Efficiency assessment of enterprise innovation activities

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Abstract: This paper suggests Efficiency Assessment of Enterprise Innovation Activities (EIA) according to the Cost Reduction Principle and value approach transforms conventional concepts of efficiency. Value, efficiency indicators of business activities of an enterprise are from relative indices of performance (productivity, profitability) towards market value assessment. The economic mechanism of efficiency of an industrial enterprise should be understood to mean the process of target-oriented formation of production and economic activities' results which satisfy, to the fullest extent, both public needs and goals of the enterprise during modernization
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Introduction

The present paper suggests using "value-oriented" approach or maximization of the market value of an operating enterprise (MVOE). Currently, the concept of risk only as a negative factor in asset management is not quite correct. Since risk is seen as a possible additional competitive advantage it is directly linked to the development of the concept of real option in practice. Shift to evaluation, and management of value added become of greater importance. Optimization of the company's asset management during investment involves creating conditions to increase the value of the enterprise, and includes the following activities:

1. Improved operating activities due to the production factors, intangible assets, new technologies, innovation as a whole. Choosing investments with ROI higher than the costs to attract the capital required for their implementation.
2. Improved asset management, e.g., due to sale or liquidation of non-core, secondary, unprofitable assets, decreased periods of accounts receivable turnover, stocks (so-called "disinvestment); the management of institutional factors of development
3. Improved governance structure of the capital.

Literature review is used to define an evaluation system for value chain management and to apply the evaluation system to the company. The article research served both the interest of the organization performance, which was to measure how profitable the company's supply chain was, and the interest of science, namely to produce knowledge about new ways of looking into supply chain performance measurement (Gummesson, 2000, Coughlan and Coghlan, 2009, Yin, 2003).

When defining EE (economic efficiency) of EIA (enterprise innovation activity) as economic category, it is worth bearing in mind that, in its general meaning, efficiency characterizes developed systems, processes and phenomena. Efficiency becomes an indicator of development of an enterprise and the most important stimulus for its modernization, growth and development [1, 2, 3]. Striving for boosting efficiency of a certain type of activity or project results in designing some measures which encourage development process and cutting off the activities which result in regression.

Efficiency assessment of enterprise innovation activities (EIA) according to the cost reduction principle

As practice shows, cost reduction principle plays an important role in EIA justifying (Fig. 1 in IDEFO form). When analyzing EE of EIA the following major stages may be highlighted:

1. Confirmation of innovation character of a project in accordance with the data available – "innovation bank" of projects, referring to products and technology.
2. Confirmation of "commercial efficiency" of EIA. EIA can include a significant number of projects whose EE can be proved as being commercial one. It can refer, in particular, to EIA with a relatively short economic life span.
3. The use of cost reduction principle and relevant technology for implementation of this principle. When individual principles and methods of economic feasibility for EIA and confirmation of their EE are absent, programs of cost reduction measures for project implementation may be used provided that the principle of "invariability (equivalency) of the obtained final result" from the project is strictly complied with.
4. After costs are reduced, new calculations, confirming EE of the project, are necessary, since the obtained level of cost reduction may be insufficient to overcome the project EE threshold. In such a case

an additional cost-reduction program for the project may be developed and implemented.

5. However, at the same time the requirement of the enterprise for equivalency of the final result may be violated. This means that cost reduction measures when being implemented may change the internal return index of EIA. Then additional confirmation of innovation nature of the project is necessary and the analysis procedure has to be repeated.

For EIA, due to the specifics of innovation projects, work and services outsourcing may play a discrete role and help reduce the cycle of the project implementation and approximate the time of the expected result. However, use of this technology results in considerable cost increase of the project, which is why outsourcing programs can become an object for cost-reduction. In this case additional aspects of EE analysis of EIA emerge and they have to be reflected in the economic feasibility technique.

This refers, primarily, to institutional aspects: if an enterprise, involved in EIA, does not use outsourcing and, correspondingly, does not bear related costs it automatically results in additional cost for these services being provided by the enterprise itself. Quite often these internal costs are lower than those for outsourcing. Validation and confirmation of EE of EIA does not automatically mean its acceptance, since existing risks have considerable significance. Risk analysis should become an integral part of decision-making when EIA is being accepted. Issues related with risk analysis and management of EIA should be dealt with separately.

