Methods of Choosing an Optimal Portfolio of Projects

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SUMMARY

This paper presents an analysis of existing methods for a portfolio of project optimization. The necessity for their improvement is shown. It is suggested to assess the portfolio of projects on the basis of the amount in the difference between the results and costs during development and implementation of selected projects and the losses caused by non-implementation or delayed implementation of projects that were not included in the portfolio. Consideration of capital and current costs components are required for the portfolio of projects efficiency calculation. An optimization model for a portfolio of projects is developed. Consideration of social and economic factors that contribute the integral assessment of the portfolio of project and methods for their calculation are proposed.
Keywords: project; portfolio; economic evaluation; reallocation of resources; interim results; comprehensive studies; probabilistic factors.
Journal of Economic Literature (JEL) codes: C2, H43, O22
DOI: http://dx.doi.org/10.18096/TMP.2016.03.04

INTRODUCTION

The present stage of the scientific and technological development is characterized by attempts to create a system of innovations. As a rule, one organization simultaneously develops a number of projects. Priorities in choosing the portfolio of projects are the selection and implementation of projects that will bring the biggest profit with the smallest possible expenses and minimal risks, as well as those that will facilitate a solution to the specific social and economic tasks.

ANALYSIS OF EXISTING PUBLICATIONS

The driving force of the knowledge-based economy is complex innovations. However, their effectiveness is currently assessed mainly on individual projects, making it difficult to choose optimal solutions. This approach is observed in the majority of published research. At the same time, a number of workshave been published that to some extent consider the problem. For example, Kozachenko & Mitin (1986), analyze the problems of effectiveness of relevant systems. The authors calculated the effectiveness due to its influence on labor efficiency and reliability. However, achieving the highest performance is not always rational in a market-based economy. This is due to circumstances such as limited demand for goods and services, and the fact that the introduction of innovation may temporarily decrease the performance.

In the economic assessment of machine reliability, Kozachenko & Mitin do not pay attention to calculating losses that occur during the failure of technology. There is no composition of costs and methods of their calculation, making it difficult to calculate the effect. However, the main lack is that their work does not take into account special aspects in determining the effect in market conditions. In particular, these are changes in demand for the product throughout its life cycle (PLC) and, consequently the volume of sales, profits, etc.

In a well-argued manner, Bulgarian scientists led by Stefanov made recommendations set out his book (Stefanov et al. 1975). They consider the programmed approach as a special variety of results based on common organizational, economic and social factors that form management integration. This improves the planning, coordination, organization and stimulation of innovation. They emphasize the need to consider the growth of intermediate results at each stage of the development of innovation. Yet, losses may also occur. The authors examine the final effect of programs as a national economic indicator based on reduced annual costs. However, in our opinion, this index should not be generalizing for market-based conditions. Changes in given costs cannot be considered as net income either by the manufacturers or by consumers. Modification of this index in the form of international value may be applied only to calculate the effect of the previous manufacturer's innovation. Composition of results and the costs together with methods of their calculation are not provided in the book. Such comments also apply to proposals for the calculation of the multiplier effect.

Behrens & Havranek (1995) proposes the allocation of resources between projects. However, the authors do not provide relevant recommendations and do not discuss the methods for calculating the effect of portfolios.

Shefrov (2003) publishes interesting results. The DASPU system developed at the Vladimir Institute (Russia) allows making recourse optimization in multi-project management of projects. However, it does not considered how selection of the most effective projects in conditions of limited resources can be carried out, or how minimal losses of possible projects' outcomes that are not brought into the portfolio can be made.

Ukrainian scientist V.P. Solovev in his monography (2006) considers the methodological basis of the system evaluating the effectiveness of innovation. He proposes calculating the total effect as the sum of its different types. In our opinion, this does not seem to be the best solution, because there are different types of impact effects on each other.

Meyer (2003) suggests a "process-oriented analysis of profitability." It can assess the impact of each business process on the final results of the companies' activity. However, profitability is not a summary measure of evaluating the effectiveness of innovation.
Analytical optimization methods are especially multi-criterial, as given in particular in Matveev et al. (2005), are very difficult in practical use. Other optimization methods such as scoring and graphic patterns may be applied.

The essence of scoring models is the requirement to provide the maximum amount of rating projects in the portfolio at the existing level of resources (Illarionov & Klimenko 2013). This method is to some extent subjective, because experts provide the corresponding estimates. In addition, the ranking of projects does not include restrictions on finance, relationships between projects, etc. Therefore, a scoring model should be considered as one of the portfolio optimization tools together with other methods of solving this problem.

A similar conclusion may be attributed to graphical methods of portfolio optimization. They give visual form to the management of the project team relationship between the selection criteria for each portfolio. Nevertheless, the human factor includes a certain amount of subjectivity. Unfortunately, the official document (PMI 2008) does not give proper attention to determining the effectiveness of the portfolio of projects.

TARGET SETTING

An analysis of existing works of this area demonstrates the need for further development of the theory and practice on evaluating the effect of portfolio of projects. In our work, we primarily examine industrial projects, as industrial development is a key factor in improving the economic effectiveness of many countries. At the same time, general principles for evaluating the effect of a portfolio of projects may also be applied to determination of innovation projects in other fields of activity.

