the current costs of providing services, which, as a rule, compensates the consumer of these services. It is about the basic means, without which it is impossible to provide these services in both quantitative and qualitative terms. That is, in order to maintain the level of services per person after increasing the number of residents of the city, it is necessary to increase accordingly the fixed assets of the city (region), and consequently, the expenses of the state and local budgets.

Fixed assets – an important component of the national wealth of the country and each region, the city. These include land, buildings, structures, machinery and equipment, vehicles, communication paths, etc.

In the absence of significant changes in the technology of services, one can assume a linear relationship between the volume of products (services) and the value of fixed assets through which these products are produced and services are provided.

For example, if the number of inhabitants of the city increased by 10% because graduates of institutions of higher education who came from other regions remain in the city, then in order to ensure that the specific number of services per person does not decrease, it is necessary to increase the corresponding fixed assets by 10 %. It should be take into account not only the total value of fixed assets, but also the cost of fixed assets per person in the region.

Suppose B_r – cost of fixed assets of region r, P_r – amount of population of region r, then the cost of fixed assets per person in region r, is

$$b_r = \frac{B_r}{P_r}, \; r = \overline{1,R}, \qquad (1)$$

where R – amount of regions.

Thus, if there is a known number of graduates of HEI remaining in the city of obtaining higher education, then it is possible to determine the additional need for money for the corresponding increase in fixed assets, and this should be taken into account when planning a state order for training specialists.

To some extent, this also applies to students who after achieving higher education leave a place of study for work in other regions. These students – throughout the entire period of study – as well as permanent residents of the city must be provided with communal and individual services. Consequently, it requires adequate funds to increase fixed assets for this period.

We present dependencies for determining the additional burden on state and local budgets in order to maintain a level of fixed assets per person, which will enable not to lower the level of services in connection with the increase in the population of the city. Suppose that the proportion of graduates of HEI who came to study from other regions and remained on a permanent work at the place of study in the region r is k_r. Then the proportion of specialists who leave the city (region) of training r and go to work in other regions is $1 - k_r$ $\left(0 \le k_r \le 1, \; \forall r\right)$.

The need for additional funds to increase fixed assets, which is associated with an increase in the population of the city r due to the arrival of students from other regions for obtaining higher education, is:

for graduates of HEI who stay for a period of study –

$$\Phi_{r1} = k_r \cdot b_r \cdot x_r, \; r = \overline{1,R}, \qquad (2)$$

where x_r – the number of students who, in accordance with the state order plan, were enrolled for study at the HEI of r city (region) to meet the needs for specialists of other regions;

for graduates of HEI who, after completing their studies, leave the region r for work in other regions –

$$\Phi_{r2} = (1 - k_r) \cdot t \cdot E \cdot b_r \cdot x_r, \; r = \overline{1,R}, \qquad (3)$$

where t – term of studying a student for acquiring higher education, years;

E – the coefficient of investments efficiency, makes it possible to determine the annual share of the total value of fixed assets. This value is inverse to the payback period of the investment $t_{окуп}$ – $E = 1/t_{окуп}$.

Thus, one can determine the general need for funds to build up fixed assets in order to maintain the specific level of services of the city (region) r upon admission to study in its higher educational institutions of students from other regions and meeting their needs in specialists:

$$\Phi_r = \Phi_{r1} + \Phi_{r2} = k_r b_r x_r + (1 - k_r) t E b_r x_r, \quad r = \overline{1,R} \ . \qquad (4)$$

The first component of the dependence (4) reflects an additional burden on budgets due to an increase in the city's population by the number of specialists who remain on permanent residence after obtaining a diploma.

The second component is a part of the fixed assets that corresponds to the period of training of students who come to study from other regions and leave the city after the completion of studies. The value of Eb_r represents the value of fixed assets per person per one year. If the training period is, for example, 4 years, then the need to increase the fixed assets will be 4 Eb_r per student.

After the expiration of this term, the need for additional fixed assets disappears. However, the educational process continues after the graduation of the specialists of this category. If the volumes of reception in the future remain at the same level, the need to build up fixed assets continues for the future. It is clear that it should be adjusted depending on the number of students in this category.

The given formulas give an opportunity to calculate the need for building up fixed assets, connected with the increase of the inhabitants of the city because of training of specialists.

But taking into account this factor when forming a plan for government order for the training of specialists should be borne in mind that only a part of fixed assets is intended to provide services for students. Mostly it is a social service such as health care, education, recreation and sports, etc. In this regard, in order to develop a plan for the training of specialists, it is necessary to determine exactly this share of fixed assets.

It should be noted that the identified problem in the increase of fixed assets could be considered not as a plan for increasing the fixed assets and the necessary investment in the state budget expenditures, but only as one of the criteria for optimal planning of training orders for specialists taking into account the regional factor[8].

Since every student has the right to choose a place of study, the state has no direct levers of influence on decision-making by entrants. In this regard, it is advisable for the state to develop policies aimed at providing higher education services to the population with a high quality of training specialists and savings in capital investment in the development of basic infrastructure that is associated with compensation for inappropriate decisions. To form a rational policy in the field of providing educational services is necessary:

to analyze the actual distribution of applicants among the regions for acquiring higher education;

to identify the need for educational capacity building by region;

to determine the share of specialists remaining to work in the region of higher education acquiring;

to determine the specific investment in increasing of the training capacity of HEI;

to determine the specific investments in the basic means of the regions to provide the appropriate level of social services that are related to the training of students from other regions;

to determine the optimal plan for the distribution of entrants between regions on the criterion of minimization of additional investments;

to form a system of informing and encouraging entrants and local government bodies to make decisions that are approaching optimal. The complex of problems of development and improvement of the quality of higher education can not be overcome by solving a specific task or tasks. It requires the development of a comprehensive state policy on the development of a higher education system. However, state policy at the level of central executive bodies and local authorities is often carried out without sufficient justification, and an example of this can be the real development of our higher education system during the last two decades. Among the reasons is the complexity of this system and the lack of substantiation of the measures and decisions that are being taken.

---

[8] Кочарян І.С., Безус А.М., Петровська Ю.В. Вплив регіонального фактора на планування державного замовлення на підготовку фахівців. *Наук. вісник Академії муніципального управління* : зб. наук. праць. Серія : Економіка. Київ : Академ. муніцип. упр., 2012. Вип. 11. С. 131–137.

To address the listed set of problems that have not been adequately addressed at the level of public administration, an optimization model should be built to help with the formulation and solution of the problem.

2. Planning of training of specialists and development of higher educational capacities

The main stages of planning the preparation of specialists in the context of regions and the development of higher education system are shown in Fig. 1 (the notations are listed below in the text).

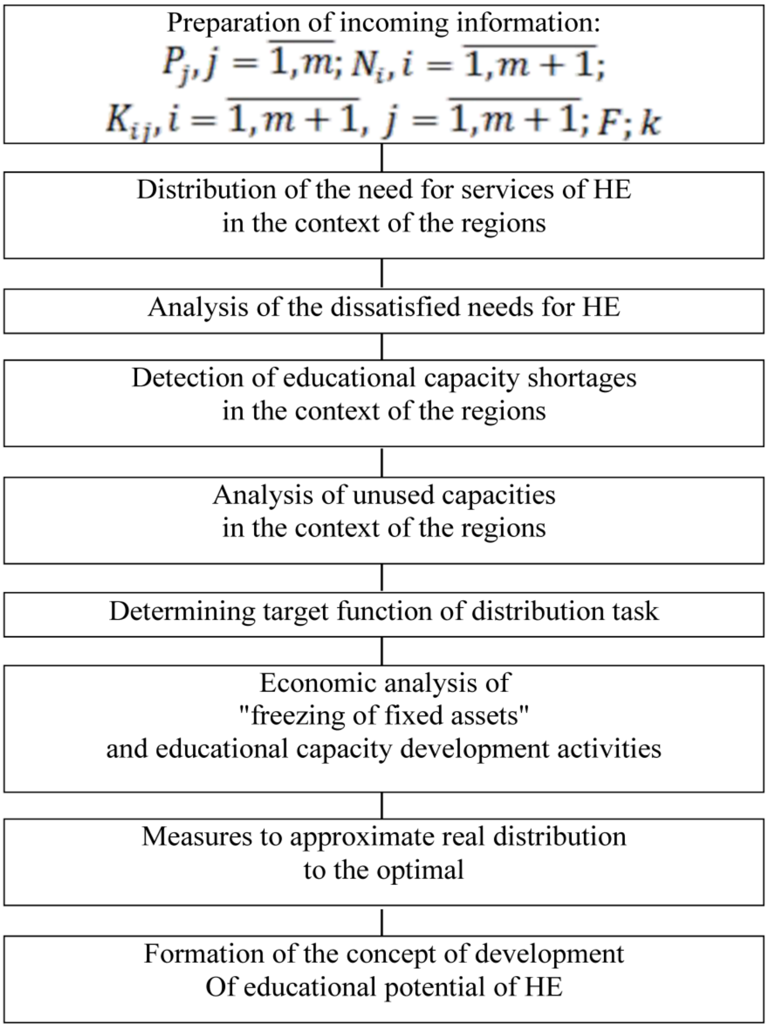

Figure 1. Scheme of realization of distribution of educational services and development of educational capacities[9]

[9] Клименюк М.М., Кочарян І.С. Моделювання планових рішень підготовки фахівців з вищою освітою в регіональному розрізі. *Економічний простір* : зб. наук. пр. Дніпропетровськ : ПДАБА, 2014. № 84. С. 225–234.

It should be determined such distribution of entrants between regions for acquiring higher education (find unknown values X_{ij} , $i = \overline{1,m}$, $j = \overline{1,m}$), which will ensure the need of each region for higher education acquiring, not exceed the educational capacity of each region, *i*, $i = \overline{1,m}$, and the total additional investment will be minimal.

To develop an optimization model for the distribution of educational services by regions and identifying reserves and deficit of training capacity, we take the notation:

i – region, HEI of which provide education, $i = \overline{1,m}$;

j – the region from which the entrant goes to acquire higher education to another region, $j = \overline{1,m}$;

N_i – educational capacity of providing higher education of HEI of region *i*, $i = \overline{1,m}$, person/year;

P_j – need of region *j* in acquiring higher education, $j = \overline{1,m}$, person/year;

F – amount of budget funds for additional investments, thousand UAH;

k_{ij} – the need for additional investments in the development of educational capacities (at their deficit) and the infrastructure of social services in case of the transfer of the entrant to study from the region *j* to region *i* thousand/person;

$m+1$ – fictitious region, introduced in case of shortage of training capacity (additional line) or its incomplete loading (additional column).

X_{ij} – the number of people who moved to the *i* region from *j* region to acquire higher education, persons.

Let us make a model of this task.

Target function:

$$\sum_{i=1}^{m}\sum_{j=1}^{m} k_{ij}X_{ij} \to \min \;. \tag{5}$$

Restrictions on meeting the needs of each region for acquiring higher education:

$$\sum_{i=1}^{m} X_{ij} \geq P_j \;, j = \overline{1,m}. \tag{6}$$

Limitations on non-exceedence of training capacity in each region:

$$\sum_{j=1}^{m} X_{ij} \le N_i \,,\ i = \overline{1,m} . \qquad (7)$$

Budgetary constraint on additional investment:

$$\sum_{i=1}^{m}\sum_{j=1}^{m} k_{ij} X_{ij} \le F \ . \qquad (8)$$

Conditions of reality (integrality) of the distribution plan:

$$X_{ij} \ge 0 \,,\ i = \overline{1,m} \,;\ j = \overline{1,m} . \qquad (9)$$

To implement the presented linear programming problem, it is necessary to make *m* constraints to meet the needs of each of the *m* regions, *m* constraints of the learning capacities of the HEI of each region, to make the matrix ($m \times m$) of the specific investment, and to determine ($m \times m$) unknown values X_{ij}, which will represent optimal solution to the problem[10].

The primary source of information on the need for economics in specialists is the enterprises, institutions and organizations of each region. The social need of each region's population for higher education is determined by forecasting using the most appropriate functions built on statistical information.

For the formation of restrictions on the training capacities of the N_i HEI of each region, the amount of capacity of all HEI located in the corresponding region is determined. The system of monitoring of educational capacities, using information technologies, allows to obtain a plurality of indicators N_i for each region, $i = \overline{1,m}$.

The preparation of information on specific additional investment is more complicated and requires prior calculations and substantiation because it depends on the region where the specialist is trained, the region from which they moved, whether there is a shortage of educational capacity in the region, or a trained specialist remains for permanent residence at the place of education, as well as the size of the main assets of the region per person and the structure of these assets.

[10] Клименюк М.М., Кочарян І.С. Моделювання планових рішень підготовки фахівців з вищою освітою в регіональному розрізі. *Економічний простір* : зб. наук. пр. Дніпропетровськ : ПДАБА, 2014. № 84. С. 225–234.

Perform calculations to determine the set of norms of specific investment depending on the situations that occur when solving the problem.

Situation 1: $X_{(m+1)} > 0,\ j = \overline{1.m}$; there is a shortage of training capacity in the region *i*.

This means that in order to prepare one specialist from this set, it is necessary to increase the educational capacity that is to make the corresponding investments in the fixed assets of higher education. We accept these specific costs at the level of the value of fixed assets of the type of economic activity "Education" in the country.

Suppose $K_{осв}$ – the cost of fixed assets "Education", $S_{осв}$ – the number of persons studying in higher education institutions, then the financial strength of one student is:

$$k_{осв} = \frac{K_{осв}}{S_{осв}}. \qquad (10)$$

Thus, k_{ij} for the situation under consideration,

$$k_{ij} = k_{осв}(1 + f_{осв});\ i = m+1;\ j = \overline{1,m}\ \sum_{i=1}^{m} X_{ij} < P_j \Big|, \qquad (11)$$

where $f_{осв}$ – the degree (coefficient) of the drift of fixed assets in the form of economic activity "Education". This coefficient $f_{осв}$ = 0,427 with total drift of fixed assets of Ukraine f = 0,581[11].

Situation 2: $X_{ij} > 0$, $i \neq j$; in region *i*, $i = \overline{1,m}$, entrants arriving from other regions *j*, $j = \overline{1,m}\ |i \neq j$, for period of acquiring heigher education. Stay of students from other regions during study should not reduce the level of social services for both residents of the region and temporary students. In this regard, proportional investment in fixed assets is required, which is the material basis for the provision of social services.

Here are some types of economic activity that provide such services and their fixed assets (Table 2).

Since the degree of drift of fixed assets for different types of economic activity is significantly different, it should be taken into account when determining additional investments in fixed assets.

[11] Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf

Table 2

Fixed assets by type of economic activity related to the provision of services to the population (on 2016, million UAH)[12]

№ п/п	Type of economic activity	The cost of fixed assets	Degree of drift, %
1.	Building	72810	36
2.	Temporary accomodation and organization of food	29772	41,9
3.	Transport, warehousing, postal and courier activities	1562079	50,6
4.	Information and telecommunications	94243	55,6
5.	Activity in the field of administrative and support services	1173933	80,2
6.	Education	3596	42,7
7.	Health care and social assistance	21245	53,4
8.	Arts, sports, entertainment and recreation Provision of other types of services	20901	39,2
	Total	**2978651**	

Denote the type of economic activity through *l*, fixed assets of *l* type K_l, drift degree f_l.

Then the cost of fixed assets will be:

$$K_l' = K_l(1 + f_l), l = \overline{1,8}, \tag{12}$$

all types of activities:

$$K' = \sum_{l=1}^{8} K_l(1 + f_l). \tag{13}$$

Specific value of fixed assets of the considered types of activities per person

$$k = \frac{K'}{S}, \tag{14}$$

where *S* – population amount, *S* = 42,4 million persons[13].

[12] Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf

[13] Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf

Thus, for situation 2:

$$k_{ij} = k\,,\; i = \overline{1,m};\; j = \overline{1,m}\;\; \big|\, i \neq j. \qquad (15)$$

Situation 3: from a set of students of situation 2, $x_{ij} > 0$, $i \neq j$, some of them after receiving higher education in the region *i* remains for permanent residence. If the consolidated costs for the training period for the situation 2 were:

$$K_{зв} = tE\sum_{ij} k_{ij}x_{ij}\,, \qquad (16)$$

Where *t* – period of student's studying, years;

E – the normative coefficient of investments efficiency, then the costs in the situation 3 are:

$$K_{соц} = \sum_{i,j} k_{ij}x_{ij}\,. \qquad (17)$$

Data given by Table 2, gives the opportunity to calculate the value of fixed assets of those types of economic activities intended to provide direct social services to the population, as well as the share of fixed assets of these activities in the total value of the country's fixed assets:

$$k_0 = \frac{K}{K_0}\,, \qquad (18)$$

Where K – the cost of fixed assets of shown in Table 2 types of economic activity;

K_0 – total cost of fixed assets of the national economy of the country;

$$K = \sum_{l=1}^{8} K_l = 2978651 \text{ million UAH;}$$

$$K_0 = 8177408 \text{ million UAH}$$ [14].

Thus, the share of fixed assets of the above types of economic activity is (formula (18))

$$k_0 = \frac{2978651}{8177408} = 0{,}37\,. \qquad (19)$$

[14] Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf

The above is a calculation of specific investment per student and resident based on the average capital of the country. These norms can be specified by taking into account the indicators of capital in each region:

$$K_{\text{i,соц}} = k_0 K_i,\ i = \overline{1,m}, \qquad (20)$$

where K_i – fixed assets of region i, then take into account the degree of their drift in each region

$$K'_{i,\text{соц}} = K_{i,\text{соц}}(1+f_i),\ i = \overline{1,m}, \qquad (21)$$

where f_i – the degree of drift of fixed assets of region i.

Present a matrix model of distribution of educational services, analysis and development of educational capacities of the higher education system (Table 3).

Table 3

Matrix model of service distribution for acquiring higher education in terms of regions

Region i	Educational capacity N_i	Need for training services by region P_j						
		1	2	…	j	…	m	m+1
		P_1	P_2		P_j		P_m	P_{m+1}
1	N_1	k_{11} X_{11}	k_{12} X_{12}		k_{1j} X_{1j}		k_{1m} X_{1m}	k_{1m+1} X_{1m+1}
2	N_2	k_{21} X_{21}	k_{22} X_{22}		k_{2j} X_{2j}		k_{2m} X_{2m}	k_{2m+1} X_{2m+1}
…								
i	N_i	k_{i1} X_{i1}	k_{i2} X_{i2}		k_{ij} X_{ij}		k_{im} X_{im}	k_{im+1} X_{im+1}
…								
m	N_m	k_{m1} X_{m1}	k_{m2} X_{m2}		k_{mj} X_{mj}		k_{mm} X_{mm}	k_{mm+1} X_{mm+1}
$m+1$	N_{m+1}	k_{m+11} X_{m+11}	k_{m+12} X_{m+12}		k_{m+1j} X_{m+1j}		k_{m+1m} X_{m+1m}	

The given model presents the input information:

i, j – index of region, $i, j = \overline{1,m}$, and the region that provides educational services is *i*, and the one who needs them– *j*;

P_j – the need for educational services in the region *j*, $j = \overline{1,m}$;

N_i – educational capacity of the region *i* of providing higher education, $i = \overline{1,m}$, person;

k_{ij} – specific investment in obtaining a higher education by a student who has moved from region *j* to region *i*, thousand UAH / person.

The matrix also indicates unknown values that need to be found when solving the problem: X_{ij} – amount of students of region *j*, who acquire higher education in region *i*, $i = \overline{1,m}$; $j = \overline{1,m}$.

For each region *j* introduce a set of regions that have learning power, but for the above reasons are excluded from the distribution. Denote this set I_j; such sets can exist for any region *j*, ie I_j, $j = \overline{1,m}$.

Present these sets:

$$I_j = \left\{ i \in \left(\overline{1,m}\right) \middle| \; k_{ij} \rangle\rangle \, k_{\text{соц}} \right\}, \; \mathrm{j} = \overline{1,\mathrm{m}}. \qquad (22)$$

Present dependencies for determining specific investments for different situations of distribution of services among the regions for the solution of the main task:

$$k_{ij} = \begin{cases} k_{\text{соц}}, i \in (\overline{1,m}) \big| i \neq j; i \notin I_j, \; j = \overline{1,m}; \\ k, i \in I_j, \; j = \overline{1,m}; \\ 0, i = j, i = \overline{1,m}; \; j = \overline{1,m}; \\ k_{\text{осв}}, \mathrm{i = m+1;\; j = \overline{1,m};} \\ 0, \; j = m+1; i = \overline{1,m}. \end{cases} \qquad (23)$$

Depending on the ratio of educational capacity and the need for higher education, to convert an open task into a closed model, it is necessary to introduce a fictitious line *m*+1 that “takes” all the dissatisfied needs of the regions in higher education, or the fictitious column *m*+1, in which, as a result of the optimal solution to the problem, will be reflected all unused educational capacity of the regions.

The value of fictitious educational capacity N_{m+1} (row *m*+1) and fictitious need for educational services P_{m+1} (fictitious column) taking into account the exclusion of certain combinations of regions (sets $I_j, j=\overline{1,m}$) can be determined:

$$N_{m+1} = \sum_{j=1}^{m}\left(P_j - \sum_{i \notin I_j} X_{ij}\right); \qquad (24)$$

$$P_{m+1} = \sum_{i=1}^{m}\left(N_i - \sum_{j=1}^{m} X_{ij} \,\middle|\, i \notin I_j\right). \qquad (25)$$

Here are examples of calculations of specific investments on real statistics. The matrix (Fig. 2) states that to solve the problem need to be prepared (m+1) · (m+1) coefficients k_{ij} of investment costs.

As can be seen from the formula (23), k_{ij} can acquire different values depending on the conditions.

Specific capital investments in fixed assets $k_{соц}$ types of economical activities (TEA), providing social services

The cost of fixed assets *K* of these types of economic activity (Table 2) is K =2978651 million UAH; total cost of fixed assets of the national economy K_0 = 8177408 million UAH, thus, share of TEA, that are considered is k_0 = 0,37.

Given the drift (f = 0,581) the cost of fixed assets, which are intended to provide services on average per country:

$$K_{соц} = k_0 K_0 (1+f) = 0{,}37 \cdot 8177408 \cdot 1{,}581 = 4783538 \text{ million UAH.}$$

Specific investments for maintenance of social services for the population at the basic level (per person):

$$k_{соц} = \frac{K_{соц}}{S} = \frac{4783538}{42{,}4} = 114 \text{ thousand UAH.}$$

These indicators are used as coefficients for those cells of the matrix (Fig. 2) $m \times m$, where $i \neq j$ and $i \notin I_{j,} j=\overline{1,m}$.

Specific capital investments in fixed assets of higher education institutions

If while solving the problem remains the dissatisfied need for acquiring higher education, this will be reflected in the line m+1. To meet this need, additional investment is needed to increase the educational capacity of educational institutions.