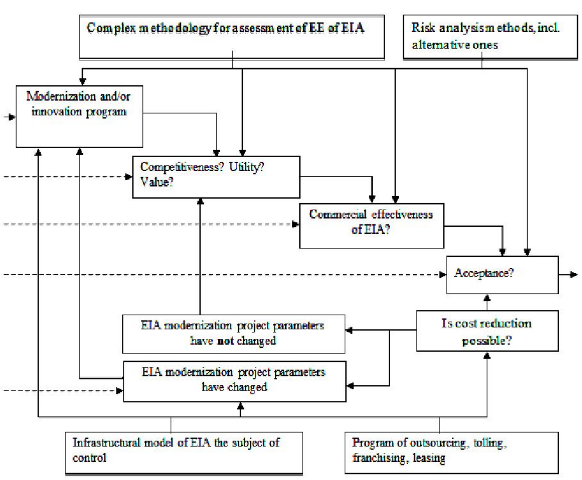

Fig. 1. Cost reduction model (CR) during EIA

Efficiency assessment of EIA with savings on semi-fixed costs and increase in production.

The prime postulate of this method is calculation of the net present value of an investment project (NPV):

$$NPV = -\sum_{t=1}^{T} \frac{I_t}{(1+r)^t}{}_0 + \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t} \quad (1),$$

where CF_t – is a cash flow, generated by the project per year t; I_t –initial investment per year t; r – discount coefficient. The criterion for project acceptance is non-negative value of $NPV \geq 0$.

Innovation in production technology of an enterprise should result in production growth of improved (new) goods or in labor productivity increase. In case production grows, relative decrease in production costs is possible due to reduction of semi-fixed costs per unit of output. Let us formulate the following basic principle, which makes it possible to use statements of marginal theory: utility of some parameter (index) can be accepted as equal to the value of the parameter (index) itself. So, let us present the method for operating risk calculation of EIA in case the industrial enterprise is modernized in accordance with an alternative approach to risk analysis [4]. Let us put down the expression for operating effect in respect to one type of products, $EOL(\bar{X})$:

$$EOL(\bar{X}) = \frac{m\bar{X}}{m\bar{X} - F}, as\ p - v = m \Rightarrow E(EOL(\overline{X})) = EOL(E(\overline{X}) - PR) \quad (2)$$

Let us apply this principle to measure the value of operating risk of EIA, related with a decision about definite volume of new products output.

We assume that actual volume of output will be different from the planned one, i.e. it will be a random quantity which adopts the value ($X_{1,}, \ldots X_s$ with probabilities $q_1, \ldots q_s$). The volume of operating risk is the volume of risk premium (*PR*), which is defined from the following balance condition (formula 2).

This condition means that the expected value of operating effect of EIA has to be exactly equal to the operating effect of the expected volume of output minus risk premium [5].

So, the real weight of the operating effect for EIA is the difference between the expected value of the operating effect and risk premium. The expression in the right part is sometimes called risk-free equivalent whereas the risk premium represents the difference between expected final result and risk-free equivalent. Such a criterion was proposed by H. Markowitz [3, 4], in which case risk premium PR can be considered as numerical quantity indicator of operating risk. In order to illustrate the method of operating risk calculation with the use of equivalency principle, we are going to follow the methodology of L. Kruschwitz so as to define the types of risk relations. Let us present the left part of the equation in the form of:

$$EOL(\overline{X}) = EOL(\overline{X}) + E(\overline{X}) - E(\overline{X})) \tag{3}$$

After which the left and right part of the equation will be presented in the form of Taylor series. For this purpose the right part of the equation will be expanded to the first-order derivative and the left one – to the second-order derivative.

Right part:

$$EOL(E(\overline{X}) - PR) = EOL(E(\overline{X})) + EOL'(E(\overline{X})) * (-PR)$$

, hereinafter we accept the designations: $f'(X) = \dfrac{df(X)}{dX}$, $f''(X) = \dfrac{d^2 f(X)}{dX^2}$.

Left part:

$$E(EOL(\overline{X})) = EOL(E(\overline{X})) + EOL'(E(\overline{X})) * E(\overline{X} - E(\overline{X})) + \frac{1}{2} EOL''(E(\overline{X})) * E((\overline{X} - E(\overline{X}))^2)$$

Let us remark the following obvious postulates:

1. $E(\overline{X} - E(\overline{X})) = 0$.
2. $E((\overline{X} - E(\overline{X}))^2) = VAR(\overline{X})$ - dispersion.