The cost of fixed assets of the TEA “Education”:

$K_{осв}$ = 72 520 million UAH; the number of people studying in educational institutions $S_{осв}$ = 5730 thousand person. The cost of fixed assets per person is $k'_{осв} = K_{осв}/S_{осв} = 72520/5730 = 12,7$ thousand UAH, taking into account the drift of fixed assets (coefficient of drift in NED “Education” $f_{осв}$ = 0,427.

$$k_{осв} = k'_{осв}(1+f_{осв}) = 12,7(1+0,427)=18,1 \text{ thousand UAH.}$$

Standards k_{ij}, placed in the cells of the matrix on the main diagonal, ie $\overline{i, j = 1,m \mid i = j}$, equal to zero: k_{ij} = 0.

For cells of the matrix, which should be excluded from the distribution according to the choice of entrants, that is for all $i \in I_j,\ j = \overline{1,m} : k_{ij} = k = k_{соц} + c$, where c – a large number.

Set of values $X_{ij}, i = \overline{1,m};\ j = \overline{1,m}$ reflects the optimal distribution of entrants by region for acqiring higher education.

Set of values $X_{im+1}, i = \overline{1,m}$ reflects the unused teaching capacity of HEI by region in the optimal plan.

Values $X_{m+1j},\ j = \overline{1,m}$ reflect unmet needs in higher education by region.

Target function determines the total amount of capital investment in fixed assets to maintain the level of social services and in the fixed assets of the TEA “Education” and is equal to:

$$K = \sum_{i=1}^{m+1}\sum_{j=1}^{m+1} k_{ij} X_{ij}. \qquad (26)$$

Including investments in the social and domestic field:

$$K_{соц} = \sum_{i=1}^{m}\sum_{j=1}^{m+1} k_{ij} X_{ij}; \qquad (27)$$

in the field of education:

$$K_{осв} = \sum_{j=1}^{m} k_{m+1j} X_{m+1j}. \qquad (28)$$

Unused training capacity

$$N = \sum_{i=1}^{m} X_{im+1} . \qquad (29)$$

Unmet needs for higher education

$$P = \sum_{j=1}^{m} X_{m+1j} . \qquad (30)$$

CONCLUSIONS

Thus, an important step in adopting an effective policy for the development of the system of higher education is the complex setting of the task of distributing and loading of educational capacities in the context of regions, identifying their reserves, the volume of dissatisfied needs for services for higher education acquiring, which will be the basis for the formation of a state policy for the development of the system of higher education. Thus, an important step in adopting an effective policy for the development of the system of higher education is the complex setting of the task of distributing and loading of educational capacities in the context of regions, identifying their reserves, the volume of dissatisfied needs for services for higher education acquiring, which will be the basis for the formation of a state policy for the development of the system of higher education. Implementation of this approach will allow maintaining an adequate level of social services in the given region with an increase in the number of graduates in it. In addition, such approach is aimed at making the most of the existing training capacity of each region, and the accepted optimality criterion will ensure minimal investment from the state budget. It is advisable to use when developing strategic measures to improve macroeconomic planning and may be the basis for managerial decisions on state regulation of higher education.

SUMMARY

The decision of the problem of the analysis of the use of educational potential and the development of the system of higher education provides an opportunity to obtain the optimal plan for the criterion of minimization of total investments, which is the basis for making effective decisions on state regulation of development and improvement of the system of higher education.

REFERENCES

1. Мазалова О.Г. Формування системи моніторингу управлінської діяльності органів управління освітою як основи ефективної діяльності регіональної системи управління освітою. URL: http://revolution.allbest.ru
2. Рамазанов С.К., Крупський К.Л. Розробка концептуальної схеми прийняття рішень при взаємодії регіональної системи освіти та ринку праці. *Бізнесінформ.* 2012. № 4. С. 154–157.
3. Щербакова Г.О. Проблеми і особливості державного управління вищою освітою в контексті адаптації діяльності регіональних вищих навчальних закладів до Болонського процесу. URL: http://www.nbuv.gov.ua/e-journals/dutp/20062/txts/ GALUZEVE%5C06 sgozbp.pdf
4. Стратегії розвитку регіонів: шляхи забезпечення дієвості : Збірник матеріалів «круглого столу» / за ред. С.О. Білої. Київ : НІСД, 2011. 88 с. URL: http://www.niss.gov.ua/content/articles/files/Broshura_Bila-a47aa.pdf
5. Статистичний щорічник України за 2017 рік. Державна служба статистики України. URL: https://ukrstat.org/uk/druk/publicat/kat_u/2018/zb/11/zb_seu2017_u.pdf
6. Статистичний щорічник України за 2013 рік. Державна служба статистики України. URL: http://ukrstat.org/uk/druk/publicat/Arhiv_u/01/Arch_zor_zb.htm
7. Кочарян І.С., Безус А.М., Петровська Ю.В. Вплив регіонального фактора на планування державного замовлення на підготовку фахівців. *Наук. вісник Академії муніципального управління* : зб. наук. праць. Серія : Економіка. Київ : Академ. муніцип. упр., 2012. Вип. 11. С. 131–137.
8. Клименюк М.М., Кочарян І.С. Моделювання планових рішень підготовки фахівців з вищою освітою в регіональному розрізі. *Економічний простір* : зб. наук. пр. Дніпропетровськ : ПДАБА, 2014. № 84. С. 225–234.

Information about the author:

Kocharian I. S.

Doctor of Economic Sciences, Associate Professor,
First Vice-Rector of Kyiv National Karpenko-Karyi
University of Theatre, Cinema and Television

DOI https://doi.org/10.36059/978-966-397-123-0/89-106

LEGAL AND ACCOUNTING SUPPORT FOR OPERATIONS WITH CRYPTOCURRENCY IN THE CONDITIONS OF INNOVATIVE APPROACHES TO DOING BUSINESS

Ovsyuk N. V.

INTRODUCTION

Currently in terms of continual technological progress, significant development of IT technology, the world is increasingly made payments using electronic money. Also there is a noticeable spread in the use cryptocurrency as a completely new, innovative payment instrument of XXI century. Today the financial systems of individual countries, as well as other components of the economy are improving and progressing in the context of globalization and the total computerization. This contributes to the emergence of new financial institutions, instruments and forms of interaction between businesses.

Dollar over the past 100 years has lost more than 95% of its value, this fact may eventually force investors to buy bitcoins that for 9 years since the establishment showed strengthening at 8.5 million percent. Bitcoin was estimated at 0.07 dollars August 16, 2010 and now it reaches the mark of 8000 dollars. No other currency or asset did not generate a similar revenue for the same period[1].

Current conditions of market economy in Ukraine and its participation in world globalization necessitate are strengthening the monetary system, improving the efficiency of monetary policy in order to strengthen their influence on structure of adjustment and further development of the economy. That is why the functioning and accounting software transactions related to cryptocurrency is relevant and requires further research, especially in the absence of a legal definition in Ukraine.

Among scientists, in the works of which were investigated cryptocurrency concept, its essence and importance in innovative forms of business distinguished: A.V. Baginsky, S.V. Vasilchak, M.V. Kunitsky-Ilyash, M.P. Dubina, A.S. Goncharenko and others. Such foreign scientists

---

[1] Obozrevatel / Ринки та компанії, 16 травня 2019 р. URL: https://www.obozrevatel.com/ukr/economics/economy/kurs-dolara-vpav-na-95-analitiki-ozvuchili-nespodivanij-prognoz.htm

as C. Reiborn, M. Sivitanides, C. Graydon and others paid attention to consideration on accounting transactions with cryptocurrency.

However a number of global, geopolitical, national, regional crises, the negative effects of globalization encourage individuals and businessmen to seek alternative means of storing and increase of money. Ukrainian modern consumer especially dire need speed, security, settlements, absence of third-party, independent currency values on the political situation in the country and cryptocurrency meet those needs. Users in Ukraine in the use of cryptocurrency increasingly recognize their performance that needs improvement to ensure these areas of financial instruments.

Cryptocurrency (digital currency) acts as a decentralized digital measurement of value business processes that can be expressed in a digital form and function as a medium of exchange, store of value or unit of account, based on mathematical calculations is their result and has encryption protection of account.

Cryptocurrency – “virtual money”. It should be noted that for the production, regulation and checking transfers use encryption encoding.

1. Peculiarities of Identification and Determination of the Legal Status of Cryptocurrency

Virtual currency has similarities with electronic money, but we must understand that these are two different concepts. Electronic money – the unit value stored on the electronic device is accepted as means of payment by other persons than the person who produces it, is the monetary obligations of the persons which is executed in cash or by bank transfer. Electronic money unlike cryptocurrency have legal status, legally defined issuer fixed the offer and made over them regulation and supervision. Digital currency, in turn, hasn't legally defined the issuer and is produced by Mining (solving difficult mathematical problems with getting a reward virtual coins), the legal status is uncertain in many states, moreover, its use carries many risks. Cryptocurrency has a number of advantages and disadvantages. The former include the following:

1. Decentralization. Cryptocurrency an independent currency. Its emissions nobody regulates or control the movement of funds.

2. Ability to self-issue (mining) cryptocurrency. It can get by exercise computational operations using its own or leased specialized equipment.

3. Anonymity transactions. Since the creation of electronic purses cryptocurrency don't require personal data and all calculations in this system are confidential, the information about the participants of transactions cannot find any other users or public authorities. But at the same time, this advantage is a disadvantage, since absence of personal data creates favorable conditions for the transfer of funds between criminal organizations. Also in case of loss of access to electronic wallet, the user can no longer turn back the funds that it kept.

4. Lack of inflation. For the most systems of cryptocurrency limit of virtual coins is limited, so inflation to this currency is not threatened.

5. Reducing the time of payment. If the payment is reduced to pressing instead of relying on the introduction of various payment information such as the card number, the time spent taxpayer is significantly reduced. In addition, the risk of fraud may be lower because the card number or the account number is not required to disclose to the recipient.[2]

There are many shortcomings that hinder the implementation cryptocurrency as payment. The main are the following:

1. Significant fluctuations (Fig. 1).

As you can see, in the early 2017 Bitcoin exchange rate against the dollar was less than $ 1,000, from the moment it began a significant increase in December 2017 and reached a peak for the entire period of its existence – about $ 17226. Then there is depreciation. On 10.04.2018, it stood at $ 6877.21 for 1 Bitcoin.

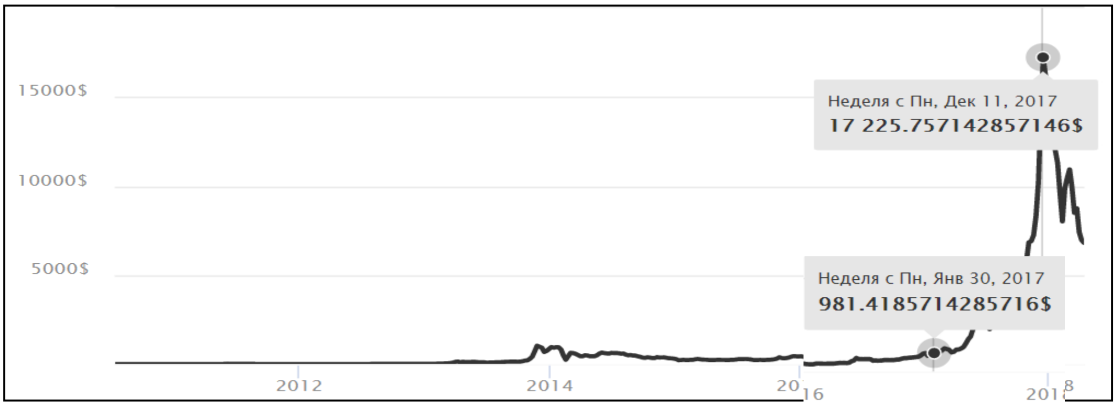

Fig. 1. Bitcoin course against the dollar[3]

[2] Васильчак С.В., Куницька-Іляш М.В., Дубина М.П. Використання криптовалют в сучасних економічних системах України: перспективи та ризики. *Науковий вісник Львівського національного університету ветеринарної медицини та біотехнологій імені С. З. Ґжицького. Серія : Економічні науки*. 2017. Т. 19. № 76. С. 19–25.

[3] Сайт моніторингу за операціями з криптовалютою. URL: http://hyipstat.top

2. The threat of national currency. Increased use in the calculation of certain forms of currency strength, and so wide spread use cryptocurrency in Ukraine may weaken the national currency. In recent years it has depreciated significantly against the dollar, so it is important to stabilize the economic situation in our country that the national currency was able to withstand the new competitor.

3. Failure to conduct effective monetary policy, as large portion of money is beyond the control of monetary regulator.

4. Irreversibility of transactions. After payment to cancel the operation is impossible. Therefore, users of a digital currency need thoroughly inspect the entities with which they carry out cash transactions for their reliability assurance and prevention of fraud.

Today in the world there are a large number of cryptocurrency. The most popular are presented in the Table. 1.

According to Table 1 it can be argued that the most popular cryptocurrency is Bitcoin, and the least popular – NEO. In addition, it should be noted that the value of the currency does not meet graduation in popularity. For example Bitcoin exchange is the largest and 6 is $ 839.03, while the rate of Tron – 0.04 $, although this type of cryptocurrency heads fifth place in the ranking.

Bitcoin, but the first place among popular with users is also the first cryptocurrency in the world, which was established in 2009 by a programmer (or group of programmers) under the pseudonym Satoshi Nakamoto without a part of the state as an alternative to "classical" currencies based on other than these principles of emissions and circulation to ignore conservative fiat-credit monetary system outside which the ordinary course money cannot be existed [4]. Bitcoin is a distributed peer network in which no single emission center and emission occurs automatically based on a mathematical algorithm. Each member of the network involved in the maintenance of the network. To ensure the anonymity of all transactions in the network uses asymmetric cryptographic methods of encoding encryption using public and private keys. The feature of the technology is Bitcoin block chain. This is a public database of all transactions ever made in Bitcoin system, which is organized in data blocks. Each newly created block contains the hash of the previous amount.

[4] Graydon C. What is cryptocurrency? *CryptoCoinsNews*, 2014. URL: https://www.cryptocoinsnews.com/cryptocurrency/

Thus creating a continuous chain of interconnected blocks of information that originates from the so-called genesis block (the first block in the system Bitcoin) to the last, found by the system unit. Using this database, each user can see how many Bitcoin belonged to wallet in a particular period of time. Block chain is stored simultaneously in all network users.

Table 1

Rating cryptocurrency 2018

№	Currency	Course	Capitalization / released	Space for 24 hours.
1	Bitcoin (BTC)	6 $ 839.03	116 050 816 167 $ 16968900	4237770000 $
2	Tether (USDT)	$ 1.00	2284581503 $ 2287140814	1226710000 $
3	Ethereum (ETH)	$ 410.56	40538793356 $ 98739279	1157230000 $
4	Verge (XVG)	$ 0.09	1302157411 $ 14859467328	$ 478,459,000
5	Tron (TRX)	$ 0.04	2423948782 $ 65748111645	$ 305,793,000
6	Bitcoin Cash (BCH)	$ 649.92	11091621629 $17066213	$ 221,670,000
7	Litecoin (LTC)	$ 114.02	6388034663 $ 56025563	$ 201,057,000
8	Ripple (XRP)	$ 0.49	19230242844 $ 39094520623	$ 155,845,000
9	Ontology (ONT)	$ 4.50	1085006773 $ 241236451	$ 136,131,000
10	NEO (NEO)	$ 52.16	3390335000 $ 65000000	$ 97,304,000

Source: the authors summarized based on[5]

Trade agreements using bitcoins held in electronic format, and purchase and sale of currency can be done through online exchanges (e.g., BTC-E). With special exchangers in online networks (Web Money) or through a broker (FX Open) cryptocurrency can be exchanged for the

[5] Сайт моніторингу за операціями з криптовалютою. URL: http://hyipstat.top

major currencies of the world. Also bitcoins can get by taking payment for the goods and services directly or through the purchase of another owner. The last option is considered the most advantageous because it does not include fees charged in the exchange office.

Another way to get digital currency is Mining. It is that in computers of users who are in different places, planed install special software with the help of which in result of solving mathematical tasks form bitcoins.

Consequently in the context of the rapid development of IT-technologies, the rapid spread of cryptocurrency in the world is an indisputable phenomenon. Its popularity lies in two features – anonymity and decentralization. There is a theory that in the future cryptocurrency will become the successor to paper money, completely taking over their functions on themselves.

It should be noted that the use of cryptocurrency is a predominantly new phenomenon in the world. Despite the lack of legal definition, cryptocurrency as a form of calculation began to gain popularity in many countries around the world. Interest in digital currencies is also gaining momentum in Ukraine.

This is caused by the crisis of the domestic banking system, the instability of the hryvnia, the changing course of currency and other socio-economic difficulties that are concentrated on the financial system of Ukraine. In Ukraine, the real popularity of cryptocurrency began in 2014, when enthusiasts created a social organization with the aim of distributing, developing and studying bitcoin and other virtual currencies on the territory of our state – Bitcoin Foundation Ukraine (DFU). Approximately at that time, the first companies and agencies began to appear, including those offering a physical exchange of cryptocurrency for cash, as well as making online cash transactions.

Cryptocurrency in Ukraine can be earned, bought or given. Some online stores and businesses indicate on their websites that they accept cryptocurrency as payment for goods or services. In some countries, employers already pay salaries to their employees in cryptocurrency, usually those who work online – in Ukraine, this practice is only beginning to spread. Today, wages in cryptocurrency among Ukraine are received mostly IT professionals working for foreign companies. Sometimes cryptocurrency can also be obtained free of charge: it's small gift amounts that attract people around the world. To do this, just enter the

CAPTCHA or view the advertisement and for this, for example, Satoshi (one hundred millionth bitcoin) will be counted. Gifts are possible from great service, for example, for a good post or article, a picture that is in demand by other users[6]

Given the significant growth of interest in virtual currency among residents of Ukraine there is urgent need of legal regulation of cryptocurrency, problem which lies in the fact that the relationship with cryptocurrency cannot be directly applied that or another current legislation. This conflict arose due to the fact that according to the legal norms cryptocurrency cannot be equated neither to means of payment nor to the currency value.

In this regard the National Bank said: “The issue of virtual currency Bitcoin does not have any security and legal obligations for the persons, it is not controlled by the state authorities of either country. So, Bitcoin is money substitutes, which does not provide real value”[7].

So cryptocurrency means the type of digital currency, the account of which is possible using cryptographic techniques[8].

Chairman of the Commission on Commodities Commerce of the USA (CFTC) Christopher Giancarlo said that cryptocurrency has the future, but competition for hard currency and dollar they do not make[1.]

2. The Main Approaches of State Regulation and Accounting for Transactions with Cryptocurrency

Note that cryptocurrency legal status remains ambiguous and its records are maintained in accordance with the professional judgment of an accountant. Therefore, the Supreme Rada registered just two bills concerning the legal status and treatment of cryptocurrency and intended to create a legislative framework for the use of cryptocurrency.

Draft Law of Ukraine of 10.10.2017 р. № 7183-1 “On stimulating the market of cryptocurrency and their derivatives in Ukraine” [9] defines

---

[6] Гусєва І.І., Петрова Т.О. Тенденції розвитку криптовалют на ринку України. *Науковий вісник Міжнародного гуманітарного університету. Сер. Економіка і менеджмент*. 2017. № 24 ч. 1. С. 48–50.

[7] Лист Національного банку «Щодо віднесення операцій з віртуальною валютою/криптовалютою «Bitcoin» до операцій з торгівлі іноземною валютою, а також наявності підстав для зарахування на поточний рахунок в іноземній валюті фізичної особи іноземної валюти, отриманої від продажу Bitcoin» №29-208/72889 08.12.2014 р. URL: http://zakon3.rada.gov.ua/laws/show/v2889500-14

[8] Багинський О.В. Перспективи використання криптовалюти Bitcoin. Матеріали міжнародної наукової конференції. *Міжнародне науково-технічне співробітництво: принципи, механізми, ефективність* (Київ 13–14 бер. 2014). Київ : НТУУ «КПІ», 2014. С. 10–11.

cryptocurrency as decentralized digital measurement of value that can be expressed in numerical form and function as a medium of exchange, store of value or unit of account, based on mathematical calculations, is the result of a cryptographic protection of accounting. Cryptocurrency for the purpose of regulation is a financial asset. This project provides for the introduction of 2% tax on compulsory state pension insurance with each e-cash transaction operation, resulting in additional revenues to the state budget of Ukraine.

Bill № 7183 "On Circulation cryptocurrency in Ukraine"[10] determined that cryptocurrency is a software code (a set of symbols, numbers and letters) that are the subject of property rights, which may be a means of exchange, information is entered and stored blokchain system as accounting unit blokchain current system in the form of data (code). The draft states that cryptocurrency applies general rules that apply to private ownership and transactions e-cash to the general provisions of barter, in accordance with the laws of Ukraine. The project also provides for distribution of tax legal operations of Mining and Mines (exchange) cryptocurrency, according to the current legislation of Ukraine (that cryptocurrency will be subject to tax).

To date none of the above mentioned legislation has not yet entered into force. However, purchases and sales of cryptocurrency according to legislation regarded as an activity which aims to profit, so actually the business activities subject to taxation[11].

Considering the sale and purchase cryptocurrency of individual note that according to art. 163.1 TCU [9] resident is subject to tax: the total monthly (annual) taxable income; income originating in Ukraine, which ultimately taxed when it charges (payments provision); Foreign income – income (profit) derived from sources outside Ukraine. Note that the actual individual in transactions of sale or purchase cryptocurrency is in Ukraine, but all operations are taking place abroad. Confirmation of the transaction outside of Ukraine may be that the most direct trade exchanges on which transactions occur registered outside of Ukraine. An example is the

[9] Проект закону України «Про стимулювання ринку криптовалют та їх похідних в Україні» №7183-1 від 10.10.2017 р. URL: http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511= 62710

[10] Проект закону України «Про стимулювання ринку криптовалют та їх похідних в Україні» №7183 - 1 від 10.10.2017 р. URL: http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511= 62710

[11] Податковий кодекс України: Закон України №2755-VI від 02.12.2010 р. ВВР. 2011. URL: http://zakon3.rada.gov.ua/laws/show/2755-17

exchange www.yobit.net. According to the Web resource www.whois.com it is registered in Russia. Actually, place of purchases and sales on the stock exchange of cryptocurrency is the country of registration of the exchange. So purchases and sales of cryptocurrency should be regarded as "foreign income" derived from sources outside Ukraine, because the trade deal with the sale process and profit take place beyond Ukraine.

Also buying and selling cryptocurrency are not operations "investment assets", therefore cannot be taxed at a rate of 5% as the position p. 170.2 TCU[9] contains an exhaustive list of concepts referred to as "investment assets" and "investment income". Information about assets like cryptocurrency it is not reflected.

Interesting is the fact that the transaction of the acquisition cryptocurrency is not taxable as a result of this operation is not received profit. However, if cryptocurrency was sold at a higher price than acquired, the positive difference on its legal merits will be considered passive income as an individual buyer does not directly affect the cost of growth factors cryptocurrency. But the current situation p. 170.2 TCU does not recognize cryptocurrency "investment income" and "investment assets", and therefore profit from such sale cannot be taxed under the provisions of paragraph 170.2 TCU at a reduced rate of 5%.

This income should be interpreted as "any income received by residents" and "other income from any activities outside the customs territory of Ukraine" according to the claim p. 14.1.55 TCU, so it is liable to tax on a common basis at the rate of 18% which provides p. 167.1 TCU[12].

The obligation to pay accrued tax arises on the day of profit, the day transfer of funds from the sale / exchange cryptocurrency for money. But it is paid to 01 August next year.

It should also be emphasized that the tax will be subject only to income derived, that is to say cryptocurrency which was exchanged for cash and transferred to a bank account / card of individual. Exchanges cryptocurrency one to another will not be taxed given the fact that the exchange cryptocurrency one to another is not income. When exchanging cryptocurrency should pay attention to the cost of the first investment, i.e. the amount for which you purchased the first cryptocurrency as well as the

---

[12] Проект закону України «Про обіг криптовалюти» №7183 від 06.10.2017 р. URL: http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511=62684

amount for which it was exchanged (sold) at the latest cryptocurrency currency. The positive difference resulting from the transactions will be subject to tax at the rate of 18%.

Considering the operations of non-residents in Ukraine on sale and purchase cryptocurrency and taking into account the provisions of paragraph 163.2 TCU, we can say that the income of non-residents from transactions with sale cryptocurrency taxed not even provided the resident is physically located in Ukraine, since purchases sale of cryptocurrency occur outside Ukraine, namely at the exchange. Non-resident has to pay taxes in the country in which he is. An exception will be transactions with non-residents on sale and purchase cryptocurrency undertaken at Ukrainian exchanges. These operations will apply the general rule as to the taxation of residents.

The world's leading standards bodies have also began to consider and investigate this perspective. Thus, the Council for Standardization US Financial Accounting, outlined the range of issues that need clarification, such as aspects of recognition, measurement and calculation of virtual currency [13].

Despite centuries of development is still in the theory and practice of monetary relations found many contradictions and unexplored areas.

One of these areas is an alternative currency, which includes the emission and use of a calculation tool extra money, namely cryptocurrency.

Because of active development of relations cryptocurrency important need arises implementation of legislative regulation. And first of all, each country should provide legal status of cryptocurrency. In various states methods for solving this problem differ (tab. 2).

However, despite revealing a positive attitude to cryptocurrency in the most developed countries, some countries virtual currency is considerable distrust and there cryptocurrency use is prohibited. These include Bangladesh, Bolivia, Ecuador, Vietnam, Iceland, China.

Thus, the international practice of using cryptocurrency indicates that states have different attitudes to its introduction into circulation. The reason is mainly the novelty of the instrument and the lack of a single definition of the “cryptocurrency” that discloses its economic substance.

---

[13] Доповідь радників для Голови Ради зі стандартів фінансового обліку США_квітень 2014 р. URL: http://www.fasb.org/jsp/FASB/Document_C/Documentpage&cid=1176164360924

Table 2

The experience of foreign countries to state regulation and use cryptocurrency

Country	Characteristic
United States	One of the most comfortable in the world of cryptocurrency for doing business. It is incorporated large hedge funds, exchanges and other companies associated with cryptocurrency. For many goods and services can pay not only fiat or electronic money, but also digital. Also common in the US ATMs (ATM), enabling the exchange cryptocurrency. Among the regulators is no common position on the legal status cryptocurrency. Digital currency is seen both as money (their equivalent), property and commodities. At the federal level, some cryptocurrency companies (e.g., Exchange) should be registered as operators of the web transfer funds to combat financial crime, and at the state level activities of such companies to be licensed. Real cryptocurrency taxed. For example, wages paid in Bitcoin, is the subject of the federal income tax and payroll tax.
Canada	Ranked second in the world after the United States for the number of set-bitcoin ATMs. In order to better understanding the technology Blokchain state develops digital version of the Canadian dollar based on it. This activity of cryptocurrency exchanges was settled back in 2014 when the bill was approved, under which such exchanges should be registered at the Canadian Center for Analysis and reporting of financial transactions and obliged to comply with legislation on counteraction to legalization (laundering). In Canada, payment for goods and services using digital money is taxable as barter. In addition, during the sale cryptocurrency tax on income (Income Tax), income tax (Corporation Income Tax) or capital gains tax.
Australia	Demonstrates intention to become one of the most progressive jurisdictions. Digital currency is not regarded as a financial product, so cryptocurrency activities are not subject to licensing (with the exception of activities related to fiat money or other financial products). Australia has actively developed legislation on counteraction to legalization (laundering) of proceeds from crime and terrorist financing, which would imply the ability to use digital currencies to commit these crimes. Real cryptocurrency taxed according to standard rules of taxation, i.e. income tax and profit tax. However, when used as an investment cryptocurrency no need to tax capital gains. In addition, in December 2016 the Code of behavior became real for members of industry digital currency.

Continuation of Table 2

United Kingdom	There cryptocurrency integration leader and one of the most convenient and the most favorable jurisdictions for cryptocurrency doing business. In addition, the state provides support to entities associated with the digital currency. However, the final position of the government on regulation of activities associated with digital money has not yet been produced. In 2014 the United Kingdom government body reaffirmed that Bitcoin – it is not currency, not money, because cryptocurrency no way regulated financial legislation in United Kingdom. Until now, digital currency in the United Kingdom believe the unique combination of digits obtained from the complex mathematical calculations and algorithms
Japan	Since April 2017 passed a law under which Bitcoin and other cryptocurrency equal in status to fiat money and become legal tender. Japan became the first country in the world to do so. One of the shocks to provide cryptocurrency status of legal tender collapse began trading on one of the largest Bitcoin exchanges-MTGox and its bankruptcy in 2014, so that its customers have suffered huge losses and cryptocurrency rate fell heavily. It is to prevent such situations and protect the rights of consumers, Japan performs legislative regulation of the issue.
Austria	In Vienna, opened the world's first Bitcoin Bank. The bank has to make buying and selling Bitcoin easier and safer. The bank established a special ATMs that allow Bitcoin exchange to the euro and vice versa. Bank customers can also get them interested in information on virtual currency. The project was very successful, and after Bitcoin ATMs began to appear in other places.
Germany	German Finance Ministry has officially recognized the Bitcoin instrument and made appropriate changes in the Banking Code. In particular, Germany is set bitcoin legal status as private money and clearing in this cryptocurrency on the territory of the state.
Netherlands	Most daring attitude to cryptocurrency demonstrated the Netherlands, where it was created “city Bitcoin” and determined the highest concentration of companies providing goods and services for Bitcoin. You cannot just pay for legal services, but also a haircut, buy a hamburger or a new suit, send an email to fix appliances or rent a hotel room.
Sweden	Another country that has a favorable attitude to cryptocurrency is Sweden. Cryptocurrency are widely used in the form of payment. The population of Sweden is almost completely abandoned cash. The proportion of cash payments in trade declined sharply from 40% in 2010 to 15% in 2016. In addition, the question of establishing a national cryptocurrency that have comprised the advantages of public money and virtual independence.

Ending of Table 2

EU countries	Considering the legislative activity of the EU, it should be noted that none of them have adopted specific rules regulating cryptocurrency activities. However, in 2016 the European Commission proposed a regulation for an extra cryptocurrency exchanges and companies providing cryptocurrency wallet users. Also, EU tax cryptocurrency and operations with it carried out in accordance with national laws of the Member States. The exception is the value added tax, since November 2015 the Court (European Court of Justice) ruled under which transactions of sales and purchase of Bitcoin for the traditional fiat money is not taxed.

Source: the authors systematically through[14, 15]

As a result of thorough research on adherence cryptocurrency standard classifications, foreign researchers reached their conclusions:

1) Bitcoins not be considered cash, as most companies do not accept them because bitcoins classification as unrealistic costs;

2) Bitcoins not be classified as cash equivalents because they are not highly liquid, not easily convertible. Bitcoins impossible to put on a bank deposit or cash from ATMs, due to the extremely high rate volatility, and therefore not subject to the criterion insignificant risk of changes in value;

3) Bitcoins although no material form, it cannot be regarded as an intangible asset. Because of the intangible assets not attributable financial instruments, but bitcoins, which is not cash, serves as a means of financial exchange, it is actually a financial instrument[16].

Thus, according to researchers, is noteworthy in modern conditions the most appropriate classification group for cryptocurrency is investments.

Taking into account the change in value of investment in accounting it's necessary to display their revaluation on each balance sheet date, which

---

[14] Гончаренко О.С. Особливості функціонування криптовалют на 32 світових ринках. *Миколаївський національний університет імені В.О. Сухомлинського*. 2015. Випуск 5. URL: http://globalnational.in.ua/archive/5-2015/168.pdf

[15] Ситник І.П., Пюро Б.І. Аналіз сучасного стану та перспектив розвитку криптовалюти bitcoin в умовах розвитку інформаційної економіки. *Вісник Одеського національного університету. Сер. Економіка*. 2017. № 22. Вип. 1. С. 157–160.

[16] Raiborn, C., Sitivanides, M. Accounting Issues Related to Bitcoins. *Journal of Corporate Accounting&Finance.* 2015. URL: https://onlinelibrary.wiley.com/doi/10.1002/jcaf.22016/epdf?r3_referer= wol&tracking_action=preview_click&show_checkout=1&purchase_referrer=onlinelibrary.wiley.com& purchase_ site_license= LICENSE_DENIED.

directly affect the item of other income and expenses (p. 8 P(S)BO 12[17], p. 32 P(S)BO 13[18]).

Companies that keep records of IFRS, the revaluation surplus are credited depending on the classification of financial instruments – to the financial results or to capital.

Taking into account the current business realities that contribute to that cryptocurrency gaining new segments of world trade, is used to pay for online goods and services, it should be noted that currently in Ukraine there are no regulatory instructions regarding accounting operations cryptocurrency.

According to the above legislative initiatives and given the need to regulate transactions associated with your directions formulated cryptocurrency software that can affect the value of business entities:

– primary current account of certain types and quantities cryptocurrency serving as a means of payment or exchange for traditional now for free exchange rate is formed on open Internet sites;

– analytical accounting cryptocurrency according to the species listed in the table. 1, which will enhance controls these financial instruments;

– accounts of spending for the organization and holding exchanges exchangers, open Internet sites that perform the function of exchange; for training personnel which will carry out operations with cryptocurrency and acquisition related software etc.;

– accounting taxation connected with the use cryptocurrency, recording the requirements of current legislation.

CONCLUSIONS

The results of the research on the regulation of company operations associated with the use cryptocurrency, made the following conclusions:

– cryptocurrency use is mostly a new phenomenon in the world. Despite the lack of legal definition, a form of calculation cryptocurrency started to gain significant popularity in many countries. Revealed that the rapid development of IT- technologies cryptocurrency rapid expansion in the world is indisputable phenomenon. Its popularity lies in two features –

---

[17] Положення (стандарт) бухгалтерського обліку 12 «Фінансові інвестиції» : Наказ Міністерства фінансів України від 26.04.2000 № 91. URL: http://zakon2.rada.gov.ua/laws/ show/z0284-00

[18] Положення (стандарт) бухгалтерського обліку 13 «Фінансові інструменти» : Наказ Міністерства фінансів України від 30.11.2001 № 559. URL: http://zakon5.rada.gov.ua/laws/ show/z1050-01

anonymity and decentralization. In the future cryptocurrency may become the successor of paper money, fully adopting their functions themselves;

– analysis of the essence cryptocurrency allowed to provide such the following definition: cryptocurrency is a decentralized digital measurement value that can be expressed in numerical form, produced by Mining and functions as a means of payment, exchange, store of value or unit of account and a cryptographic protection;

– analysis of foreign experience in government regulation, use, accounting and taxation of cryptocurrency allowed to state that cryptocurrency, though is not considered cash serves as a means of financial exchange, is actually a financial instrument. Therefore, in the present conditions the most appropriate classification group for cryptocurrency is investments;

– for the purposes of cost management business conditions of business transactions related to cryptocurrency need to provide:

– primary current account number, types cryptocurrency now used to facilitate the control and efficient use of these financial instruments;

– cryptocurrency of analytical accounting entity that provides the ability to control its movement, including the use of different types of cryptocurrency for individual enterprises;

– accounting reflection of function of function cryptocurrency exchange, services of brokers, personnel training and others that determine the value of spending related to activity of an enterprise to implement operations with cryptocurrency;

– determining the order of taxation of Mining, exchange cryptocurrency to facilitate additional revenues to the state budget of Ukraine and establishing liability company for violation of applicable regulatory requirements regarding the use cryptocurrency.

Prospects for further research is the introduction of special software which will record cryptocurrency possible in accordance with national and international accounting standards.

SUMMARY

The purpose of the study is to analyse the legal regulation of the functioning of cryptocurrency in Ukraine, as well as the approaches to accounting for operations related to it, taking into account the practice of foreign states.

The author pays attention at that despite centuries of development, as before, in the theory and practice of monetary relations, there are many contradictions and unexamined aspects. One of such aspect is alternative money circulation, which involves the use as a calculating tool of cryptocurrency the accounting of which is based on asymmetric encryption and the application of various cryptographic methods of protection. Up to date there are a lot of cryptocurrency in the world. The most popular among them is Bitcoin.

The publication examines the peculiarities of displaying information on operations of an enterprise, related to cryptocurrency and due to innovative approaches to doing business. The author's definition of cryptocurrency is proposed, taking into account its economic essence. The main directions of accounting of operations related to cryptocurrency are formulated, which will allow to improve the process of managing the cost of business in the conditions of such operations. The peculiarities of taxation of operations with cryptocurrency are determined, taking into account the requirements of the current legislation.

REFERENCES

1. Obozrevatel / *Ринки та компанії*, 16 травня 2019 р. URL: https://www.obozrevatel.com/ukr/economics/economy/kurs-dolara-vpav-na-95-analitiki-ozvuchili-nespodivanij-prognoz.htm

2. Васильчак С.В., Куницька-Іляш М.В., Дубина М.П. Використання криптовалют в сучасних економічних системах України: перспективи та ризики. *Науковий вісник Львівського національного університету ветеринарної медицини та біотехнологій імені С. З. Ґжицького.* Серія : Економічні науки. 2017. Т. 19. № 76. С. 19–25.

3. Сайт моніторингу за операціями з криптовалютою. URL: http://hyipstat.top

4. Graydon C. What is cryptocurrency? *CryptoCoinsNews*, 2014. URL: https: // www.cryptocoinsnews.com/cryptocurrency/

5. Гусєва І.І., Петрова Т.О. Тенденції розвитку криптовалют на ринку України. *Науковий вісник Міжнародного гуманітарного університету. Сер. Економіка і менеджмент*. 2017. № 24 ч. 1. С. 48–50.

6. Лист Національного банку «Щодо віднесення операцій з віртуальною валютою/криптовалютою “Bitcoin” до операцій з торгівлі іноземною валютою, а також наявності підстав для зарахування на

поточний рахунок в іноземній валюті фізичної особи іноземної валюти, отриманої від продажу Bitcoin” № 29-208/72889 08.12.2014 р. URL: http://zakon3.rada.gov.ua/laws/show/v2889500-14

7. Багинський О.В. Перспективи використання криптовалюти Bitcoin. Матеріали міжнародної наукової конференції. *Міжнародне науково-технічне співробітництво: принципи, механізми, ефективність* (Київ 13–14 бер. 2014). Київ : НТУУ «КПІ», 2014. С. 10–11.

8. Проект закону України «Про стимулювання ринку криптовалют та їх похідних в Україні» № 7183 – 1 від 10.10.2017 р. URL: http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511= 62710

9. Проект закону України «Про обіг криптовалюти» № 7183 від 06.10.2017 р. URL: http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_1?pf3511=62684

10. Податковий кодекс України: Закон України № 2755-VI від 02.12.2010 р. ВВР. 2011. URL: http://zakon3.rada.gov.ua/laws/show/2755-17

11. Доповідь радників для Голови Ради зі стандартів фінансового обліку США_квітень 2014 р. URL: http://www.fasb.org/jsp/FASB/Document_C/Documentpage&cid=1176164360924

12. Гончаренко О.С. Особливості функціонування криптовалют на 32 світових ринках. *Миколаївський національний університет імені В.О. Сухомлинського*, 2015. Випуск 5. URL: http://globalnational.in.ua/archive/5-2015/168.pdf

13. Ситник І.П., Пюро Б.І. Аналіз сучасного стану та перспектив розвитку криптовалюти bitcoin в умовах розвитку інформаційної економіки. *Вісник Одеського національного університету*. Сер. Економіка. 2017. № 22. Вип. 1. С. 157–160.

14. Raiborn, C., Sitvitanides, M. Accounting Issues Related to Bitcoins. *Journal of Corporate Accounting&Finance*. 2015. URL: https://onlinelibrary.wiley.com/doi/10.1002/jcaf.22016/epdf?r3_referer=wol&tracking_action=preview_click&show_checkout=1&purchase_referrer=onlinelibrary.wiley.com&purchase_site_license=LICENSE_DENIED

15. Положення (стандарт) бухгалтерського обліку 12 «Фінансові інвестиції» : Наказ Міністерства фінансів України від 26.04.2000 № 91. URL: http://zakon2.rada.gov.ua/laws/show/z0284-00

16. Положення (стандарт) бухгалтерського обліку 13 «Фінансові інструменти» : Наказ Міністерства фінансів України від 30.11.2001 № 559. URL: http://zakon5.rada.gov.ua/laws/show/z1050-01

Information about the author:
Ovsyuk N. V.
Doctor of Economic Sciences,
Associate Professor at the Department of Economics,
Entrepreneurship and the Natural Sciences,
V. I. Vernadsky Taurida National University
33, John McCain str., Kyiv, 02000, Ukraine

DOI https://doi.org/10.36059/978-966-397-123-0/107-149

BENCHMARKING OF THE PARADIGMS OF INNOVATION POLICY FORMATION: THE CONCEPTUALIZATION OF POSSIBLE BORROWING EXPERIENCE

Shostak L. B., Dikarev O. I.

> "rules of art can be useful but they do not determine
> the practice of an art; they are maxims, which can serve
> as a guide to an art only if they can be integrated
> into the practical knowledge of the art"
> *(Polanyi, 1962: 50)*

INTRODUCTION

Benchmarking in this study dedicates examples of successful' practices process of adapting in foreign experience during shaping innovative policy. The concept of benchmarking was developed by McAdam R., Watson G., Kyro P., Davis P., Bogan C., et al. Benchmarking includes two matters: the continuity of the process and its structuredness. The concept of a national innovation system was introduced in the twentieth century and subsequently described by many experts. The earliest work in this sphere belongs to B.A. Lundvall, R. Nelson, C. Freeman, P. Patel, K. Pavitt.

It should be first of all noted that in the world there are more than 20 countries that are considered OECD as innovative and practice such policy. These are the states with the following features: 1) the country has organized the production of new knowledge and their transformation into innovations and new technologies; 2) an information infrastructure is created that allows the storage and dissemination of knowledge and innovation; 3) an organized demand process from the part of production for innovation in order to increase competitiveness; 4) the social structure of society leads to the spread of innovations in all spheres of life.

Secondly, we need to conceptualize that, despite the recent slowdown in global growth, innovations continues to be a crucial driver of the economy in developed and developing countries. It is the main source of investment in research, development and innovation (R&D&I), with manufacturing companies responsible for more than 85% of the R&D carried out by the private sector in Germany, Japan and South Korea. Technology and innovation have been and will remain central to how production evolves and is transformed. Over the past 20 years, labor productivity across industries in the United States increased by 47%, driven primarily by technology adoption and innovation. Society is at the juncture of the increasing convergence of production and consumption, which is mainly driven by new business models enabled by transformations in technology. In the context of the Fourth Industrial Revolution, production is at the cusp of a paradigm shift driven by three technological megatrends that have reached unprecedented pace and breadth, even as their full-scale adoption and benefits in production is yet to be realized[1].

Third, we need to recognize concept of analysts:

1. Richard R. Nelson about that a national innovation system emerges from the belief that a nation's technological capabilities are its primary source of competitive performance and that these capabilities can be built through national action (Nelson 1993)[2];

2. Philip E. Auerswald and Lewis M. Branscomb about that a nation's innovation system is shaped by how the nation leverages its endowments-natural resources, culture, history, geography, and demographics – through policies that create a thriving market-oriented (firm-centric) economy and accelerate the transition of new technologies, processes, and services to the market. The core of a nation's innovation system, then, are its endowments and how government and industry leverage these endowments – the nation's government through policy investments, incentives, regulations and industrial firms through strategies, investments, and training[3].

Fourthly, it is necessary, when comparing, to consider the uncertainty factor highlighted by Richard R. Nelson that in spite of the fact that the core of the innovation economy, which is the national innovation system, was created in many developed countries of the world as early as the end of the 20th century, the theoretical construct of innovative economics has hitherto been used by many researchers as insufficiently defined concepts. There is,

[1] Zimmermann V. An international comparison of R&D: Germany benefits from industrial research strength", KFW research, No. 105, 25 August 2015.

[2] Richard R. Nelson. National Innovation Systems: A Comparative Analysis 1st Edition / Richard R. Nelson. Oxford University Press; 1 edition, 1993. 560 p.

[3] Auerswald Philip E. Valleys of Death and Darwinian Seas: Financing the Invention to Innovation Transition in the United States / Philip E. Auerswald and Lewis M. Branscomb. *The Journal of Technology Transfer.* August 2003, Volume 28, Issue 3–4, pp. 227–239.

first of all, the concept to a national innovation system itself. Each of the terms can be interpreted in a variety of ways, and there is the question of whether, in a world where technology and business are increasingly transnational, the concept as a whole makes much sense. Consider the term "innovation", the participants, interpret the term rather broadly, to encompass the processes by which firms master and get into practice product designs and manufacturing processes that are new to them, whether or not they are new to the universe, or the nation. Richard R. Nelson does that for several reasons: 1) the activities, and investments associated with becoming the leader in the introduction of a new product or process, and those associated with staying near the head of the pack, or catching up, are much less sharply distinguishable than commonly is presumed; 2) much of the interest in innovative capability is tied to concern about economic performance, and here it is certainly the broader concept rather than the narrower one that matters. This means that our orientation is not limited to the behavior of firms at the world's technology forefront, or to institutions doing the most advanced scientific research, although in some countries the focus is here, but is more broadly on the factors influencing national technological capabilities. Then there is the term system. While to some the word connotes something that is consciously designed and built. Rather the concept here is of a set of institutions whose interactions determine the innovative performance, in the sense above, of national firms. There is no presumption that the system was, in some sense, consciously designed, or even that the set of institutions involved works together smoothly and coherently. Rather, the "systems" concept is that of a set of institutional actors that, together, play the major role in influencing innovative performance. The broad concept of innovation that we have adopted has forced us to consider much more than simply the actors doing research and development. Indeed, a problem with the broader definition of innovation is that it provides no sharp guide to just what should be included in the innovation system, and what can be left out[4].