Let us define from this condition, the amount of risk premium *PR:*

$$PR = \frac{1}{2} * VAR(\overline{X}) * \left(-\frac{EOL''(\overline{X})}{EOL'(\overline{X})}\right) \tag{4}$$

This is approximate formula for risk premium calculation for small amount of risk. The expression in brackets in the economic theory is called “the coefficient of absolute risk aversion” or Arrow-Pratt coefficient. On its basis it is possible to acknowledge that risk premium PR of EIA is equal to half of the product of the existing operating risk, which is expressed by uncertainty with regard to the actually obtained volume of output (sales), which is measured by dispersion of this value and subjective degree of risk aversion, defined by the absolute risk aversion coefficient. This coefficient may be taken as an index to define operating risk of EIA: If $EOL'(\overline{X}) = -\dfrac{m * F}{(m * \overline{X} - F)^2}$, $EOL''(\overline{X}) = -\dfrac{2 * m^2 * F}{(m * \overline{X} - F)^3}$, the risk aversion coefficient, as the ratio of these values is equal to: $\dfrac{2 * m}{m * \overline{X} - F}$. The coefficient shows that volumes of output in proximity to the breakeven point (*BEP*) are related with the highest operating risk of EIA and, consequently, “work” around the breakeven point entails high risk aptitude or, which is identical, low degree of risk aversion. This formula also implies that at the breakeven point, this coefficient has an infinitely large value and its value decreases as the volume of output of EIA increases.

In order to carry out an analysis by the methodology proposed (Fig. 2), it is essential to provide monitoring of the dynamics change of the resulting indices of EE [6], considering their interrelation, i.e. on the basis of evaluation of new technology impact on economy of an enterprise. As mentioned before, this can entail labor productivity growth and lower wages expenses. If labor productivity grows faster than cost rates on technology operation and maintenance, the prime cost will go down and vice versa. Consequently, in order to take economically competent decisions when choosing certain technology to implement, it is not enough to be limited to the analysis of investment EE. So, the complex method of EE assessment of EIA, presented in Fig. 2, is aimed at the analysis of internal economic results of modernization and innovation implementation at an enterprise.

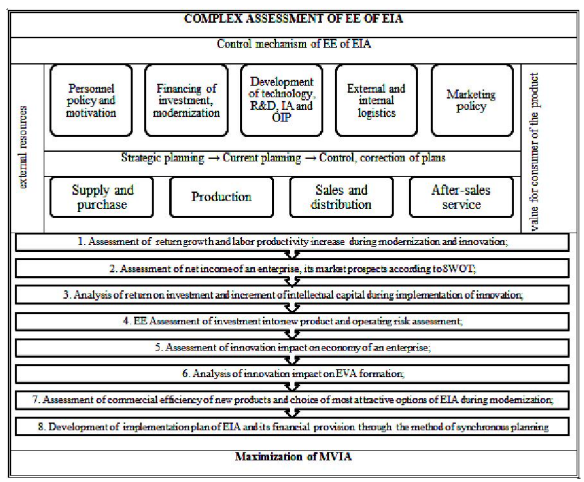

Fig. 2. Complex model of EE assessment of EIA and calculation algorithm

Key indices of investment return of new product or modernization program: increment of intellectual capital, return on investment and increase of sales revenue from new product, net income, labor productivity increase, increment of economic value added and competitive recovery of the enterprise. Efficiency assessment of EIA, choice and formation of investment plan during modernization of an enterprise have to be within the context of the following condition: **EVA > 0**, value increment (V) is maximal [7]. When analyzing impact of new technology on economy of an enterprise, the basis for comparison can become economic data before implementation of EIA in the business entity as a whole. In order to assess the impact of improving technology it is reasonable to carry out a comparison study and compare indices directly for the innovation company area. Results, obtained on the basis of these indices, can be both optimistic and pessimistic. So as to choose the optimum direction for innovation development and take a final decision about attractiveness of new products, it is worth to consider the dynamic analysis of these indices and do calculations of synchronous investment and financial planning by the Albach model [8].

In order to increase EE of management of an industrial enterprise it is possible to apply the model of synchronous investment and financial planning or one-stage multi-period Albach model, according to the developed methodology. This model considers the goal of "maximization of the total value of the capital of investment and financial program". With the help of liquidity conditions, financial balance is guaranteed for all accounted projects for the planned period. The enterprise's own funds for modernization of the investment objects (hereinafter – objects) are limited. For each program of production, a certain quantity of manufacture (new) products of each type is set in such a way so that the total quantity of products does not exceed the quantity of sales (marketing plan) [9].

The goal function of an industrial enterprise's value maximization accounts for weighted average value of the cost of capital, which ensures reality of conditions. At the same time, in order to elaborate the financing plan of investment measures for modernization of production, the following conditions have to be complied with:

1. "Realistic" or "similar" alternative options of development and modernization pan are suggested, which can be implemented by the beginning of the planned period in the course of modernization program implementation [10]. Future investment projects and planned financial sources are included totally only provided that there are future investment and financial possibilities, which comply with the predetermined interest rate. I.e. efficiency spread is (r_e - WACC)>0, where r_e – enterprise's own capital return on new investment.