Fifth, it is necessary to take into account the factor of national peculiarities. Countries differ in their traditions, ideologies, and beliefs about appropriate roles for government, and they will guard the differences they think matter. A national innovation system also encompasses many

[4] Nelson Richard R. National Innovation Systems: A Retrospective on a Study. *Industrial and Corporate Change*. 1992 January, 1(2), 347–374.

innovation "pipelines", which are strategies for advancing innovation to industrial output. Such strategies are not necessarily linear. These pipelines aim to create a healthy innovation ecosystem through functional policies that guide primary actors to foster innovation. National governments may have a range of motives for pursuing innovation. Chief among them is economic development to increase national wealth and prosperity via the creation of new products and services and, in turn, high-paying jobs. For high-wage countries like South Korea, this may mean having more attractive products or better production processes than firms in low-wage countries. In the economic reality of the post-Soviet countries, to date, there is a number of components without which it is impossible to imagine an efficiently functioning national economic innovation complex (such a complex, for example, already established and operating in the US): 1) in the opinion of the Belarusian economist, L.M Kryukov, "Today, none of the CEE and CIS countries have a scientific innovation system. But there is an active search for the most effective approaches to its creation. This problem is intensively being developed in Russia"[5]. However, at present "there is no reason to say that national innovation. The system in Russia has already been established, it remains to be completed. She is only at the beginning of the path"[6]. For its creation in the "Basic directions of the policy of the Russian Federation in the field of development of the innovation system for the period up to 2010" included the relevant activities, which are planned to be implemented within the next five years. However, the Russian researcher E. Semenov expresses reasonable doubt as to the specified time, fairly assuming that "to form a modern innovation system for this period of time, apparently, is unlikely" (B. Kuzyk, Yu. Yakovets, 2005, p. 26). For comparison, in the United States, such an innovative system was created over 50 years[7].

In view of the absence in the modern economic practice of the post-Soviet countries of the above-mentioned components, of which, in many respects, the innovative economy as a national economic system develops, many researchers in their works prefer to call the last "innovative sector of

---

[5] Крюков Л.М. Национальная инновационная система: проблемы становления и развития. *Белорусский экономический журнал*. 2003. № 4. С. 66–75.

[6] Кузык Б.Н., Яковец Ю.В. Россия-2050: стратегия инновационного прорыва. 2-е изд. Москва, 2005. 440 с.

[7] Иванова Н.И. Национальные инновационные системы. Москва, 2002. С. 86–87.

the economy”[8], which corresponds more to domestic economic realities. From other sectors of the domestic multi-layered, “multi-layered, multifunctional economy”[9] innovation sector is characterized by the fact that innovation is used as the main economic resource, while in the high-tech sector it is high technologies, in the financial sector, finance, etc. The conceptual block of questions associated with the development of an innovative economy is considerably better developed in the post-Soviet countries, the content of which allows us to consider it as a frontier scientific discipline, formed at the junction of economic science, innovation and science. An addition, a number of innovative models, which are abstract constructs that simplify the main features of the economic system of this type, have been created by specialists in innovative economics, innovation and science. So, in the opinion of the Belarusian economist M.V. Myasnikovich, “in the majority of them they are reduced to two: the economy of small and the economy of big money”[10]. One of the leading Ukrainian experts in the science of economics B.A. Malitsky considers that the initial frontier of the innovative model of economy can be spoken then, when the innovation described by its assistance to the national economic system reaches 40%[11]. Finally, the authors of the monograph “Innovative Economic Development: Model, Management System, State Policy” (K., 2005), not only describe different models of innovative economic development, but also distinguish several types of innovative economy[12]. The analysis of the typological features of the domestic innovation economy allows V.K. Shcherbin to give it the following definition that is: 1) the emerging industrial relations of innovation character; 2) the national economy sector, which provides GDP growth through the commercialization of research and development; 3) border scientific discipline, formed at the junction of economic science, innovation and science[13].

[8] Семиноженко В.П. Інноваційна політика України як національний проект. *Економіка знань: виклики глобалізації та Україна* / Під заг. ред. А.С. Гальчинського, С.В. Льовочкіна, В.П. Семиноженка. Київ, 2004. С. 18–39.

[9] Потемкин А. Виртуальная экономика. Москва, 2004. С. 27.

[10] Мясникович М.В. Роль науки в инновационной деятельности Беларуси. *Инновационная политика государства и пути ее реализации* : Материалы семинара. Мн., 2004. С. 81–96.

[11] Малицький Б.А. Перепони інноваційного розвитку економіки та шляхи їх подолання. *Утвердження інноваційної моделі розвитку економіки України*. Матер. наук.-практ. конф. Київ, 2003. С. 160–165.

[12] Інноваційний розвиток економіки: модель, система управління, державна політика / За ред. Л.І. Федулової. Київ, 2005. С. 31–32.

[13] Щербин В.К. Типологические отличия инновационной экономики. URL: http://iee.org.ua/files/alushta/66-scherbin-tipologi4eskie_otli4iya.pdf (18.01.2012).

1. Innovation' paradigm: what is this?

A review of the literature on innovation and diffusion reveals several paradigms as to just what an innovation is:

1. Problem of technological innovations has not been considered a priority by the classic theorists. Due to the fact, no special importance is ascribed to the innovation development theory, in spite of the fact that Smith, Ricardo, Marks, Marshall, Keynes and Solow are almost unanimous, stating that long-term efficiency growth is inextricably related with introduction and diffusion of technological and organizational innovations;

2. One of the paradigms was developed by Everett Rogers. He defines innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption"[14]. For E. Rogers, innovations are singular inventions that are adopted via a process of protagonist "marketing". At issue is the potential adopters behavior (i.e. attitudes and personality) – rather than their ability to adopt, and the ability of the agent promoting the innovation to persuade the potential adopter;

3. In contrast to the Rogers's concept, H. Barnett (1953)[15], B. Agarwal and others have argued that innovation and diffusion are not separate processes – that innovation is essentially the first step in the diffusion process – and those potential adopters decisions concerning adoption is based on rationality rather than persuasion[16]. In this paradigm, innovations are ideas or technologies which are continually adapted as they are adopted, and represent sequential sociocultural change. J. Schumpeter's simple definition that innovations are "the carrying out of new combinations" also fits this contrasting school of thought[17];

4. So called Economists have focused on the economic factors "inducing" innovation, and have taken a market rather than personal perspective. Ruttan and Hayami (1984), utilize a functionalist, neo-classical argument that innovation results from the endogenous scarcity of some component of production[18]. The neo-classical school has been criticized by another group of economists that emphasize the importance of

---

[14] Rogers E. M. Diffusion of Innovations / Rogers E. M. – 3rd ed, The Free Press. – New York, NY, 1983. P. 11.

[15] Barnett, H.G. (1953). Innovation, the Basis for Cultural Change. New York: Mc Graw Hil.

[16] Barnett, H.G. (1953). Innovation, the Basis for Cultural Change. New York: Mc Graw Hil.

[17] Schumpeter J. The Theory of Economic Development / Schumpeter J. // Harvard University Press, Cambridge – 1934.

[18] Ruttan, V.W. and Hayami, Y. (1984) Toward a Theory of Induced Institutional Innovation. *Journal of Development Studies,* 20, 203–223.

exogenous, structural factors (history, international markets, politics and institutions) in "inducing" innovation (A. de Janvry 1985)[19];

5. So called Anthropologists are divided largely between those who consider humans to be pragmatists with innovations a function of their rational objectives and characterized by the materials at hand, and those who consider humans meaning- and symbol-making beings with innovations a function of their subjectively defined beliefs. Two anthropologists, H. Barnett and S. Gudeman, offer arguments that bridge this gap between the "induced" argument of the economists and the "culturalist" arguments of some anthropologists. At the personal level, the "induced" innovation model of Ruttan and Hayami would fit within Barnett's model[20]. Accepting the Barnett's and Schumpeter's definition of innovation – as that of making new combinations of familiar things – S. Gudeman proposes that people create new things for use, and simultaneously create culture (Gudeman 1991). A discarded food bowl used for a chimney cap is thus both an innovation with practical use value and a cultural creation. This proposal is both a refinement and extension of the Barnett model.

Using the idea of a hierarchy of levels of innovation and working within the evolutionary approach, Geels (2002) put forward a multi-level perspective of how transitions to radically new technological systems could occur and how policy support (i.e. transition management) might this facilitate. This multi-level perspective is important for an understanding that breakthroughs of innovations are dependent on multiple processes in the wider contexts of regimes and landscapes.

According to Geels, transitions do not only involve changes in technology, but also changes in user practices, regulation, industrial networks (supply, production, and distribution), infrastructure, and symbolic meaning or culture. Geels uses three explanatory levels: technological niches at the micro level, sociotechnical regimes at the average level, and landscapes at the macro level, as first proposed by Kemp (1994). A socio-technical regime reflects the interaction between the actors and institutions, and the resultant routines and practices, involved in creating and reinforcing a particular technological system (Winskel and Moran, 2008). These

---

[19] Alainde Janvry, Elisabeth Sadoule. A study in resistance to institutional change: The lost game of Latin American land reform. *World Development*. 1989. Volume 17, Issue 9, September. P. 1397–1407.

[20] Ruttan, V.W. and Hayami, Y. (1984). Toward a Theory of Induced Institutional Innovation. *Journal of Development Studies*, 20. P. 203–223.

practices include: engineering practices; production process technologies; product characteristics, skills and procedures embedded in institutions and infrastructures (Foxon et al., 2010 [in press]). Thus, in so far as firms differ in their organizational and cognitive routines, then there is variety in the technological search directions of engineers. In so far as different firms share similar routines, this form a regime. Technological regimes produce technological trajectories, because the community of engineers searches in the same direction. Technological regimes thus create stability in the direction of technical development (Geels, 2002). This is closely related to the concepts of path dependency and lock-in.

Alongside the multiple-level perspective has emerged the proposal for "transitions management" and "strategic niche management" by governments in order to promote and protect the development and use of promising technologies (Fouquet, 2010). Strategic niche management differs from simple "technology push" policies, particularly in the role that states undertake (Maréchal, 2007). Echoing the multiple-level perspective, there is recognition that government and firms, as well as other stakeholders, have a central role to play in a system change and, for example, in the diffusion of low carbon technologies and that there is a need for policy-makers to manage the dynamics of possible transitions in order to avoid early lock-ins. According to Rennings et al. (2004), transition management is not so much about the use of specific economic instruments but more about different ways of interaction between entities, the mode of governance, and goal seeking. If innovation and learning are the aims of transition management then this requires a greater orientation towards outsiders, a commitment to change and clear stakes for regime actors.

Research under the transitions approach is to develop "socio-technical scenarios". Such a scenario "describes a potential transition not only in terms of developing technologies but also by exploring potential links between various options and by analyzing how these developments affect and are affected by the strategies (including policies) and behavior of various stakeholders" (Foxon et al., 2010 [In press]). Elaborating on the socio-technical scenarios method, Foxon et al. offers a theoretical approach to developing transition pathways. Three main steps to specifying transition pathways are identified: Characterize key elements of existing regime (socio-technical, actors, and landscape). Identify key processes that influence dynamics and stability, especially at the niche level. Specify interactions giving rise to or strongly influencing transition path[21].

As a result of this diversity a number of studies have attempted to identify specific innovation determinants (e.g. Damanpour 1991, 1996; Wolfe 1994; Ravichandran 2000). In an impressive meta-review, Damanpour (1991) identified thirteen determinants of innovation: specialization, functional differentiation, professionalism, and formalization, and centralization, managerial attitude toward change, managerial tenure, technical knowledge resources, administrative intensity, slack resources, external communication, internal communication, and vertical integration. As such determinants still fail to yield consistent findings, researchers have introduced a number of moderating variables in order to tease out the different relationships and establish more stable and cumulative results. Examples of such moderators are organizational characteristics such as conservative and entrepreneurial (Miller and Friesen, 1982), mechanistic and organic (Burns and Stalker, 1961), traditional, mechanical, organic and mixed (Hull and Hage, 1982), manufacturing or service oriented (Mills and Marguiles, 1980), old or new (Koberg at al., 1996), big or small (Nord and Tucker/ 1987), prospecting, defending and analyzing strategy (Miles and Snow, 1978), and innovation characteristics in the form of administrative and technical (Daft, 1978), product and process (Utteback and Abernathy, 1975), appropriability regime and level of output (Klepper, 1996), incremental or architectural (Tidd, 1995), level of complexity (Rogers and Shoemaker, 1971). While Damanpour (1991) claims that some determinants of innovation may indeed be stable and cumulative once suitable moderators have been included, the generally poor track record of these research efforts is enough to warrant some reflection[22].

2. Types of innovation policy in developed countries

According to the typology, the following types of innovation policy are distinguished:

1. Countries aimed at realizing the goals of sovereignty.
2. Countries aimed at diffusing technologies or spreading technologies in the industrial sector.

[21] Innovation Theory: A review of the literature ICEPT Working Paper May 2012.

[22] Berglund Henrik. Interesting Theories of Innovation: the Practical use of the Particular / Henrik Berglund. Department of Innovation Engineering and Management Chalmers University of technology. 2004. WP # 2004:1, 22 p.

3. Countries that catch up with the leaders of innovative development.

It should be noted that individual programs and projects of each country at different periods of development and priorities of innovation policy may be related to a different type of policy.

For example, in Germany, which belongs to the group of countries focused on the diffusion of technology, there are projects corresponding to the group of countries – “mission carriers” and aimed at goals of national importance. Separately, Japan should be singled out, which from the group of catching-up countries “broke free” into a complex of orientation towards diffusion of technologies and orientation towards goals of national importance.

Thus, it is advisable to consider the development of the innovation process in each of the most successful countries in more detail. The degree of penetration of innovation, technology in all areas of life in the ***United States*** is one of the highest in the world. For many years the United States has been a recognized leader in the innovation market, and the United States is the benchmark for the development of other countries in the field of innovation. However, in recent years, some countries are catching up and even ahead of the United States in some parameters of innovative development, such as patent activity, the concentration of researchers per million people, etc. Elements of the post-war national innovation system of the United States originated in the 1945-50s. The federal government played a large role in this process, supporting research and development not so much in public sector laboratories as in universities and the private sector (71.1%). It was then that cooperation began between these three elements, which led to amazing results. Currently, the state, in cooperation and coordination with business and universities, is developing practical programs in the field of science and technology. The efficiency and prosperous state of the US innovation system is associated with fierce competition and the self-development of companies. The success of the American NIS is not only the exact formulation of development strategies and ideas, but also the organization of the innovation process. Scientific centers, laboratories within corporations, research centers, both state and universities, study, formulate innovative proposals that small companies then engage in. With regard to R&D, there are three main elements of activity: universities, national laboratories, innovation clusters. Universities prepare specialists and are engaged in technological developments, national laboratories are engaged in government orders, and innovative clusters are “engaged” in high-tech production and research.

Separately, it is necessary to single out the Federal Contracting Centers, which are an example of cooperation between the state, universities and the private sector. The federal contract system has a strong influence on the innovation market through maintaining and creating government demand. We can distinguish two features inherent in federal contract centers: state funding and the organization’s contract system. Federal contract centers are designed to solve problems in the field of R&D (which are funded by the state) by combining the resources of laboratories and universities. Separately, it is necessary to allocate the main cluster in the United States – Silicon Valley. The creation of Silicon Valley is an example of both the cooperation of business, universities and the state, as well as an example of the creation of a leading innovation cluster. Attempts to recreate or copy the success of Silicon Valley by different countries at different sites do not lead to the expected results. No one managed to create “their” Silicon Valley. The reason for the success of the United States is the combination of individual characteristics that add up to the system: the US innovation policy, the developed venture market, the open labor market, and the interaction between business, research centers, and universities[23].

Germany is proving that even a high-wage nation can compete globally in manufacturing. Exports of everything from kitchen equipment and industrial machinery to high-speed trains and wind turbines by small and large firms alike 296 surged by 18.5 percent in 2010 to €951.9 billion ($1.3 trillion), leading the country out of recession. German net exports of goods contributed 1.4 percentage points to its 3.6 GDP growth in 2010, or 40 percent of the total increase. German exports to China soared by 44 percent, which could become Germany’s biggest export destination overall by 2015. Unemployment in Germany fell to an 18-year low in January 2011. Innovation and a system for efficiently converting new technologies into marketable products and large-scale production are keys to this success. Germany’s innovation system is characterized by heavy corporate and government investment in research, innovative small- and medium-sized enterprises, extensive workforce training, and strong institutions such

[23] The U.S. National Innovation System: Recent Developments in Structure and Knowledge Flows David C. Mowery/ Haas School of Business, University of California, Berkeley and Canadian Institute for Advanced Research, 1996.

as Fraunhofer-Gesellschaft that collaborate with Germany industry. The government also works to assure that the nation is a “lead market” for important, emerging technologies through methods such as consumer incentives, government procurement, and standards. Such policies have enabled Germany to become the world’s leading exporter of research-intensive products, according to the German Institute for Industrial Research (DIW Berlin). More than 12 percent of Germany’s exports are research-intensive that double the level of the US. Germany is a world leader in optics, a €2 billion industry that also has received significant public support. German machine tool makers are the world market leaders with a share of 19 percent. The nation has some 500 biotechnology companies, and the nanotechnology sector boasts 740 companies and 50,000 industrial jobs. Germany also ranks No. 4 in the world in patents granted. Over the past decade, the German government has implemented an ambitious agenda designed to maintain the strength of Germany’s global competitiveness. Chancellor Angela Merkel’s government has increased investments in R&D, which raised by one-third to €12 billion ($17.1 billion) from 2005 through 2008. Germany spent €80 billion in economic stimulus during the financial crisis, followed by a further €11 billion in stimulus that went to education and science and technology. The government also has been implementing a wide range of policies and programs to improve its innovation system. They include initiatives to upgrade basic science, boost private R&D spending, strengthen collaboration between universities and business, improve the environment for high-tech start-ups, and nurture regional innovation clusters. The government also has unveiled what it describes as Germany’s first comprehensive national innovation framework, High-Tech Strategy 2020, which seeks to consolidate public programs around well-defined missions. German innovation still faces a number of serious challenges, however. They include a scarcity of venture capital and bank loans for innovative companies, declining momentum in sectors such as electronics and aircraft, and weak performance in eastern Germany and Berlin, which consume a large share of federal research spending but produce relatively little innovation. Germany ranks below most other industrialized nations in researchers as a percentage of total employment, measures of international collaboration in research, and venture capital as a percentage of GDP. There also are fears of a looming skills shortage due declining university enrollment as the population ages and disinterest in science and technology fields grows among German youth. The Expert Commission on Research and Innovation, known by its German acronym EFI, reports an "urgent need to expand education, research and innovation" and warns that Germany's global competitiveness is under threat. The EFI also contends that Germany's tax system must become more innovation-friendly.

Germany's innovation system differs from that of the US is several fundamental ways. While the US has an "entrepreneurial economy", Germany's model is more oriented toward "solid, high-quality progress". While labor and skilled talent easily move to other jobs in the US, mobility is more limited in Germany. In terms of federal science and technology policy, programs are dispersed across many agencies in the US. In Germany, the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung), better known as the BMBF, has a broad portfolio that includes most federal R&D activities and programs to promote commercialization. The Federal Ministry of Economics and Technology, known by its German acronym BMWi, also has a range of technology and innovation programs. The "innovation rhetoric" differs in Germany and the United States, too, Mr. Beyer said. In the US, it is generally believed that government should play a limited role in industry and commerce. In Germany, "it is quite common to refer to government as a problem solver," Mr. Beyer said. Dr. Jäkel of BMWi pointed out that the German government has no qualms about providing "cradle to grave" financial assistance for R&D and commercialization efforts by small- and medium-sized enterprises in the case of "market failure" by private lenders. The government has the right to intervene. The German system also distributes its R&D investments very differently than the United States. While the US innovation system seeks breakthroughs in a broad spectrum of sciences and technologies, most German Research programs in Germany have tended to be dispersed across the country, making it difficult to develop regional innovation clusters that commercialize new technologies. Several public private initiatives have sought to form regional innovation clusters in emerging industries. The Fraunhofer institutes are leading a government effort to help consolidate research activities into 16 innovation clusters. An emerging bioenergy cluster based in North Rhine-Westphalia district, for example, has 17 regional partners from industry and academia. Other innovation clusters that the Fraunhofer institutes are helping to organize include one in optical technologies based in Jena, electronics for sustainable energy based in Nuremberg, turbine production technologies based in Aachen, and digital production based in Stuttgart. The BMBF also has a program to support regional innovation clusters. In 2007, the ministry launched the Top Cluster competition in which industrial strategic partnerships around Germany vied for €200 million in BMBF funds. The first five winners were an aviation cluster forming in the Hamburg region, Solar Valley in Mitteldeutschland (Middle Germany), energy-efficiency innovations in Saxony, and electronics and cell- and molecular-based medicine in the Rhine-Neckar metropolitan region. Innovation Alliances: New forms of German public-private partnerships are being encouraged to advance new technologies. One initiative is called “innovation alliances.” Under the program, corporations must decide at the board level to co-invest with government. The German government is investing €500 million and private industry €2.6 billion in nine such alliances. Government funds are typically leveraged five-fold through private investment. An initiative for a cluster in molecular imaging for medical engineering, for example, includes Bayer Schering Pharma, Goehringer Ingelheim Pharma, and Siemens.

Despite its population of just 5.4 million, ***Finland*** has emerged as a global leader in innovation, consistently ranking the near top of the World Economic Forum’s annual Global Competitiveness Index. Finland ranked No. 3 in innovation and No. 4 in overall competitiveness in the World Economic Forum Global Competitiveness Index for 2011-12. Finland has been acted as Europe’s most innovative business environment. This has enabled the nation to restructure an economy that depended on pulp and paper for two-thirds of its exports in the 1960s to one dominated by electronics, most notably telecommunications equipment. Finland’s economy also has grown faster than the OECD average both before and after the 2008 recession. Much of the credit goes to far-sighted government technology policies initiated in the 1980s that focus both on scientific research and on disseminating new technologies to industry. As a result, a close “Triple Helix” relationship has developed among Finnish universities, private industry, and government funding agencies. In 1981, R&D accounted for around 1.2 percent of Finland’s GDP. R&D intensity increased significantly in the mid-1990s and by 2009 had risen to 4 percent of GDP, one of the highest levels in the world, before falling slightly to 3.9

percent in 2010. Private companies accounted for 70 percent of Finnish R&D spending in 2009, or €4.85 billion. Between 1992 and 2008, Finland's annual exports of high-tech products leapt more than five-fold, to €11.4 billion. But high-technology exports fell sharply in 2009 and 2010 as electronics and telecommunications products fell dramatically, primarily mobile phone sales. In addition to electronics and telecom equipment, Finland achieved dramatic export growth in energy technologies and chemicals. Finland's innovation system is guided by the Science and Technology Council, which issues broad technology investment recommendations every three years that other ministries and agencies use as guidelines for setting funding priorities. The council is chaired by Finland's prime minister and includes five cabinet ministers and representatives from industry, unions, and academia. There is a high degree of coordination between the Academy of Finland, which funds basic research, and Tekes, a Ministry of Trade and Industry agency that funds applied-research collaborations between the public and private sectors.

Japan has taken a number of actions since the mid-90s to improve its innovation system, many of them inspired by the United States. Japan has strengthened protection of intellectual property, overhauled science and technology policy institutions enacted its own version of the Bayh-Dole Act to make it easier for universities and research laboratories to commercialize technology, and bolstered industry and academic science partnerships. Japan also undertook a number of initiatives to increase entrepreneurialism, including a small-business loan program similar to America's Small Business Innovation Research program. To spur corporate R&D spending, Japan grants generous tax credits. Largely as a result, Japanese spending on research and development surged from 2.77 percent of GDP in 1994 to 3.8 percent in 2008 before declining slightly to 3.62 percent in 2009. Japanese companies account for three quarters of that spending, the highest ratio among OECD nations. Driving this change was the realization that innovation would be central to restoring growth to the Japan's stagnating economy in the wake of the financial crash of 1990. Even though Japanese R&D investment and output of patents remained quite strong on world standards throughout the 1990s, Japanese companies stumbled as they tried to make the transition from products derived from well-developed technologies to the creation of more fundamental breakthroughs. Japan's competitiveness in industries such as semiconductors and consumer electronics waned with the rise of new rivals in South Korea and Taiwan. Japan had largely missed out on the U.S.-led booms in biotechnology and software. Japan's commercial scene, dominated by large conglomerates, was not producing many dynamic start-ups. The rapid pace of change ushered in by the information technology revolution and globalization did not play to the strengths of Japan's large industrial conglomerates. Japan's policy shift began in earnest with passage of the Basic Law on Science and Technology in 1995. Under that plan, the government spent ¥17 trillion ($206 billion in current US dollars) from 1996 through 2000 on science and technology programs. During the subsequent five-year basic plans, another ¥49 trillion were invested. These funding increases helped Japanese universities and national laboratories upgrade laboratories that had become outdated. Japan also strengthened national coordination of its innovation strategy. The Council for Science and Technology Policy, established in 2001, became part of the Prime Minister's Cabinet. The council drafts comprehensive science and technology policies to respond to national and social needs, advises on how to allocate resources, and evaluates major projects. Funding focused on life sciences, nanotechnologies and new materials, information and communication, and environmental technologies. The government did not, however, assume greater central control over research. To the contrary, in 2004 it gave national universities and research institutes more autonomy to allocate resources, collaborate with industry, and set their own research priorities by separating them from the civil-service system. These institutions were transformed into non-profit corporations. Because they account for the bulk of scientific and technological research, the independence given universities and national labs is expected to allow resources to be used more flexibly and efficiently. In another crucial institutional reform, government agencies have begun to allocate much greater shares of R&D funds on the basis of peer-reviewed competition. The greater focus on innovation has led to dramatic increases in scientific research in strategic areas. In 1992, the government set a goal of tripling investment in life sciences over the next decade. By 2001, the number of biotech companies had risen from a few dozen to 250; the goal was to have 1,000 biotech companies by 2010. In nanotech, Japan was spending almost as much on research as the United States – $940 million – as of 2004. Fuel cells, an important technology not only for portable electronic devices but also for future electrified vehicles, also received heavy emphasis. Robotics is another top Japanese research priority. The government is especially interested in developing technologies used in core components that can be applied across the industry, such as power sources, control systems, mechanics, software, and structures. Two of Japan's biggest investments in science were the $1 billion Spring-8, one of the world's largest synchrotron radiation facilities, and the Earth Simulator, a $450 million scientific computer billed as the worlds fastest when it opened in 2003. Japan also has resuscitated R&D consortia, a key element of industrial policy until the 1980s. The government cut funds for consortia in areas like semiconductors following trade friction with the US, but began to renew such programs after Sematech started to benefit US producers and Japanese chipmakers' fortunes decline. Stronger protection of intellectual property rights has improved Japan's innovation system since the early 1990s. Initially, the Japanese government responded to pressure from the US to strengthen enforcement of violations. The World Trade Organization's Trade-Related Aspects of Intellectual Property Rights (TRIPs) agreement in 1995 also had a major impact. The government enacted a series of other reforms since then, including the Basic Law on Intellectual Property in 2003 and establishment of the Intellectual Property High Court in 2005, which is modeled after the US Court of Appeals of the Federal Circuit. Criminal sanctions have been raised, and the scope of invention that is patentable has been greatly broadened[24].

The dual faces of its economy define India's great innovation challenges. On the one hand, ***India*** is a global leader in information technology and business-process outsourcing services, which account for nearly $60 billion in annual exports and employ more than 2.5 million[25]. For the Indian government, however, the most urgent priorities in science and technology policy have been basic economic development. Although India's economic growth rate has accelerated sharply since 2003, the benefits of India's dynamic technology sectors have been slow to make a difference in the lives of hundreds of millions of people living in poverty. India is not just focused on improving its capacity to create new products,

[24] Wessner Charles W. Rising to the Challenge: U.S. Innovation Policy for Global Economy Committee on Comparative National Innovation Policies: Best Practice for the 21st Century. Board on Science, Technology, and Economic Policy, Policy and Global Affairs / Charles W. Wessner , Wolff, Editor. National Academy of Sciences, 1212.

[25] NASSCOM, "Indian IT-BPO Industry," 2011. URL: http://www.nasscom.in/indian-itbpo-industry

therefore. The Indian Government also now is paying more attention to what it calls "inclusive innovation", which is defined as "using innovation as a tool to eliminate disparity and meet the needs of the many"[26]. India suffers from inefficiency in transforming its S&T investments into scientific knowledge (publications) as well as into commercially relevant knowledge (patents).[27]. To satisfy the demands of both industry and society, India must dramatically improve its national innovation system. India has enormous potential. It has an immense and growing pool of young English-speaking technology talent, a much younger population than China's, and a large Diaspora of overseas Indian technology entrepreneurs and researchers who are rebuilding ties in their homeland. India's economy is projected to grow by more than 7 percent a year for decades. India also has a highly innovative private sector and a number of elite higher-education institutes. India is an important high-tech R&D base for multinationals. Government controls around 70 percent of national R&D spending, and the biggest recipients have been areas relating to national security, such as atomic energy, aerospace, and ocean exploration. Venture capital is scarce. The talent pool is constrained by the facts that only around 12 percent of college-age Indians are enrolled in higher education, and only 16 percent of Indian manufacturers offer worker training, compared to 42 percent in South Korea and 92 percent in China. India produces only 6.000 Ph.D. a year in science and 1.000 – in engineering. There is little collaboration between India's 400 national laboratories and 400 national R&D institutes and private companies. 70 percent of technologies developed by government-funded laboratories remain on the shelf and promote technology transfer and the commercialization of public R&D. India's 358 universities and famed Indian Institutes of Technology, meanwhile, traditionally have played little role in commercializing technology. India also has several large initiatives to boost its global standing in strategic science and technologies areas. The government has more than tripled the budget for the Council of Scientific and Industrial Research, which oversees India's national laboratories, in recent years. It also has announced plans to establish 50 centers of excellence in science and technology over six years. Centers will include biotechnology, bio-informatics, nano-materials, and high performance computing, and engineering and industrial

[26] National Innovation Council, Towards a More Inclusive and Innovative India, September 2010. URL: http://www.innovationcouncil.gov.in/downloads/NInC_english.pdf

[27] National Academy of Sciences, S&T Strategies of Six Countries, op. cit., p. 43.

design. They will offer doctorate programs and be based at existing institutions. India has big ambitions in nanotechnology. Under the 10 billion rupee ($220 million) National Science and Technology Nano Mission, created in 2006, three new R&D institutes are being created. Some 50 to 60 science and technology institutes also are to be involved in building nanotech clusters across the country. The some 300 R&D centers operated by multinationals in India are another powerful force connecting India to global innovation flows. In most emerging markets, multinationals set up research and product-development operations mainly to serve the needs of the local market. In India, however, foreign companies have tended to hire top engineering and design talent to help develop products sold around the world. According to one survey, the biggest reason multinationals invest in China is to access new consumer markets and to tap low-cost labor. In India, foreign companies cited new outsourcing opportunities and access to highly skilled labor as the biggest reason they invest there. India has become a closer partner with the United States in recent years. A 2005 bilateral agreement called for greater cooperation in civilian uses of nuclear, space, and dual-use technology. The two nations also concluded a 10-year framework agreement for defense. The US and India established a new joint science and technology endowment fund to facilitate research collaborations for industrial applications. A $100 million U.S.-India Knowledge Initiative focuses on raising agricultural productivity and increasing agroindustrial business. The US and India also have launched a bilateral dialogue seeking cooperation in oil, gas, nuclear, clean-coal, and renewable energy sources and began discussing cooperation in civilian use of space.

Taiwan's rise from poverty in the 1950s to one of the world's premier high-tech powers has made it a role model of how to use science and technology policy for rapid economic development. Since the 1970s, the government has executed a systematic strategy to absorb advanced technologies from the West and Japan, develop globally competitive products and manufacturing processes, and then transfer the know-how to private companies to create world-class industries. These efforts quickly transformed Taiwan's economy. In 1981, food and textile industries accounted for 40 percent of Taiwan's manufacturing sector, with electronics accounting for less than 15 percent. By 2004, electronics was 35 percent of the island's manufacturing economy, with food and textiles accounting for less than 10 percent. Meanwhile, per-capita income in Taiwan rose from less than $500 in the early 1950s to $18,558 in 2010. Taiwan's standings in the areas of technology, advanced manufacturing, and knowledge-based industries have risen just as dramatically. Taiwan is the world's leading producer of mask ROMs and optical discs and the world's largest integrated circuit foundry producer and largest packager of integrated circuits. Taiwan is the second-largest producer of large high definition LCD panels, IC design services and crystalline silicon solar cells. Taiwanese industry is making impressive progress in next-generation industries such as solid-state lighting, thin-film electronics, photovoltaic cells, and biomedical devices using nano-scale materials. The portion of GDP devoted to research and development has risen more than fivefold since the late 1980s, and reached 2.9 percent of GDP in 2009. Taiwanese companies, once low spenders on R&D, contributed more than 69.7 percent of total spending on research in Taiwan. The Island is beginning to excel in innovation as well. Taiwan is among the world leaders in US utility and design patents. Indeed, Taiwan generates more patents per 1 million citizens than any other region or nation. Taiwan also has been winning international innovation awards. National research institutes had three winning entries in R&D Magazine's 2010 R&D top 100 Awards, for example. One was for FlexUPD, billed as the first technology to enable the commercialization of paper-thin, low-cost, flexible flat-display panels for electronic products. Taiwan also won awards for a display technology that allows both 2D and 3D information to be viewed simultaneously with the naked eye and for the first non-toxic, fire-resistant composite technology. What's more, Taiwan's science and technology investments have enabled the economy to meet one of its most crucial strategic challenges: remaining a globally relevant sector in the wake of a rising China. Its giant neighbor has lower costs, vastly more engineers and scientists, and aggressive policies targeting all of the same industries as Taiwan. Despite a massive shift of factory work to the mainland, the value of Taiwanese exports continues to rise. Taiwan had record exports in 2010 of $275 billion, with 42 percent going to China, up from 24 percent in 2000. Taiwan is reaping the benefits of heavy investments in education and decades of comprehensive science and technology policies aimed at building globally competitive industries. The island of 23 million also has expertly leveraged its strategic geographic location off the coast of China. Estimates of Taiwanese investment in mainland China, including those made through third parties range from $150 billion to $300 billion. Taiwanese companies control and manage much of the electronics export sector. Taiwan has positioned itself as a global engineering and innovation hub bridging East and West.

The express purpose of Taiwanese government science and technology policies has always been to establish and sustain domestic industries. The island started in electronics manufacturing with duty-free export zones in the 1960s, when Taiwanese wages were extremely low. In the 1970s, it began investing heavily in industrial technology institutes to stimulate more sophisticated indigenous industries. Ninety-two percent of R&D was devoted to manufacturing as of 2006, compared to 65 percent in the United States and 83 percent in South Korea. Of that, 69 percent was devoted to high-tech manufacturing. The key elements of the Taiwan method have been to carefully identify industries where the island can make its mark, rather than attempt to invent new technologies from scratch[28]. Taiwan's strategy has been to focus on technologies that multinationals already possess and that Taiwanese companies want to apply. Then the government develops the necessary skills base, builds or upgrades common laboratory facilities, and systematically acquires the needed technologies through a combination of licensing, in-house R&D, and partnerships with foreign companies and universities. The backbone of Taiwan's strategy has been its industrial research institutes. ITRI is by far the biggest. Established in 1973, ITRI has grown to a network of 13 research centers that focus on information and communications, advanced manufacturing, biomedical, nanotechnology and new materials, and energy and environmental technologies. More than 60 percent of ITRI's 6,000 employees hold master's or doctorate degrees. ITRI consults with more than 30,000 domestic companies each year. It has helped create 165 start-ups and spinoffs, and generated more than 10,000 patents. More than 20,000 ITRI alumni work in Taiwan's private sector, around 5,000 of them holding senior executive positions Hsinchu Science Park. International collaboration is likely to become a more important aspect of Taiwanese innovation strategy. ITRI already has extensive overseas ties. In addition to the relationship with the Media Lab, ITRI works with MIT's

[28] Innovation Policies for the 21st Century: Report of a Symposium, Charles W. Wessner, editor, Washington, DC: The National Academies Press, 2007.

artificial intelligence lab. ITRI has joint research programs with the University of California at Berkeley in nanotechnology and clean energy, five labs at Carnegie Mellon University, and a strong relationship with Stanford Research Institute. Among its many other collaborations are projects with Japan's RIKEN, the University of Tokyo, the Netherlands' Organization for Applied Scientific Research, Russia's Ioffe Physical-Technical Institute, and Australia's Commonwealth Scientific and Industrial Research Organization. ITRI's long list of multinational partners includes Corning, Broadcom, Sun Microsystems, Hewlett Packard, Bayer, BASF, ARM, GSK, and Nokia.

Science and technology policy has been central to ***Singapore's*** emergence as one of the world's wealthiest nations. Since separating from Malaysia in 1965, per-capita income has soared from a mere $512 to $42,653 in 2009. Like Taiwan, Singapore's takeoff was fueled first by labor-intensive manufacturing in the 1960s. Singapore then thrived as an Asian hub for trade, services, manufacturing, and corporate product development. Now the island of 5.1 million aspires to become one of the world's premier innovation zones for 21st century knowledge industries. As the government's science and technology plan for 2006-2010 stated that the crucial success factor for Singapore will be its ability to become an international talent node-nurturing its own talent as well as drawing creative and talented people from all corners of the world to live and work in Singapore. Singapore is making impressive progress. The nation's heavy investments in higher education and R&D infrastructure and ability to execute visionary and comprehensive innovation policies has enabled the country to reinvent itself as a magnet for multinational research labs and top-notch international talent in fields such as genomics, infectious diseases, advanced materials, and information technology. R&D manpower more than doubled between 1998 and 2009 to 41,388, research organizations increased from 604 to 854, and total R&D spending more than doubled to US $6.04 billion, despite contracting by 15 percent from 2008 levels because of a sharp decline in private sector R&D as a result of the global recession. Singapore ranks No. 2 worldwide in global competitiveness. Singapore's innovation system is built upon a strong foundation in education. The share of university graduates in the population leapt from 4.5 percent in 1990 to 23 percent in 2010, and the portion of the resident workers with degrees jumped from 14.6 percent to

27.8 percent between 1999 and June 2010. More than 153,000 students were studying at the nation's universities and polytechnics as of 2009. Singapore grade-schoolers perennially rank at or near the top in math and science scores. The government's strong commitment to science and technology encourages students to pursue those fields, and the highly skilled workforce in turn enables Singapore to frequently transform itself, explained Yena Lim of the Singapore Agency for Science, Technology, and Research. In terms of international patents, start-ups, and the dynamism of domestic companies, Singapore is still far from an innovation powerhouse. The government has charted an ambitious agency to push its innovation system to a higher level. The Agency for Science, Technology, and Research (A*STAR) leads many of the programs aimed at making Singapore a global R&D base. A*STAR spearheads efforts to develop clusters in high value-added manufacturing, such as microelectronics, new materials, chemicals, and information and communications equipment, and the rapidly growing biomedical sector. The agency also manages Singapore's ambitious new multibillion-dollar science parks, Biopolis and Fusionopolis, which combine a high concentration of public and corporate research organizations in a contemporary urban setting. A*STAR also leads Singapore's aggressive efforts to recruit top international scientists and to develop homegrown talent. Its policy is described as "pro-foreign and pro-local".

South Korea has grown tremendously over the last 30 years by following a strategic approach to science, technology, and innovation to create world-class companies. In technology innovation, South Korea's success in leapfrogging technology generations has been underscored by a pragmatic strategy of starting at the low end of the market in new product segments and continuously improving their product sophistication, using economies of scale to secure a competitive market share.

South Korea's industry and economy is dominated by business conglomerates called chaebol (Samsung, Hyundai, Pohang Iron and Steel Company, and LG electronics). These companies have moved from safe technology investments and incremental innovation toward cutting-edge science-based innovation by adopting Western business practices; as the country has developed, South Korea's historical focus on manufacturing has shifted to services and investing in research and development (R&D) at the forefront of technology. In a Booz & Company ranking (The 2012

Global Innovation 1000: Key Findings), Samsung is ranked fourth among the world's most innovative companies, behind Apple, Google, and 3M. In a different ranking of innovative companies ("The Most Innovative Companies 2012: The State of the Art in Leading Industries"), Hyundai gained the top spot among the automotive companies moving up 12 rankings in the past 2 years to surpass Toyota. The South Korean private sector's strengths provide opportunities for the country to continue on its innovation trajectory. But South Korean business practices face challenges as well. While the chaebol culture is a source of South Korea's success, it is not a transparent culture, and many of its business practices are considered corrupt. The growth of the chaebol has come at the expense of small and medium sized companies, as they attract the top talent in the country, creating a dichotomous economy. The presence of the chaebol also creates obstacles for entrepreneurs and has depressed the prospects of a venture-backed, start-up culture. South Korean social issues also pose threats to continued success.

This analysis of South Korea's innovation system shows that:

1. Both governance and socio-economic factors play important roles in determining how well a country is able to use its endowments to create a strong national innovation system.

2. A high-quality of education, particularly in the STEM fields, is foundational for developing the human capital needed for an innovation-driven economy.

3. Consistent, long-term investments in research and development are instrumental in achieving a leadership position in technology-based fields. The South Korean government supports long-term research in the basic sciences and defense technologies while the private sector is the primary funder of applied research.

4. An underdeveloped and uncompetitive small and medium enterprise sector can reduce the capacity for innovation in the overall economy.

5. Finally, in today's globalized economy, countries and companies are increasingly looking outward to learn about other cultures and increase their ability to be responsive to their global customers in a competitive market[29].

[29] Gupta David W Nayanee. Innovation Policies of South Korea / Nayanee Gupta David W. Healey Aliza M. Stein Stephanie S. Shipp. Institute for defense analyses, 2013. IDA Document D-4984. 71 p.

The South Korean government has developed a robust science and technology capacity following two parallel tracks: 1) creation of a state-led research and educational capacity; 2) corporate research and development efforts by the country's large conglomerates. The government's science and technology policy is implemented in the form of Science and Technology Basic Plans every 5 years. The most recent, the 577 Initiative focuses on sector-specific strategies, including automobiles, shipbuilding, semi-conductors, steel, machinery, textiles, and materials. South Korea is also developing in the three broad areas of green technologies, value-added services, and technology convergence, such as the convergence of telecommunications and network technologies into a single system or device.

South Korea has focused historically on manufacturing but has shifted the focus to services and creation of a knowledge economy as the nation has developed. To achieve the goal of increasing R&D investments as a share of gross domestic product (GDP), the government launched a variety of financial incentives to encourage private investment in R&D, notably by encouraging private financial institutions to turn their collateral-based loans into technological value-based loans. The government also spends extensively on infrastructure. Korea is ranked thirteenth in the world in infrastructure, and leads in broadband penetration. The government's investments have been largely effective in spurring S&T-based innovation and progress. South Korean companies have achieved high levels of global competitiveness in leading edge technologies, ranking second globally (behind the United States) in innovation in 2013. Over the past two decades, South Korea has transformed itself into a leading innovator by adopting Western business practices and making aggressive R&D investments while capitalizing on the strengths of a consolidated manufacturing supply 5 chains. Today, innovation in the South Korean economy is primarily driven by the private sector, which is dominated by chaebol, such as Samsung, Hyundai, Pohang Iron and Steel Company (POSCO), and LG electronics. These firms typically span a broad spectrum of related and unrelated businesses and control about 70% of South Korea's total spending on R&D (with government contributing about 25%). For example, Samsung is diversified across the food, infrastructure, shipbuilding, life insurance, surveillance, recreation, advertising, and financial industries, among others, leading many to refer to South Korea as the "Republic of Samsung" South Korean companies have moved from safe technology investments and incremental innovation toward cutting-edge science-based innovation. Capitalizing on future possibilities in science and technology requires disruption and risk taking. Koreans prize efficiency; their desire for success leads them to be highly strategic in their approach. They emphasize planning for R&D in government and industry and using metrics to track success. The government's long-term (technology agnostic) investments in basic science R&D, raised standards for universities, and emphasis on global collaborations will secure Korea's evolution of a knowledge-based economy, but only if paired with an increasing tolerance for risk taking.

South Korea's economic success followed aggressive industrial development on the part of the government and the pursuit of an export-driven economy. Additionally, the government nurtured close ties with the large, family-owned industrial conglomerates known as chaebol that have dominated the Korean economy for decades. During this crucial developmental time, the Korean industry had import and FDI restrictions, direct credit, and tax relief, which allowed it to develop in a protected economic environment and become internationally competitive. The government, in turn, wielded influence through industrial policy, choosing and nurturing strategic industry sectors like shipping, refining, and semiconductors. Exports from the huge multinational chaebol continue to drive the Korean economy, and their competitiveness drives innovation. The four largest chaebol: Samsung, Hyundai, LG, and SK2 are strong in a wide range of activities from automobiles to shipping to banking to tourism to consumer electronics. Continued government assistance and economies of scale allow the chaebol to be extremely competitive. South Korea is currently the largest shipbuilder in the world, with close to 50% of the world market; the largest electronics company (Samsung)[30]; and the eighth largest auto maker (Hyundai). The southeastern industrial district of Ulsan alone contains the largest automobile factory, the largest shipyard, and the third largest oil refinery in the world. South Korea is also a major player in the manufacture of liquid crystal displays (LCDs), which now account for 5% of exports.

The S&T policy governance structure in South Korea in many ways resembles that of the United States. The two main advisory and

[30] Bishop W. The Elements of Leadership in a Global Environment. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/joe.21505

coordination bodies serving the executive branch are the South Korean National Science and Technology Council (NSTC) and the Presidential Advisory Council on Science & Technology (PACST). The two ministries most responsible for setting innovation policy in South Korea are the Ministry of Education, Science, and Technology (MEST) and the Ministry of Knowledge Economy (MKE). MEST is the most influential, as it is primarily responsible for formulating policies for S&T development and R&D investment and supporting the nation's universities and research institutes (both government and private). MKE, on the other hand, works primarily with industry. Technology selection considers a large number of factors, including US S&T policy. The National Science and Technology Commission's technology planning and investment is a consensus-based adaptation of US and European Union science, technology, and innovation plans. The programmatic technology selection is based on input from evaluation studies. This approach has been criticized for putting excessive pressure on researchers, incentivizing short-term research, and therefore dampening creativity in scientific research[31]. At the operational level, the MKE and MEST have the power to allocate about 30% of the R&D budget. The MKE's science, technology, and innovation policy is implemented in the form of Science and Technology Basic Plans every 5 years. Since the implementation of the first of four S&T Basic Plans in the late 1990s, the government has emphasized investment in R&D, highlighting the role of researchers in the economy and strengthening innovation policy.