2. The quantity of product types, manufactured by a certain investment object, and maximum volume of their sales can definitely be referred to a certain period or point of time.

Let us characterize variable parameters. Herewith, an important condition has to be mentioned: «payment row of investment objects and object to be financed is represented as *negative* balance of payment", according to the traditional representation of the Albach model:

Variables: x_j = number of units of investment object j (j=1,…,J); y_i = volume of use of the financed object i .

Parameters: $a_{j\tau}$ = negative balance of payments per unit of an investment object j at the point of time τ (τ =0,1,…,T); $d_{i\tau}$ = negative balance of payments per unit of the financed object at the point of time τ ; c_j = cost of capital per unit j of the investment object; v_i = cost of capital per unit i of the financed objet; E_τ = enterprise's own funds available at the moment τ ; X_j = maximally implemented j units of the investment object; Y_i = maximally implemented volume i of the financed object.

Objective function:

$$\sum_{j=1}^{J} c_j x_j \quad + \quad \sum_{i=1}^{I} v_i y_i \quad \Rightarrow \max \tag{5}$$

Where $\sum_{j=1}^{J} c_j x_j$ - value of the cost of investment capital; $\sum_{i=1}^{I} v_i y_i$ - value of the cost of the capital of financial measures. Total cost of capital on investment and financial programs have to be maximized.

Liquidity conditions:

$$\sum_{j=1}^{J}\sum_{\tau=0}^{t} a_{j\tau}\cdot x_j \quad + \quad \sum_{i=1}^{I}\sum_{\tau=0}^{t} d_{i\tau}\cdot y_i \quad \leq \quad \sum_{\tau=0}^{t} E_\tau \tag{6}$$

Where $\sum_{j=1}^{J}\sum_{\tau=0}^{t} a_{j\tau} x_j$ - at the point of time t negative balance of payments of investment objects;

$\sum_{i=1}^{I}\sum_{\tau=0}^{t} d_{i\tau} \cdot y_i$ - at the point of time t negative balance of payments of financed objects; $\sum_{\tau=0}^{t} E_\tau$ - at the point of time t enterprise's own funds.

For every term t (t=0,1, ..,T) it is necessary to ensure that total value of the negative balance of payments from investment and financial activities does not exceed the value of enterprise's own funds. If the latter ones are interpreted as incomings, a rule comes into force, which says that the total amount of incomings at a certain point of time should exceed or be equal to payments.

Conditions of the project: $x_j \le X_j$ *, for j = 1,...,J;* $y_i \le Y_i$ *, for i = 1,...,I;* $x_j \le 0$ *, for j = 1,...,J;* $y_i \le 0$ *, for i = 1,...,I.*

Total number of all investment objects j, as well as the use of all financed objects i should not be negative or exceed the upper limit.

Conclusion

So, internal complication of the problem of economic efficiency management of an enterprise in the process of its development and modernization, introduction of new information technology and intellectual property objects is conditioned by the lack of analogues for definite industrial conditions. In order to solve the problem of economic efficiency boosting, it is essential to consider various combinations of conditions and factors, as well as presence of feedbacks in the mechanism of economic efficiency management, including the need for collection and timely assessment, processing, correction of a large amount of information, which results in problematic situations that require detailed analysis in order to take the most efficient management decisions. However, methodology of EE management requires solving the problems that correspond to the aforementioned characteristics and features. This conditions development of relevant tools for complex assessment of economic efficiency of capital investment into modernization of production, makes it necessary to use an economic mechanism for justification of system innovation efficiency. At the same time, application of "common practice for assessment of commercial projects efficiency" negatively affects the efficiency parameters of management mechanism of an enterprise with implementation of new technologies, introduction of R&D, technology modernization.

The article provides a control mechanism for EIA on the basis of the value maximization mechanism, which provides EE of EIA from the standpoint of creation of long-term value for owners (increment of economic value added), assessment of new product utility for end-users plus internal operating efficiency, motivation and training of personnel, development of production activities [11]. This, eventually, helps to increase competiveness of an industrial enterprise, i.e. capacity of the enterprise for adaptation of new ideas, provision of its management flexibility in constantly changing economic conditions, orientation on constant improvements. There have been developed and elaborated models of system innovation control with practical relevance: model of production cycle decrease due to technological innovation, model of investment distribution into production innovation.

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