Over the past two decades, Korea has systematically built up a global-savvy brain trust by strategic external sourcing and assimilation of knowledge at the university and workforce education levels. This state-promoted endeavor, reinforced by its education focused culture, gives Korea an advantage over Japan. In the past decade, leading Korean firms such as Samsung and Hyundai have been incorporating western business practices into their "Japanese system", disrupting the traditional organizational structure by bringing in outsiders into an insular culture and sending company executives overseas to get first-hand experience of foreign markets, resulting in knowledge sourcing on a global 26 scale. This has allowed them to succeed in understanding the customer in

[31] Mahlich Jorg. Korean Science and Technology in an International Perspective / Mahlich Jorg, Pascha Werner. Physica-Verlag Heidelberg, 2012. 288 p.

emerging markets, while also improving their marketing and design competencies to gain recognition in established markets. In addition, there are several Korean organizations such as the Korea-US Science Cooperation Center (KUSCO), a non-profit that sponsors about 140 students yearly for 18-month internships at US companies. These internships immerse students in business, accounting, marketing, and public relations functions. The number of Korean students going overseas for university education has steadily increased over the past two decades, increasing 32% between 2006 and 2011 and is the highest with 19.99 per 10,000 people, followed by Japan (4.92), China (3.07), and India (1.19) (APEC 2008). The United States is the top destination for students, followed by China and Japan. While STEM fields account for 25% of enrollment, business management and social studies degrees (areas where Korean universities are particularly weak) attract more than 40% of Korean foreign students (Institute of International Education (IIE) 2012). Private R&D Investment Business innovation in South Korea has been accelerated by substantial R&D investments by South Korean industry over the past decade. Samsung's R&D investment has doubled over the past 3 years from $6 billion in 2009 to $12 billion in 2012 (with an additional $30 billion in facilities and capital investments), going mainly to research in memory chips, LED displays, and systems-on-chip, a next generation semiconductor technology. As a comparison, leading competitors Intel Corp spent $11 billion in 2012, and Taiwan Semiconductor Manufacturing Corporation (TSMC) spent $9 billion in 2013 (Gupta, Kim, and Levine 2013). Hyundai Motor spent $12 billion on R&D and facilities in 2012 (compared with Toyota which spent $9.9 billion in 2011). Of the $12 billion, $4.4 billion was allocated to fuel efficient cars (Beene 2012). Patenting activity in top Korean companies has risen to fourth place behind the United States, China, and Japan. Korea follows the United States in nanotechnology patents (Shapira and Wang 2010). More significant than the increase in number of patents is the trend in types of patents. While patents were predominantly process and product patents 10 years ago, with the chaebol increasing their investments in fundamental research, the number of patents related to platform technologies is slowly increasing, an indicator of growing expertise at the forefront of new technology paradigms. For example, Samsung, a leading competitor in the smartphone industry, is also gaining ground in the battle on patenting technological platforms (such as 4G) on which future telecommunications services will be delivered.

South Korea's chosen route to industrial catch-up has its drawbacks. The legacy of siphoning off capital, top talent, and other resources toward developing South Korea's industrial chaebol has come at the cost of a widening gap between big and small firms, and between manufacturing and services. It has created a sharp dichotomy in the industry, a world with "a few big fish and lots of minnows". Outside the chaebol, much of Korean industry is imitative and faces low profit margins and competition from China and other foreign competitors. SMEs, which supply parts and components to the chaebol are disenfranchised compared to their counterparts in Japan and Taiwan (which operate in a similar structure) in that they are locked into fairly closed production networks with very limited decision-making power, which has denied them learning opportunities with diverse firms, both foreign and domestic, to improve internal competitiveness. Recently, the government has been pushing for financial incentives and technology commercialization opportunities for small and medium-sized firms (although the human capital equation is difficult to address, as employment by chaebol is far more socially prestigious), and their effectiveness remains to be seen. South Korea's service sector is the second smallest in the OECD area, accounting for almost 58% of its GDP (OECD 2012). Only 4 of its 30 largest enterprises are in services; small and medium-sized companies dominate the service sector, accounting for about 80% of output and 90% of employment. Productivity in services is 53% of the productivity level of the manufacturing sector, much below the OECD average of 87%; this mirrors the ratio of wages between the two sectors.

The ***Chinese*** government set out its research policy requirements in plans such as the National Medium- and Long-Term Program for Science and Technology Development (2006–2020) and the 12th Five-Year Plan (2011–2015). These include the objective of increasing research and development (R&D) expenditure to a minimum of 2.5 percent of GDP per year in the period up to 2020. By that same deadline, only 30 percent of the technology needed is to be imported from abroad and Chinese scientists should rank among the world's Top 5 when it comes to patents and citations.

With this "innovation initiative", China wants to establish itself as a location for the development and production of high-technology products. The aim is to overcome the technology gap and become a technology leader. The associated set of measures reflects the government's determination to transform China into an innovation-focused nation by 2020 – one that exports cutting-edge technologies and successfully competes with the world's leading industrialized nations. Concrete measures include significantly increased investment in science and technology (S&T), tax incentives, financial assistance in government procurement, protection of intellectual property rights (IPR) and the promotion of young scientists. China wants to develop an economy which combines the service industry with a modern manufacturing industry. Renewable energies, materials, environmental protection, biopharmaceuticals, telecommunications and internet applications are all deemed strategically important industries.

Investment in higher education has risen steadily in China in recent years as well. Public expenditure on higher education almost quadrupled in the period 2006 to 2012. To ensure that China's higher education institutions join the world's elite, various funding quantitatively speaking, China is already one of the strongest research countries in the world. In the past fifteen years, it has increased its R&D expenditure as a share of GDP from 0.9 percent (2000) to 1.32 percent (2005) and then to 2.08 percent (2013). In 2015, R&D expenditure is expected to amount to 2.2 percent of GDP. The 2.5 percent goal for 2020 appears to be reachable. Since 2001, R&D expenditure has risen by just under 17 percent per year, in absolute terms.

China could soon overtake the US as number one. In 2013, China spent some $336.5 billion (approximately EUR 253 billion) on R&D (this compares with $457 billion/EUR 344 billion in the U.S., and $101 billion/EUR 76 billion in Germany).

Another impressive example of the rapid development of China's R&D sector is the number of its patent applications. Since the country's first patent law entered into force in 1985, the number of patent applications initially rose slowly, but by the end of the 1990s, it was growing dramatically. In 2014, some 928.000 patents were applied for in China (of which 127.000 were from abroad). Approximately one in four of these were approved. Of the approved patents, one in three came from outside China (70.548 out of 233.228). As regards the number of patent applications submitted under the Patent Cooperation Treaty, China overtook Germany in 2011 and ranked third behind the US and Japan in were introduced to give selected institutions the financial assistance they need to become top-class research establishments.

China's political system is controlled centrally from Beijing and, despite earlier decentralization measures, tends to take a more top-down approach. Nonetheless, provincial governments and other stakeholders (such as local and regional science and technology commissions) are playing an increasingly important role in China's innovation landscape. Since the 11th Five-Year Plan (2006–2010) was implemented, the plans have been less in the nature of "instructions" from central government and take more of a macromanagement approach. This gives the provincial governments enough autonomy to define their own research policy focus areas while adhering to the strategic requirements and to decide independently on how to spend the available budget. In many instances, the regional and local stakeholders are more flexible and thus faster in their decision-making than institutions operating at central level. Under the 11th Five Year Plan, the city of Beijing for instance spent a total of RMB 75.8 billion (about EUR 9.1 billion) on some 1,200 projects. To secure a better position in countrywide competition, regional and local stakeholders expend great effort in establishing international contacts, in some cases financing a significant portion of the costs of cooperation projects conducted with foreign partners and offering incentives for foreign research centers to set up premises in the respective regions, 2014 with 25.539 patents. It must, however, be noted that the growing number of patent applications is by no means an indication of their quality and innovative content. This is partly due to distorted state incentive systems (with a focus on incremental innovation and design adaptation for the Chinese market, applications for 'junk patents' and copyright and trademark patents rather than on invention patents). Despite the strong rise in the registration of domestic patents in recent years, China is spending almost twenty-four times more on the use of foreign IPR than it generates in revenue from Chinese IPR. The estimated expenditure incurred by German research, funding and intermediary institutions in their cooperation with China, has grown considerably in recent years. While spending in 2006 amounted to EUR 26.3 million, it had risen to EUR 40.7 million in 2010 and to EUR 46.5 million in 2014.

These cooperation activities are largely defined by the respective roles and missions of the German research organizations within the research system, their respective internationalization strategies and their overarching goals and objectives. Depending on the reason for the cooperation, these can include not only the primary research goals, but other objectives such as strengthening Germany's image as a research location (by securing its international compatibility) and direct and indirect benefits to German industry.

The Max Planck Society (MPG) has collaborated with the CAS since 1974. Particularly noteworthy in this regard are the CAS-MPG Partner Institute for Computational Biology in Shanghai, the establishment of independent young researcher groups in China in line with the MPG model (12 groups since 1995) and the Max Planck partner groups (over 30 established since 1999) run by young Chinese scientists who prior to founding the groups had held a post-graduate position at a Max Planck institute for at least one year. The Helmholtz Association of German Research Centers (HGF) has had an office in Beijing for more than ten years. Apart from the cooperation activities of individual Helmholtz institutes, the Helmholtz-CAS Joint Research Groups should also be highlighted. More than a third of the almost 90 institutes belonging to the Leibniz Association have established relations with China; some institutes have maintained a local presence with their Chinese partners for many years. The Fraunhofer-Gesellschaft (FhG) has been represented in Beijing since as far back as 1999. This presence forms a bridge to Chinese partners such as the CAS and the Chinese Academy of Engineering. The FhG also cooperates with a large number of universities, including Tsinghua, Tongji and Shanghai Jiao Tong, and with institutes of the Beijing Academy of Science and Technology, the Shanghai Academy of Estimates based on figures provided by the MPG, the HGF, the FhG, the DFG, the AvH and the DAAD. In the case of the AvH and the DAAD, figures include funding managed on behalf of the BMBF under international programs involving cooperation with China.

Science and Technology, and the Shandong Academy of Sciences in 2007, the FhG and the CAS established jointly funded programs for Chinese postgraduate students. The aim of all FhG projects in China is to work with excellent research partners on topics which in the light of the country's dynamic economic growth and rapid urbanization require qualitative and quantitative technological solutions. Fields of interest include environmental technologies, infrastructure, transportation and energy-efficient buildings in megacities, and public health. The German National Academy of Sciences Leopoldina maintains contact with China in the form of mutual delegation visits and symposiums held with Chinese partners on varying topics in both Germany and China.

In ***Brazil***, most public R&D is not mission-oriented. For instance, only 30% of Brazil's R&D resources are connected to institutions and ministries whose mission is to solve problems in the areas of health and agriculture. In the North American case, more than 90% of publicly funded R&D is results oriented. Thus, the suggestion here is that we maintain the budget for S&T currently overseen by the MCTI and MEC, but that we create conditions that enable sectoral ministries to foster R&D programs that are directed towards solving Brazil's concrete problems. This would involve: Increasing the investments in R&D in sectoral ministries, such as Health, Energy, Defense, Agriculture, etc., and using these investments to solve concrete problems, such as i) developing medication and vaccines for SUS, the Brazilian Unified Health Care System; ii) developing technologies to increase energy efficiency or reduce water consumption (so as to alleviate the water crisis); iii) developing new telemedicine technology systems in order to increase efficiency and reduce the costs of our health care system; and iv) developing depollution technologies. Training staff in sectoral ministries on how to contract and follow up this type of investment. Adding explicit and clear mechanisms allowing public sector agencies to contract R&D. Article 20 of the Innovation Law already stipulates this possibility, but law needs to be improved in order to give more legal guarantees to public managers and establish new ways to contact the suppliers. Reinforcing policies are using government procurement power and applying demand-side innovation instruments in the innovation policy mix. The focus should extend beyond the procurement power. For instance INMETRO has a major potential to guide demand though industrial standards. According to several existing criteria, Brazil has one of the most closed economies in the world. In Brazil, the total trade flow represents just over 20% of the GDP and import tariffs (nominal or effective ones) are among the highest in the world. However, Brazil is not only a "closed" country in terms commerce. It is also a country that is closed to ideas. The number of Brazilian students and researchers living abroad is quite small, even though this number has risen, mainly among undergraduate students, as a result of the CsF Program. The number of foreign students, researchers and industrial technicians in Brazil is even smaller. This lack of openness has implications that affect the Brazilian economy's innovation capacity in at least two major ways. First, this lack of openness limits their capacity to follow changes on the world's technological frontier. The time it takes to incorporate state-of-the-art technology produced abroad is an obstacle to Brazil's capacity to generate relevant science and innovation when compared to international standards. Moreover, a dynamic innovation system is characterized by the constant flow of ideas and people. Due to this lack of openness, several data measures describing the world's flows of knowledge make it evident that Brazil is on the margins of these flows.

The second aspect of the Brazil's lack of openness has to do with competition. In a capitalist economy, the engine of innovation is the search for the extraordinary profit that can be derived from new ideas. In an economy in which the market is protected from competition, the incentives for innovation are not as great. Hence, it is important for the Brazilian economy to adopt some strategies, including the following: moving towards a greater openness in relation to the international market, in a gradual and transparent way, starting with segments in which the positive impacts resulting from this openness (gains in efficiency resulting from access to new technologies incorporated into some capital goods or reduction of the price of imported inputs) are greater; developing incentives and mechanisms that will attract foreign researchers to work at Brazilian universities, companies and research institutes; facilitating the granting of work visas to foreign professionals, with a greater focus on highly qualified workers; creating swift and low-cost mechanisms (reducing tariffs whenever necessary) for importing inputs, research equipment, and prototypes; Prioritizing programs to send Ph.D. students and post-doctoral researchers in fields of specific interest abroad; allowing public Brazilian universities to hire foreign professors; encouraging learning and use of English in society as a whole, and particularly in undergraduate courses.

3. Recommended innovation strategy for Ukraine

A complex and bureaucratic institutional environment discourages investment, especially investment in innovation. Estimates made by Ipea's team show that the impacts of an improvement in the World Bank's Doing Business publication on investments and productivity would be substantial. From the perspective of innovation, these difficulties manifest themselves in many areas, including the follow: i) the time required for a patent to be granted; ii) the time and requirements necessary for approval of research or new medications by the National Health Surveillance Agency (ANVISA); iii) the existing restrictions on opening and closing companies; iv) the regulation of investments made with venture capital funds; v) the difficulty associated with importing inputs and research equipment; vi) the operational difficulties involved in funding research institutions using public resources; vii) the difficult relationship between universities and companies; and viii) the time spent on due diligence. The difficulties pointed bellow and the level at which they affect the innovation system in Brazil are diverse and require systematization. Thus, a priori, some basic strategies are as follows:

1. Consolidating an agenda for improving Brazil's business environment and tracking progress in this area; identifying exactly which norms, regulations, and legislation could be modified in order to improve our institutional environment for innovation.

2. Reformulating and modernizing the Innovation Law. A new law was created in 2016, but its paralegal instruments must be straightforward and easy to execute. Additionally, the controlling agencies must be made aware of the legal possibilities.

3. Reviewing the legislation governing the opening and closing of companies in order to facilitate and expedite this process, and to encourage entrepreneurship.

4. Reducing the bureaucracy associated with R&D, especially in the life sciences. In this sense, the Biodiversity Law was a step forward, but needs to be followed up and modernized frequently.

5. Streamlining the process by which researchers from public institutions can develop innovation projects and offer consultancies to companies.

6. Eliminating all public policy instruments that discourage innovation processes. An example is the basic production process associated with the Informatics Law, Lei de Informática, which establishes manufacturing norms in order for companies to have access to tax incentives. An innovation, by definition, will not be covered by the PPB.

7. Jointly with control agencies, building a clear and consensual understanding with regard to the legal limits and possibilities of public managers when fostering innovation, in a way that encourages control and efficiency, but does not hinder our technological progress[32].

Australia's experience will be useful for Ukrainian innovative strategy. There Innovation System actively discourages and disincentives true innovation. The vast majority of Commonwealth spend on (so-called) "innovation" is actually spent supporting invention and a relatively lesser portion supports true innovation. Invention is the realm of research and discovery, basic science and the development of new ideas and knowledge. Innovation on the other hand is the new and successful application of those ideas to address issues. The distinction between invention and innovation is important because the blurred lines in popular/vernacular usage create structural flaws in our innovation systems. Australia's academics are a significant intellectual resource. As a national priority needs active drive, facilitate or contribute to true innovation at all levels of society. Australia's innovation systems however, squander this resource. Through incentives policies we explicitly encourage and manage our academics to reprioritize commercialization of their work and to pursue instead a model governed almost exclusively by publication and citation. Australian industry has a very poor record of collaboration (with suppliers, customers and especially with academia) and, as a broad generalization, consequently fails to recognize, develop or implement many progressive innovations that could otherwise result. Significant and frequent changes to government-driven innovation support systems available to industry greatly complicate the landscape for companies, particularly SMEs, and make it hard for them to embrace that support. Widespread technology literacy greatly enhances efforts to encourage innovation. We don't have this literacy in Australia – the issue arises in primary schools and is entrenched through the secondary system. Unfortunately schooling systems operate without a nationally coordinated strategy for the STEM subjects (science, technology, engineering and mathematics). A knock-on effect is a lack of school leavers emerging from that system with a passion for technology, which in turn for instance leaves Australia near the bottom of the OECD rankings for the number of engineers per head of population – a metric that correlates

[32] Negri Fernanda De Negri, Innovation policies in Brazil during the 2000s: the need for new paths / Fernanda De Negri, Andre Tortato Rauen. Institute for Applied Economic Research – ipea 2018. 60 p.

strongly with economic growth. These issues are not unrelated. They are heavily interconnected and in many cases represent direct cause and effect. The measures to address these issues are equally interconnected.

Australians have a long a successful record of inventing. Despite significant ingenuity and capacity for innovation, we have by contrast a poor record of implementing and delivering sustained innovation. Historically there are many fine examples of excellent Australian innovations; however they stand alone as isolated examples. Typically national system and institutions strongly support and encourage invention, and they hope that innovations will magically arise from that. Sometimes they do. But they are yet to successfully systematize or institutionalize the transition from invention to innovation; rather they seem to rely on a presumed good fortune here in The Lucky Country to carry the day. Innovation is not invention, and it doesn't happen by accident. They are different. Basic research and ideas generation is invention. Australia has a good track record of invention – "we encourage it, we incentivize for it". By contrast, innovation is "ideas, successfully applied" – and this they need to get significantly better at. Unfortunately the terms are mixed in common usage with the distinction between them often lost. For instance whilst Australian public spending on "innovation" (a term as used by government departments, treasury, etc.) has averaged the best part of A$8-9bn/year over the last decade, at most a quarter of those funds (partitioned on a very generous basis) are spent supporting actual innovation. By contrast the bulk of Australia's public spending on (so called) "innovation" is actually spent on more basic research – on invention.

The typical/traditional model of intellectual property (IP) management at most Australian universities aims to derive significant revenue (well, as much as "possible") from patented IP. This is simply a direct outcome of today's university funding models that encourage/require universities to source as much additional revenue from anywhere to further the institution's core missions. There are two standard flaws in the normal approach: not uncommonly efforts to exploit that IP are pursued on terms that are unrealistic for companies (especially startups, but also for existing SME and large enterprises), and more often than not the IP is not successfully used by anyone. The perceived value of the IP being licensed is often overstated, and the need to generate a financial return is too highly prioritized by the university's technology transfer offices. When such IP is successfully licensed to some commercialization effort (either an existing company or a new startup), the arrangement between the university and the relevant academic(s) that were the source of the invention/IP are usually considered by the academics to be of poor net value in comparison with the time, difficulty and strain involved in negotiating the agreements. The opportunity cost for the academic is simply too high to divert them from pursuing academic research and generating research output (publications).

CONCLUSIONS

Even if an invention has been captured in a patent, then as per the details above, academics find there is often little incentive to seek to commercialize their inventions. If it happens, great (The Lucky Country at work again!), but if not there are more important things to pursue. From the perspective of local industry it is a commonly expressed sentiment that collaborating with academia is harder than it should be. As above – there are reasons that motivate that outcome. From a national perspective, we have a very small pool of local enterprises (far too few) that are willing to engage and collaborate with academia – by and large Australian companies simply do not collaborate with academia. By contrast we need a system that encourages that outcome. To build a vibrant innovation culture in Australia we need a much bigger pool of companies that will collaborate with academia. Today's academics can/should be incentivized to form new enterprises/start-ups for many reasons, including:

– to exploit and commercialize their own existing and future inventions, i.e., those ideas they have developed themselves;

– by encouraging academics to cross over into commercialization, create a new pool of SME(s) that can and are willing to engage in collaborative effort with academia (as initially they'll be "collaborating" with themselves);

– and most significantly, to expand the number of local enterprises with positive collaboration experiences that will share their stories and encourage in others (their peers) a willingness to engage in collaborative efforts with academia Today's academics can seed and encourage an expanded pool of willing and enthusiastic SMEs.

To kick-start a vibrant local innovation ecosystem the nation, with government leadership on this score need to boot-strap a new cohort of (young) companies that are enthusiastic about innovation and engaging with the intellectual power resources available. Success breeds success, and we need to act today to seed tomorrow's innovation ecosystem. Today's academics are the key to bootstrapping this, and government policies implemented through various funding mechanisms and management controls are the method by which this can be achieved. It is the assertion of this paper that the most direct way to achieve these collective objectives is to encourage industry and academic collaboration and commercialization by changing the incentives and barriers that currently limit their interaction. To achieve this outcome the following recommendations are made[33]:

1. Change the ERA and ARC's grant awarding and assessment criteria to include measures of commercialization and industry impact for academic career advancement. Whilst these are in practice non-trivial to achieve it is crucial.

2. Require publically funded research to set aside a portion of such funds for capturing IP related to inventions generated in the research. Include metrics for invention disclosure/IP protection capture in the ARC/ERA metrics.

3. Furthermore since that research is publically funded consider mechanisms for requiring that the IP/patents so generated be licensed non-exclusively to "National enterprises" with net zero licensing fees/royalties. Universities should remain free to derive any licensing/royalty fees possible from overseas entities.

4. Encourage (perhaps require) interdisciplinary research and industry collaboration on academic grant funding applications. There are successful overseas examples implementing such arrangements that can act as model for this.

5. Incentivize companies to innovate – the present 45% R&D tax rebate is a significant program that does help. Continue the program / expand as appropriate.

6. Incentivize companies to collaborate – consider R&D tax incentive schedules that might further incentivize collaborative effort, especially with academia.

7. Stabilize the government innovation support programs for industry. Refinement and tweaks are good – it is the wholesale disbanding and or significant restructuring on a frequent basis that seriously undermines the

[33] Cerneaz Nick. Australia's Innovation System. URL: https://thewarrencentre.org.au/wp-content/uploads/2014/08/wc2662-1hr-SenateInnovationSystemInquiry.pdf

innovation eco-system. Deliver the funds supporting innovation programs through an independent fund administered by an independent board.

8. Support the Chief Scientist's call for a National STEM strategy for our schools. Country needs significantly deeper Encourage a broader understanding of the full suite of STEM subjects across the community – promote deeper technology and engineering literacy across the community. Country needs a nationally coordinated STEM strategy for primary and secondary schooling.

SUMMARY

The article has been dedicated to the problems of innovative development of Ukrainian economy. It was determined that international experiences in those sphere are useful for implement innovative instruments to create economy of knowledge in Ukraine. We need a system that encourages innovative products outcome. So we need a much bigger pool of companies that will collaborate with academic and university scientists. Today's they can/should be incentivized to form new enterprises/start-ups including: to exploit and commercialize their own existing and future inventions, to cross over into commercialization, create a new pool of innovations that can and are willing to engage in collaborative effort with academia and universities. And most significantly, to expand the number of local enterprises with positive collaboration experiences that will share their stories and encourage in others (their peers) a willingness to engage in collaborative efforts with science. To kick-start a vibrant local innovation national ecosystem, with government leadership on this score need to boot-strap a new cohort of (young) companies that are enthusiastic about innovation and engaging with the intellectual power resources available, and government policies implemented through various funding mechanisms and management controls are the method by which this can be achieved.

REFERENCES

1. Zimmermann V. An international comparison of R&D: Germany benefits from industrial research strength", KFW research, No. 105, 25 August 2015.

2. Richard R. Nelson. National Innovation Systems: A Comparative Analysis 1st Edition / Richard R. Nelson. Oxford University Press; 1 edition, 1993. 560 p.

3. Auerswald Philip E. Valleys of Death and Darwinian Seas: Financing the Invention to Innovation Transition in the United States / Philip E. Auerswald and Lewis M. Branscomb. *The Journal of Technology Transfer*. August 2003, Volume 28, Issue 3–4, pp. 227–239.

4. Nelson Richard R. National Innovation Systems: A Retrospective on a Study. *Industrial and Corporate Change*. 1992 January, 1(2), 347–374.

5. Крюков Л.М. Национальная инновационная система: проблемы становления и развития. *Белорусский экономический журнал*. 2003. № 4. С. 66–75.

6. Кузык Б.Н., Яковец Ю.В. Россия-2050: стратегия инновационного прорыва. 2-е изд. Москва, 2005. 440 с.

7. Иванова Н.И. Национальные инновационные системы. Москва, 2002. С. 86–87.

8. Семиноженко В.П. Інноваційна політика України як національний проект. *Економіка знань: виклики глобалізації та Україна* / Під заг. ред. А.С. Гальчинського, С.В. Льовочкіна, В.П. Семиноженка. Київ, 2004. С. 18–39.

9. Потемкин А. Виртуальная экономика. Москва, 2004. С. 27.

10. Мясникович М.В. Роль науки в инновационной деятельности Беларуси. *Инновационная политика государства и пути ее реализации* : Материалы семинара. Мн., 2004. С. 81–96.

11. Малицький Б.А. Перепони інноваційного розвитку економіки та шляхи їх подолання. *Утвердження інноваційної моделі розвитку економіки України*. Матер. наук.-практ. конф. Київ, 2003. С. 160–165.

12. Інноваційний розвиток економіки: модель, система управління, державна політика / За ред. Л.І. Федулової. Київ, 2005. С. 31–32.

13. Щербин В.К. Типологические отличия инновационной экономики. URL: http://iee.org.ua/files/alushta/66-scherbin-tipologi4eskie_otli4iya.pdf (18.01.2012).

14. Rogers E. M. Diffusion of Innovations / Rogers E. M. – 3rd ed, The Free Press. – New York, NY, 1983. P. 11.

15. Barnett, H.G. (1953). Innovation, the Basis for Cultural Change. New York: Mc Graw Hil.

16. Schumpeter J. The Theory of Economic Development. Harvard University Press, Cambridge, 1934.
17. Ruttan, V.W. and Hayami, Y. (1984) Toward a Theory of Induced Institutional Innovation. *Journal of Development Studies*, 20, 203–223.
18. Alainde Janvry, Elisabeth Sadoule. A study in resistance to institutional change: The lost game of Latin American land reform. *World Development*. 1989. Volume 17, Issue 9, September. P. 1397–1407.
19. Ruttan, V.W. and Hayami, Y. (1984) Toward a Theory of Induced Institutional Innovation. *Journal of Development Studies*, 20. P. 203–223.
20. Innovation Theory: A review of the literature ICEPT Working Paper May 2012.
21. Berglund Henrik. Interesting Theories of Innovation: the Practical use of the Particular / Henrik Berglund. Department of Innovation Engineering and Management Chalmers University of technology. 2004. WP # 2004:1- 22 p.
22. The U.S. National Innovation System: Recent Developments in Structure and Knowledge Flows David C. Mowery/ Haas School of Business, University of California, Berkeley and Canadian Institute for Advanced Research, 1996.
23. Wessner Charles W. Rising to the Challenge: U.S. Innovation Policy for Global Economy Committee on Comparative National Innovation Policies: Best Practice for the 21st Century. Board on Science, Technology, and Economic Policy, Policy and Global Affairs / Charles W. Wessner, Wolff, Editor. National Academy of Sciences, 1212.
24. NASSCOM, “Indian IT-BPO Industry,” 2011. URL: http://www.nasscom.in/indian-itbpo-industry
25. National Innovation Council, Towards a More Inclusive and Innovative India, September 2010. URL: http://www.innovationcouncil.gov.in/downloads/NInC_english.pdf
26. National Academy of Sciences, S&T Strategies of Six Countries, op. cit., p. 43.
27. 27.Innovation Policies for the 21st Century: Report of a Symposium, Charles W. Wessner, editor, Washington, DC: The National Academies Press, 2007.
28. Gupta David W Nayanee. Innovation Policies of South Korea / Nayanee Gupta David W. Healey Aliza M. Stein Stephanie S. Shipp. Institute for defense analyses, 2013. – IDA Document D-4984. 71 p.

29. Bishop W. The Elements of Leadership in a Global Environment. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/joe.21505

30. Mahlich Jorg. Korean Science and Technology in an International Perspective / Mahlich Jorg, Pascha Werner. Physica-Verlag Heidelberg, 2012. 288 p.

31. Negri Fernanda De Negri, Innovation policies in Brazil during the 2000s: the need for new paths / Fernanda De Negri, Andre Tortato Rauen. Institute for Applied Economic Research – ipea 2018. 60 p.

32. Cerneaz Nick. Australia's Innovation System. URL: https://thewarrencentre.org.au/wp-content/uploads/2014/08/wc2662-1hr-SenateInnovationSystemInquiry.pdf

Information about the authors:
Shostak L. B.
Doctor of Economic Sciences,
Professor at the Department of Economy,
Entrepreneurship and Natural Resources,
Taurida National V. I. Vernadsky University, Ukraine
Dikarev O. I.
Candidate of Political Sciences,
Associate Professor of the Chair
of International Studies in Journalism,
Kyiv National University of Culture and Art, Ukraine

DOI https://doi.org/10.36059/978-966-397-123-0/150-170

FORMATION OF THE ORGANIZATION MANAGEMENT SPACE MODEL

Bezus A. M.

INTRODUCTION

To ground the purpose of management, it is necessary to note the composition of the management system, the main features of the subsystems and what they lack to achieve the goal of the system. The system includes two main parts (subsystems): the control object and the subject (body) of management. The object is endowed with the basic material factors (resources), the use of which makes it possible to achieve the goal system. However, the object has an formidable obstacle for it, namely, the uncertainty about how to use these factors which would ensure that the system achieves the goal, that is, the uncertainty of the behavior of the object. So, if this uncertainty is not eliminated or, at least, significantly reduced, the available resources and factors of the object cannot be effectively used, therefore, the goal of the system cannot be achieved. And if the goal is unattainable, then the existence of such a system does not make sense. It turns out that the elimination or the maximum possible reduction in the uncertainty of the object's behavior is a mandatory procedure. To perform this mandatory function, a management body is provided in the management system. The main purpose of the subject of management is to eliminate the uncertainty of the behavior of the object on its path to achieving the goal.

The goal can be achieved only through specific actions of the object. In every situation and at every moment in time, there are many possible actions in front of the object, but only one (or several of them) is the one or those that will lead the system to the goal. The object has no information which of them are those. This is the uncertainty of the behavior of the object[1]. Thus, the function of eliminating uncertainty is assigned to the management body. The performance of this function is the main purpose, mission of management body. Let's note, that the management body is a

[1] Клименюк Н.Н., Безус А.Н. Доказательный менеджмент: введение в теорию : монографія. Київ : АМУ, 2015. 272 с.

subsystem designed for informational impact on the control object to achieve a system of goals. And this influence is carried out, mainly due to the elimination of the uncertainty of the behavior of the object. By processing the initial information, the management body receives and transfers to the facility such management decisions that eliminate or at least significantly reduce the uncertainty of its behavior. The implementation of such decisions by the control object ensures the achievement of the goal system.

1. Management process. Control phases

The definition of management changes with the development of science and the views on science of individual researchers. From the point of view of information processing, any control system solves three problems: collecting and transmitting information about the object; information processing; the issuance of management decisions of the management object. We take the following definition as a basis: management is the process of influencing the control object with the goal of its purposeful behavior in the conditions of changing. In the future, this definition will be adjusted, in particular, the content of the process of influencing the object. In the meantime, you should pay attention to the importance of having a goal, since management is aimed at ensuring that it is achieved. A feature of the control process among other processes is that the impact on the object is carried out using information.

The management system, like any system, includes interconnected elements and the mandatory presence of a goal or purpose that it must fulfill. The control system consists of a control object, which, in order to achieve a goal or a necessary state in control actions, and a management body that implements these actions (Fig. 1). The management object includes all those material and human factors that are necessary for the conversion of the subject of labor into a product, that is, for the production of goods and / or the provision of services.

A management body is a subsystem that, based on the initial information and knowledge of the purpose of the system, produces management decisions and transfers them to the object for execution. These decisions are the information impact on the object, which allows you to use the potential of the object to achieve the system’s goal. By analogy with the management object, the management body includes those material and human resources (factors) that are necessary for collecting and processing the initial information into ready-made management decisions and transferring their management object for implementation.

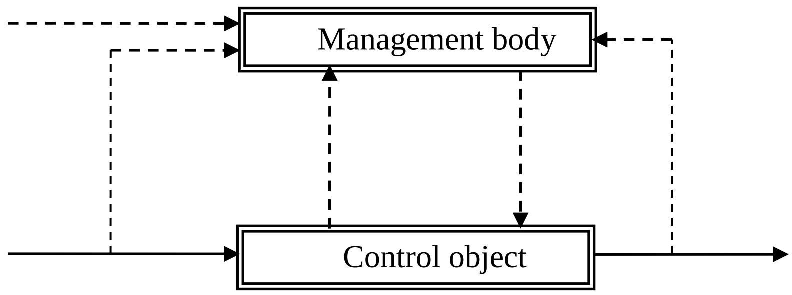

Figure 1. Composition and connections of management system

Depending on the goal or purpose of the system, the management body receives relevant information from the external environment (pointer 1).

In addition to information from the external environment, the management body receives information about the control object itself (pointer 2), and more specifically about its production capabilities, that is, an array of data characterizing the maximum allowable intensity of processes and their results that can be produced per time unit. Production capabilities can be understood as limiting resources, which can include production capacities, material and labor resources, money, time. At the input of the object (pointer 5) come resources from the external environment (material resources, raw materials, energy resources and others) used for production, information on the quality and quantity of which are submitted to the management body (pointer 3).

Production processes taking place in the control object turn labor objects into products (pointer 6). Information on the quantity of products and their parameters is received (pointer 7) to the management body for the development, if necessary, of decisions on the regulation of production and the transfer of their control object (pointer 4). Also, all the input information described above obtained by the management body allows the control entity, based on the purpose of the system and based on performance criteria, to develop a task at each time period, the results of which are transmitted (pointer 4) to the control object for subsequent implementation.

In general, the management process is presented as a process of influencing an object in order to achieve its goal, but there is a need to detail, present and describe it in terms of its individual components, phases.

The initial or zero stage of control, which should be implemented by the first phase, is to establish the purpose of the system. If such a goal has already been set from a higher level of management, it should be perceived as important information for the development of solutions in the first phase of management. Modeling the control process in time allows us to present it with the following sequence of actions (Fig. 2):

Zero stage – setting and formalizing the goal (s) of the managed system (subsystem).

The first phase is planning: determining the desired results of the object's functioning for a given period, which bring it closer to the goal.

The second phase is accounting: obtaining information from the object about the actual results of its activities, for example, the quantity of products for current periods of time that are less than the specified duration, processing and summarizing this information with increasing levels of production units and time periods.

The third phase – control: comparing accounting information about the actual results of the planned activity and calculating deviations.

The fourth phase – adjustment: development of management decisions aimed at eliminating or minimizing deviations identified at the previous stage, and transferring these decisions to the control object for implementation.

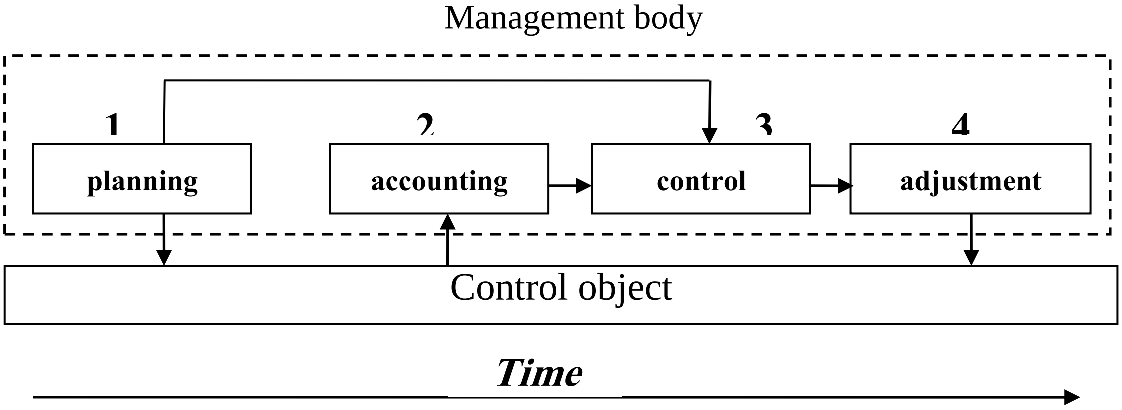

Figure 2. Stages (phases) of a closed cycle of informational relationships of the body and the control object

The object is controlled by the sequential implementation of the presented phases. Each phase represents many management tasks. Some of the management phases presented above, such as planning and control, coincide in name with the management classics listed in the textbooks. But only there they are called management functions. The reader himself has the right to give preference to the concept of “phase” or “function”. According to the concept adopted in this work, it is more logical to call each stage of a closed control cycle a phase. If we talk about the functions of the highest level, the function can affect the control object in such a way that it achieves its goals. Of course, this function can expand as the object is disaggregated, processes occurring in it for periods of time for which management decisions are developed.

2. Management space. Defining management tasks

Over the past decades, management theory has been stagnant, despite the significant spread of management – the opening of new universities and specialties, the graduation of specialists, the publication of hundreds, if not thousands, of various books on management. And this despite the great objective need of the real economy in the development of theory, and, consequently, the widespread use of the theory in practice for a significant increase in the efficiency of organizations and the economy as a whole.

Important attention is paid to the description of management functions, such as planning, organization, motivation, control and others. These functions are presented in theory as a subsystem of the entire control system. But for an organization of medium complexity, each of these subsystems is so cumbersome and complex that it is hardly possible and expedient to solve this problem.

Each manager can solve specific management tasks, and not subsystems (functions), which can include hundreds and thousands of tasks. Therefore, the problem of representing these subsystems as a set of control problems remains, which has not yet been done in theory.

If the study and description of management functions is a favorite topic of researchers, then the definition of management tasks can be attributed to problems that authors of modern textbooks and monographs bypass without paying enough attention to them or not mentioning them at all in their works. However, the control task is the main element of the control system[2]. It is the solution of control problems that is the only way for the control system to purposefully influence the control object. In addition, management tasks, their characteristics, quantity and complexity of implementation determine the structure of the management system.

It is advisable to accept the concept of a task in general to the definition of a control problem. We define the tasks as a situation described by known information, which is characterized by some uncertainty, and to eliminate which it is necessary to find some quantities (unknown).

Let us move on to the organization (enterprise) management system. In management theory, there is no well-founded concept of a management problem. This does not mean representing any situation as a specific management task. The point is that the set of these tasks should represent all the many issues that need to be addressed by the control system for successful facility management.

The main problem is to detect many control tasks, which, on the one hand, would be necessary and sufficient for effective management of the facility, and on the other hand, control tasks should not exceed the potential of the corresponding control body in its complexity.

One of the most important principles of building control systems V.M. Glushkov called the principle of a systematic approach, which consists in determining goals and criteria and carrying out structuring, which reveals the whole range of issues that need to be addressed to achieve certain goals[3].

The relevance of the structuring of the control system is confirmed by the fact that, due to complexity, it cannot be fully implemented and, therefore, it is necessary to divide the system into parts, or tasks.

The importance of determining the structure of the control system is emphasized in the works of many authors. The author[4] notes on the structures of control systems: “The first conclusion is recorded by the fact that, dividing the system into subsystems, finding individual blocks (tasks) and developing a project for each of them, we seem to get those “bricks” in finished form, from which then the house of the whole system can be

[2] Каныгин Ю.М., Парфенцева Н.А. Как планировать и оценивать работу ВЦ? *Экономика и организация промышленного производства*. 1983. №3. С. 48–60.

[3] Глушков В.М. Введение в АСУ. Київ : Техніка, 1974. 320 с.

[4] Рыбальский В.И. Об организации проектирования автоматизированных систем планирования и управления строительством. *Кибернетика и вычислительная техника в строительстве*. Київ : Будівельник, 1971. С. 25.

composed. The second conclusion boils down to the fact that when designing individual blocks, you should not miss any significant connections between them.”

Carrying out the structuring of the control system is, first of all, the identification of the full set of tasks for managing this object. In turn, the identification of all tasks is a prerequisite for the quality management of the organization. In addition, this is the basis for building the organizational structure of the management system.

The absence of an accepted concept of a control problem makes it advisable to formulate requirements for this process and its results (many tasks):

1. all organizational management tasks, the results of which are required by the object for its effective behavior, must be reflected in the prevailing set (structure);

2. any issue, including the indicator, should be solved only in one task, that is, elimination of duplication;

3. the input to the set of tasks as its elements should not exceed in their complexity the capabilities of the control system for the qualitative and timely implementation of these tasks (receiving, processing information and transmitting decisions of the control object);

4. when forming a set of management tasks, the main connections between them should be reflected, which is aimed at maintaining the integrity of the management system.

Let us analyze on the example of one of the proposed for a manufacturing enterprise the structure of a control system in which the functional part of the system is divided into functional subsystems:[5]

1) planning;
2) technical preparation of production;
3) operational management;
4) accounting;
5) resource management;
6) production management.

Let us consider the proposed functional subsystems in terms of duplication. We denote these subsystems in accordance with S_1, S_2,… S_6. First of all, we exclude from the analysis the subsystem S_2 as such, which

[5] Ляшенко И.Н., Клименюк Н.Н., Калишук Д.А., Килиевич А.И. Моделирование предплановых решений в управлении производством. Київ : Вища школа, 1984. 128 с.

does not apply to the control process, since it is a controlled material process. Let us consider the pairs of subsystems S_1 and S_3. Subsystem S_1 includes planning for all time periods, including those related to operational. Subsystem S_3 includes operational management and, accordingly, the planning phase, namely, operational planning. So, the subsystems S_1 and S_3 have a common part – operational planning: $S_1 \cap S_3$ = operational planning. Subsystems S_1 and S_4 do not have common elements, that is, $S_1 \cap S_4 = \varnothing$ (their section is an empty score). Subsystems S_1 and S_5 intersect in the "resource planning" part: $S_1 \cap S_5$ = resource planning. This is explained by the fact that S_1 (planning) covers all processes in the organization, including the provision of resources, and S_5 includes planning (as a control phase) of resources, that is, $S_1 \cap S_5$ = resource planning. Similarly, S_1 intersects with S_6 in terms of "production planning": $S_1 \cap S_6$ = production planning.

The intersection of other subsystems is presented without explanation:

$S_3 \cap S_4$ = operational accounting;

$S_3 \cap S_5$= operational resource management;

$S_3 \cap S_6$= operational management of production;

$S_4 \cap S_5$= accounting of resources;

$S_4 \cap S_6$ = production accounting;

$S_5 \cap S_6 = \varnothing$ (no intersections).

This analysis revealed significant drawbacks in the construction of structures due to the large number of intersections of the proposed subsystems. The result of such intersections will be the duplication of solutions to the same questions and the receipt of ambiguous answers that are difficult to use for the management object.

The proposed functional subsystems are parts of the entire system and their selection should be carried out according to certain criteria.

The "planning" subsystem S_1 is highlighted by the "control phase" attribute, S_3 (operational control) by the time attribute; S_4 (accounting) – according to the control phase; S_5 (resource management) and S_6 (production management) – by type of controlled process.

Any control system is so complex both algorithmically and informationally that it requires its distribution into parts (blocks). We denote the control system by S, and the blocks (subsystems) into which it will be divided – S_1, S_2 …, S_m. Each of these blocks is simpler than the S system, however, if they are too voluminous and complex, then each of them must again be divided into parts. It is advisable to continue the distribution process until we get blocks whose capacity and complexity does not exceed a given one, that is, one that the control body is able to overcome in the required time. The blocks (parts) of the control system obtained at this level should be called control tasks. Then the parts of the system obtained at higher levels will be complexes of tasks or subsystems.

The most important requirement that must be observed during decomposition is that the distribution of the system (or subsystems) at each level should be carried out on one basis.

Consider some manufacturing enterprise. We will understand production activity in the broad sense, referring to it the provision of services. This clause allows you to include any organization. For the effective functioning of this organization there is a management system (governing body), which is designed to manage all activities. In other words, the governing body needs to solve the problem of "managing the activities of the organization.» Due to the extreme algorithmic and computational complexity of this task-system, it should be divided into separate subsystems.

Let us assume that the enterprise includes 10 production workshops, and each of them consists of 5 production sites (Fig. 3). The structure of the enterprise includes only those departments where production processes take place (for example). Each of the units represented in the diagram is directly involved in the production process, at one stage or another of the conversion of the subject of labor into finished products.

We list the main production processes characteristic of any enterprise. The main one is the production process. For the course of which the following processes are necessary: provision of production with materials (objects of labor); providing production with energy resources; provision of production with fixed assets; staff production.

So, we have an enterprise for which it is necessary to identify a list of management tasks. We apply the decomposition method for this.

We denote the control system, that is, the full range of control tasks, by S. Denoting the signs of decomposition by i, we select the first sign (i=1).

As the 1st sign, we take the **form of a controlled process**. Let us imagine the structure of the controlled processes of this enterprise (Fig. 4). Let k be the number of the controlled process. For a simulated enterprise, such processes will be: k = 0 – production; k =1 – ensuring the production of raw materials, semi-finished products; k = 2 – ensuring the production of energy resources; k = 3 – ensuring the production of fixed assets; k = 4 – ensuring production personnel.

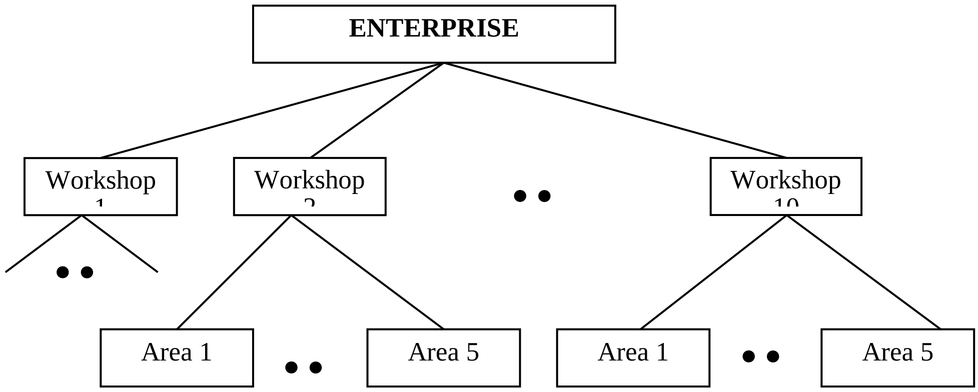

Figure 3. The production structure of the simulated enterprise

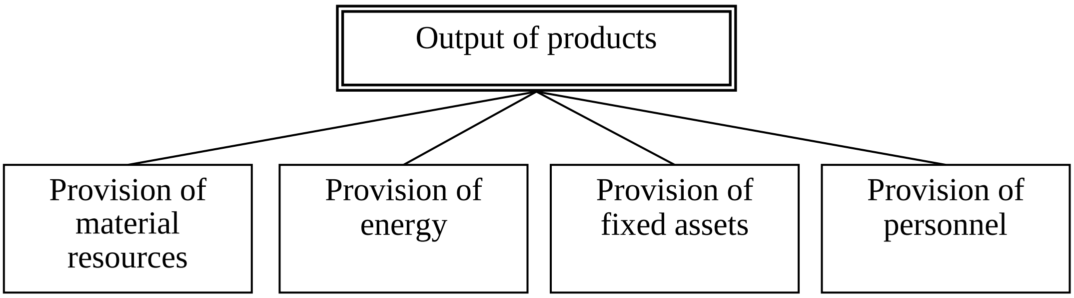

Figure 4. The structure of production processes of the enterprise.

At the first sign, we divide the control system S into subsystems:

$$S = \{ S_0, S_1, S_2, S_3, S_4\} = \{ S_k, k = 0, 1, 2, 3, 4 \text{ or } k = \overline{0,4} \},$$

$$S = \{ S_k, k = \overline{0,K} \}. \quad (1)$$

That is, S_k is the control subsystem of the k-th process, it consists of subsystems, for exampleд: S_0 – production control; S_4 – personnel support subsystem. The resulting subsystems cannot have common elements. That is, they should not intersect:

$$\bigcap_{k=0}^{4} S_k = \varnothing \quad (2)$$

And the number of subsystems received is:

$$M_1\ (S) = 5. \qquad (3)$$

Each of the obtained control subsystems requires further division into parts.

To do this, for the second sign of decomposition ($i = 2$) *we take the* ***production structure****. According to this sign, each process control subsystem will decompose into a number of parts equal to the number of divisions of a given enterprise. We denote:* l – *number (index) of the production unit. Taking the production structure shown in fig. 3, we denote:* l = 0 – *enterprise; l* = *1 – workshop* 1*; l* = 2 – *workshop* 2*;* …; *l* =11 – section № 1 of workshop 1; …; ***l*** = 60 – section № 5 of workshop 10.

The *k* process control subsystem S_k *will* be divided into 61 parts:

$$S_k = \{ S_{kl},\ l = \overline{0{,}60} \},\ k = \overline{0{,}4}. \qquad (4)$$

We got control subsystems of the *k*-th process in the *l*-th production unit. We substitute specific processes and divisions instead of the indices *k* and *l*:

S_{01} – production management ($k = 0$) in the workshop *l* (l = 1);

S_{10} – management of production support materials ($k = 1$) for the enterprise (l = 0);

$S_{4,12}$ – management of production support for personnel ($k = 4$) in area 2 of the workshop 1.

As with the distribution of the system for the 1st sign, intersections of subsystems are also unacceptable here:

$$\bigcap_{l=0}^{60} S_{kl} = \varnothing,\ k = \overline{0{,}4} \qquad (5)$$

It is easy to calculate the number of control subsystems obtained after the distribution of the system according to two criteria:

$$M_2\ (S) = 5*61 = 305. \qquad (6)$$

In order to reduce the algorithmic and computational complexity of the formed subsystems, we take the following, third sign of decomposition, $i = 3$, **the control phase,** which we denote by *p*. Using the structure of the management process we take: $p = 0$ – management (as a generalizing and coordinating process); p =*1* – planning; p = *2* – accounting; p = *3* – control; p = *4* – regulation.

According to the control phase, each of the S_{kl} subsystems is divided in this way:

$$S_{kl} = \{S_{klp},\ p=\overline{0,4}\},k=\overline{0,4};l=\overline{0,60}, \tag{7}$$

where S_{klp} – management of the *k* – th process by unit *l* by phase *p.*

Taking specific values for *k*, *l* and p, as a fragment of the resulting structure, we will present: S_{243} – control (*p* = 3) ensuring production of energy resources (*k* = 2) in workshop 4 (*l* = 4). All subsystems formed by three signs should not have common elements (intersections):

$$\bigcap_{p=0}^{4} S_{klp} = \varnothing,\ k=\overline{0,4};\ l=\overline{0,60} \tag{8}$$

Let us determine the number of control subsystems obtained as a result of decomposition according to three criteria: $M_3(S) = M_2(S)*\ 5= 305*\ 5 = 1525$, where 305 – is the number of subsystems by distribution according to two preliminary signs; 5 – the number of control phases, including the generalizing phase – control.

To simplify the obtained tasks, we introduce the fourth sign of decomposition *i* =4. As this feature, we take the **time period (control interval)**, which we denote by *t*. By management interval, we understand the duration of the period for which it is necessary to make management decisions. These periods have different durations, and they should all be displayed in the appropriate structure. Duration of periods may be five years, year, day, shift. The structure of the management period for different organizations may vary, but among them there are mandatory periods such as a year, quarter, month, only just because organizations have certain information obligations to the state. To simplify, we will accept the structure of the management period for the enterprise under study, the largest interval of which is a year, a year is divided into quarters, quarters, months, a month into decades, decades into days.

Continuing the distribution of each of the obtained S_{klp} subsystems according to the 4th criterion, we obtain:

$$S_{klp} = \{S_{klpt},\ t=\overline{0,412}\},k=\overline{0,4};l=\overline{0,60};p=\overline{0,4}, \tag{9}$$

where S_{klpt} – *process control k* in unit l by phase p for the period *t.*

Substituting the specific values of the listed parameters *k, l, p, t,* we present a fragment of the set obtained as a result of decomposition according to four features of the problems:

S_{0214} – planning *(p* = 1) of production (*k* = 0) of workshop 2 (*l* = 2) for the 4th quarter (*t* = 4);

S_{1925} – accounting for the production of materials of workshop 9 for the 1st month of the 1st quarter (January);

$S_{2, 11, 3, 412}$ – control (3) of ensuring the production of energy resources (2) to section 1 of workshop 1 (11) for December 30 (i.e., the 10th day of the 3rd decade of the 3rd month of the 4th quarter) (412).

In accordance with the requirements for the structure of the management system, the formed tasks should not allow duplication, i.e.:

$$\bigcap_{t=0}^{412} S_{klpt} = \varnothing,\ k = \overline{0,4};\ l = \overline{0,60};\ p = \overline{0,4} \qquad (10)$$

The number of received parts of the control system as a result of its distribution according to 4 signs: M_4 (*S*)= 1525*413 = 629825, where 413 – is the number of time periods in the accepted structure.

To assess the complexity of the obtained parts of the system, we note that each of them includes one controlled process occurring in one production unit, one control phase and one-time period. Therefore, it can be noted that their complexity does not exceed the capabilities of managers. So, the further distribution of the system is impractical, and after the decomposition can be called each received part as management task.

Depending on the specific goals of the control system, from their entire set of received tasks, any of their complexes and control subsystems can be formed.

As well as decompositions, the integration of control tasks into subsystems must be carried out according to characteristics. *For example*, on the basis of the "production uni" management tasks can be reduced to the subsystem "Planning for the production of material resources for all production units for the 1st quarter".

At the same time, groups of tasks can be distinguished depending on the main type of activity of the analyzed unit of the enterprise, *for example*:

for the planning department, we can consider the combination of management tasks by all indications, except for the management phases, while highlighting only one of them – planning, as a result we get the subsystem “planning of production processes for various departments of the enterprise and time periods”;

for the human resources department – by all indications, except for a controlled process, namely, ensuring production by personnel, as a result we get the subsystem “planning for production support by personnel for all departments of the enterprise for all periods”;

similarly, you can create a subsystem for the department of the chief power engineer – only a controlled process here can be the provision of energy production, then we will get the subsystem “management of the production of energy resources for all production divisions and time periods”.

Management objectives can be combined with two or three attributes.

For example, on the grounds of “production unit” and “time period”, the complex “production accounting” can be called (meaning the consideration in this complex of all production units and time periods).

Combining tasks into complexes can be carried out on three grounds simultaneously.

For example, a set of tasks “managing the provision of production with material resources for all production units of the enterprise, and time periods” is synthesized from the corresponding management tasks according to the characteristics: control phase, production units and time period.

Thus, the implementation of the decomposition algorithm of the enterprise management system using the example under consideration allows us to obtain a complete set of tasks.

Let u recall that each control task is associated with the search for unknowns according to the four signs of decomposition listed above, namely, **a controlled process, a production unit, a control phase, a time period**.

Hence the name of the control task consists of listing these features in this sequence:

control phase → controlled process → production unit → time period.

This rule allows us to standardize the names of tasks, make their interpretation unambiguous and get their complete list. We bring it to table 1.

Using the form of the table below, it is easy to compile a complete list of management tasks of any organization.

If we talk about the organization considered in the example, then you need to refer to the given directories (structures), namely: control phases; managed processes; production units and time periods.

Substituting specific values from these directories into the table in the corresponding columns of the table, we obtain the name of the corresponding task.

Table 1

Formation of a list of tasks for managing an organization using the decomposition method (fragment)

№ S. No.	Sign of decomposition of the control system			
	1. Control phase	2. Controlled process	3. Production unit	4. Time period
1.	Planning	production of goods	in workshop № 1	for the 2nd quarter
2.	Accounting	Providing energy	by enterprise	for the third decade of the 1st month
3.	Regulation	provision of production with materials	on the 2nd section of workshop 10	on the 2nd month
…	…	…	…	…

To make a complete list of tasks, it is necessary to add all the elements from each directory to the table in turn.

The presented method of decomposition of the control system made it possible to obtain a complete list of control tasks. Each task contains four parameters – one from each structure formed by the corresponding signs of decomposition. We represent each feature as some coordinate axis.

Let the first axis be “controlled process”.

Then, being attached to the organization considered in an example, we will present this here (fig. 5).

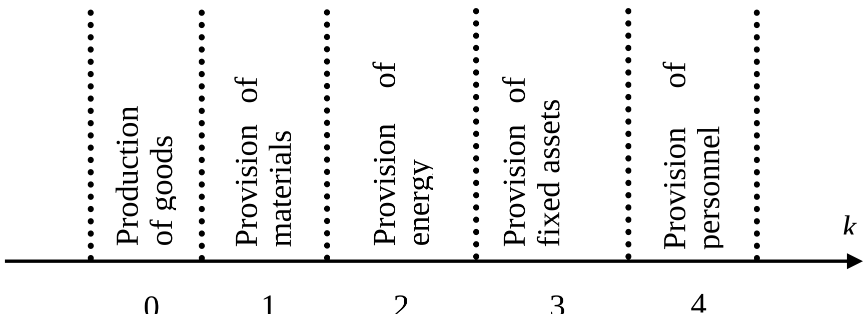

Figure 5. Parameters of the axis "controlled process"

Any control problem includes only one coordinate of this axis, i.e., any process k from the score: $k\ \overline{0{,}4}$.

Each process takes place in the production units of the organization. Let us represent the production structure as the second coordinate axis (Fig. 6).

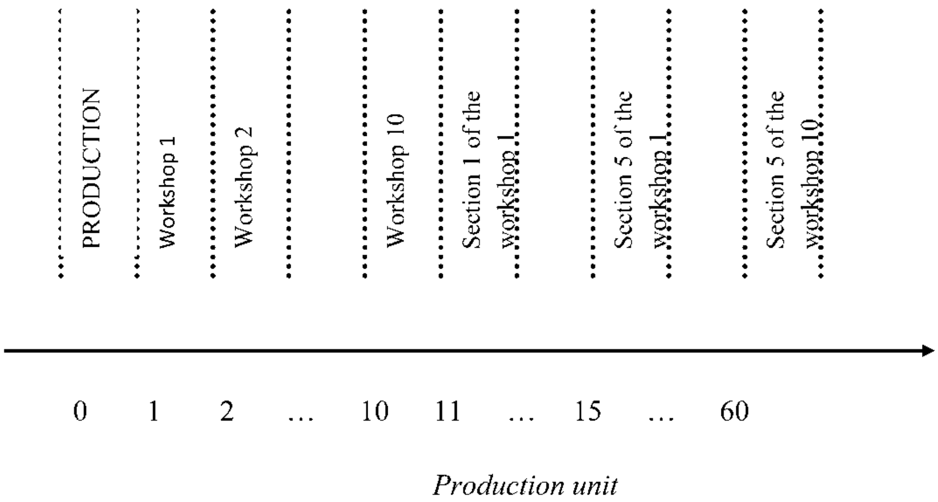

Figure 6. Coordinates of the axis "Production structure" (for example, the organization considered above)

Given two coordinate axes, the control task includes one coordinate of the first axis and one coordinate of the second. The task can display any subdivision l from the given score: $l \in \left(\overline{0{,}60}\right)$.

As the third sign of decomposition, the control phase was accepted. We accept it as the third coordinate axis (Fig. 7).

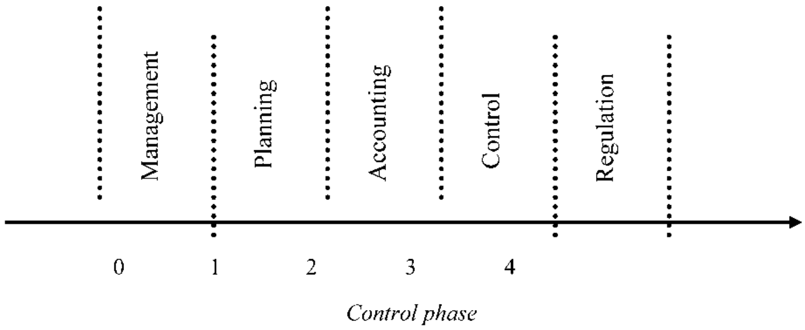

Figure 7. Coordinate axis "control phase"

One of the total number of control phases represented on this axis is reflected by each control task: the *p* phase is an element of this set – $p \in \left(\overline{0,4}\right)$.

If *p=0* (control), then we have in mind the management process that performs a coordinating role in all other phases of management.

We take time as the fourth coordinate axis. When solving control problems, time is usually represented as discrete periods. The structure of the time period adopted in the control system decomposition example is represented on this coordinate axis (Fig. 8).

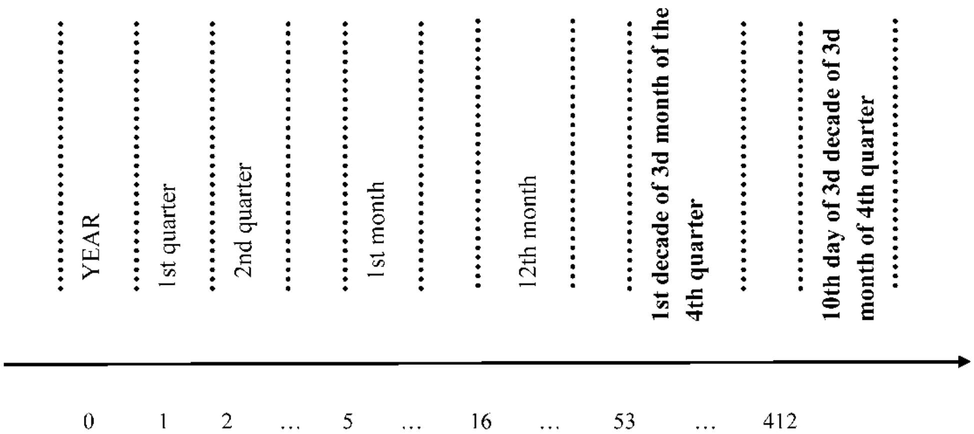

Figure 8. The coordinates of the axis "control period (time)"

The presented coordinate axes allow you to describe the organization control space. This means that any management task is located in this space. The four coordinate axes are described above, therefore, we are talking about four-dimensional space. Each control task has specific coordinates that determine its exact position in the control space.

We denote the control problem by S_{klpt}, where the indices *k, l, p, t* represent, respectively, the coordinates of the above axes.

The task coordinates determine not only its position in the management space of a given organization, but also its purpose. *For example*, substituting the specific coordinates of the problem, let $k = 3$; $l = 2$; p = 1; $t = 5$, we get task S_{3215}, the content of which is to develop a plan (p=1) to ensure production of fixed assets *(k = 3)* in workshop № 2 *(l = 2)* for the 1st month *(t = 5).*

The coordinates presented above (Fig. 5-8) correspond to the organization considered in the example. For this organization, a **management space** can be represented:

$$\{ k = \overline{0,4}; l = \overline{0,60}; p = \overline{0,4}; t = \overline{0,412} \}.$$

To describe the management space in a general way, that is, for any organization (enterprise) in which the processes of production of goods or the provision of services take place, there are some departments where these processes take place and they need to be managed, and these management decisions are necessary for different periods time, take:

k – number of the controlled process, their number in the organization $K + 1$, that is, $k = 0, 1, \ldots, K$ (since the process numbering starts at 0, the last number is *K*);

l – production unit number, their numbering $l = 0,1,\ldots, L$;

p – control phase number, $p = 0, 1, \ldots, P$;

t – period number, $t = 0, 1, \ldots, T$.

In the general case, the management space for any organization is:

$$\{ k = \overline{0,K}; l = \overline{0,L}; p = \overline{0,P}; t = \overline{0,T} \}. \tag{11}$$

The presented model of the control space is a kind of "portrait", a reflection of a real existing organization and its management system. And the organization functions and develops, its parameters change, which, of course, should be reflected in the model of the management space. There is no reason to believe that these changes will lead to a change in the structure of the model, for example, to a change in the coordinate axes. But a change in the coordinates along each of the axes can take place to comply with the adequacy of the model to a real system.

In real dynamic systems, changes can occur along each axis.

Indeed, it is quite natural to change the organization's production structure so that it meets the changing goals and conditions of the organization.

The structure of the time period also cannot remain constant, since it should contribute to obtaining sufficiently reliable managerial decisions in stochastic conditions during the transition from one period to another.

A feature of the presented model of the control space is that it is discrete, since the coordinates along all axes are discrete.

The described management space is the "place" where all the management tasks of this organization are located. Each task has four coordinates. Despite the fact that each task is a complex aggregate, we consider the problem here as a unit cell of a given space.

The description of the control space makes it possible to define the control problem as part of this space.

CONCLUSIONS

The elimination of the uncertainty of the object's behavior on the way to solving its main tasks is the main purpose of the control subject. A system requires control when uncertainty is inherent in it. Management itself is designed to eliminate or at least reduce this uncertainty, which opens the way for the system to achieve the goal.

Management is the set of management tasks and the relationships between them and the external environment. It is the solution of control problems that represents finding unknown quantities that eliminate (reduce) the uncertainty in the behavior of the system. Each task eliminates the uncertainty of the corresponding share of the system, and all their set – the entire organization as an object of management.

From this we can conclude that the achievement of the organization's goal lies on the path to eliminating the uncertainty in its behavior, which, in turn, is achieved by solving management problems.

But for this, at a minimum, it is necessary, firstly, to identify the entire set of tasks aimed at reducing uncertainty in the organization's behavior, and secondly, to determine unknown quantities, the finding of which will eliminate the existing uncertainty in the process of functioning.

The purpose of the management body is to eliminate this uncertainty, which should be based on the theoretical provisions of management. Due to the lack of such a theoretical base, an approach is proposed that provides the classification and ordering of many unknown variables by constructing a control space model. It is hoped, that the stated principles of the theory will be sufficient for the thoughtful reader to pose and solve practical issues of managing the functioning of the organization.

SUMMARY

The description of the control space makes it possible to define the control task as part of this space. The control task is a single cell of the control space, which is characterized by a set of internal and external data, which requires liquidation of the uncertainty of finding information (unknown values) that relates to a given fraction of this space.

From the definition it follows that to solve a specific problem, source information can be used on any other cells of this space (that is, other tasks) and with an external to the organization environment, and the results of solving the problem relate to this corresponding cell in the control space.

The identification of the full set of organization management tasks, regardless of its structure, goals, products and services provided, is the main condition for the formulation and solution of practical issues of organization management. Even with a huge variety and differences between organization management tasks, regardless of management processes, production structure, phases and duration of management periods, the reader will find practically useful recommendations for each task and an approach to its formulation and implementation.

REFERENCES

1. Клименюк Н.Н., Безус А.Н. Доказательный менеджмент: введение в теорию : монографія. Київ : АМУ, 2015. 272 с.
2. Норберт Винер. Кибернетика, или управление и связь в животном и машине. 2-е изд. Москва : Наука, 1983. 340 с.
3. Каныгин Ю.М., Парфенцева Н.А. Как планировать и оценивать работу ВЦ? *Экономика и организация промышленного производства*. 1983. № 3. С. 48–60.
4. Глушков В.М. Введение в АСУ. Київ : Техніка, 1974. 320 с.
5. Рыбальский В.И. Об организации проектирования автоматизированных систем планирования и управления строительством.:

Кибернетика и вычислительная техника в строительстве. Київ : Будівельник, 1971. С. 25.

6. Ляшенко И.Н., Клименюк Н.Н., Калишук Д.А., Килиевич А.И. Моделирование предплановых решений в управлении производством. Київ : Вища школа, 1984. 128 с.

Information about the author:
Bezus A. M.
Candidate of Economic Sciences, Associate Professor,
Associate Professor at the Department of Management,
Kyiv National University of Trade and Economics
19, Kyoto str., Kyiv, 02156, Ukraine

Publishing house “Liha-Pres”
9 Kastelivka str., Lviv, 79012, Ukraine
44 Lubicka str., Toruń, 87-100, Poland

Printed by the publishing house “Liha-Pres”
Passed for printing: September 21, 2019.
A run of 150 copies.