METHODOLOGY

For methodology, we use theory and methods associated with the efficiency of social production as well as with project management and strategic planning.

RESULTS OF RESEARCH

In view of restricted resources and limited time it is suggested to calculate the effect of a portfolio of projects as their greatest possible value on the basis of the difference between outcomes resulting from the development/implementation of chosen projects and losses incurred from the non-implementation or delayed implementation of other projects. This difference is evidenced in decrease and in loss of income caused by unimplemented or lately implemented projects, by – among other things – premature obsolescence of similar projects with regard to decreases in time necessary to make products, the amount of products made and sold, and in price per unit of products, etc. Additional effects of the use of intermediate outcomes resulting from the development of individual projects from the portfolio will also take place that can be used to develop other projects.

Based on similar grounds, it is possible to calculate the risk of portfolio of projects and optimize the allocation of resources among specific projects with the above factors taken into account.

Joint development of a portfolio of projects

The effect resulting from the joint development of a portfolio of projects involves the following components:

1. The use of intermediate outcomes obtained in the course of individual projects implementation and during the development of other projects. This influences:
   a. The reduction in time limits imposed on the fulfillment of portfolio of projects;
   b. The reduction of development expenses;
   c. The revision of implementation progress of a number of projects with regard to the possibility of their further improvement;
   d. The reduction in expenses for the use of various resources;

e. The speed-up of the production volume due to more comprehensive market research with consideration for the flexibility of production;
f. A superior organization of work by taking advantage of a project team and other means of the project management system;
g. The selection of the most effective alternatives of the project.

2. Improvement of resources distribution that affects quality increase and reduces the development terms. This improvement may be performed by using human, computer and other kinds of resources in the best possible way.

The above-mentioned advantages shouldbe calculated in the following manner.

Effect resulting from the use of intermediate results

A. An increase of income ΔП due to the reduction in time it takes to develop a portfolio of projects and to fulfill them ahead of schedule.

$$\Delta\Pi = \sum_{i=1}^{m}\sum_{t=1}^{T}\left(Ц_{1it} - C_{1it}\right)A_{it}\Delta A_i : \left(1+E_t\right)^t \qquad (1)$$

where $Ц_{1it}$ is the price of the product unit to be produced as a result of the implementation of the i^{th} project in year t, in euro/year; C_{1it} is the base cost of the production unit to be made as a result of implementation of the i^{th} project in year t, in euro/year; A_{it} is planned volume of production according to the i^{th} project in year t, in units/year; ΔA_i is an additional volume of production according to the i^{th} project, in year t, in units/; E_t is the coefficient of discounting, in relative units; t is the targeted year, in years; T is the number of years it takes to develop projects ahead of schedule, in units.

Similar advantages can be also calculated on the basis of an indicator of the real current value. The same considerations are also true for the identification of other items of results and expenses.

B. The reduction in expenses due to the use of intermediate outcomes.

$$\Delta З = \sum_{i=1}^{m}\sum_{t=1}^{T}\left(Зpi - Зфi\right)\cdot \Delta Ti : \left(1+Et\right)^t \qquad (2)$$

where $Зpi$, $Зфi$ are calculated and factual expenses on the implementation of the i^{th} project, respectively, in euro.

In this context, there is a reduction in both capital costs (due to the superior use of project-related scientific equipment) and current-specific depreciation costs, as well as conditional-constant costs.

C. Similarly to item A, calculations are made for the effects resulted from the most effective projects, from the monitoring over the implementation of individual projects and their revision, from better organization of work, etc.

D. The teamwork contributes also to improvement of the projects' quality, making it possible to raise the price for new products per unit of consumer value and to reduce expenses on the project development per unit of products.

E. The better organization of work in implementation of portfolio of projects, as compared to work on implementing one individual project, leads also to time reduction $Э_{\Delta T}$ necessary for measures such as the organization of tenders to find co-workers and for purchases of equipment, component parts:

$$Э_{\Delta T} = \sum_{j=1}^{n}\sum_{i=1}^{m}\Delta T \cdot Зn_{i1}\cdot n_j\left(1+H\right) - \Delta T' \cdot З'n_{j1}\cdot n'_j\left(1+H\right) \qquad (3)$$

where $Зn_{i1}$ is the hourly wages for taking respective steps according to the i^{th} project being implemented in the set of portfolio of projects, euro/hour; n_i is the number of respective steps of work being done, in units; H is the additional sum to the wedges, in %; ΔT is the saving of time it takes to fulfill work, in hours, $\Delta T = \sum t_{Oi} - \sum t_{\Pi i}$; $\sum t_{Oi} \sum t_{\Pi i}$ are the time it takes to fulfill work on the i^{th} project in the portfolio and taken alone, respectively, in hours.

Some additional time expenses to coordinate work on a portfolio of projects will be taken into account. They involve the following:

– $З'n_{j1}$ is the additional hourly pay on completion of measures taken under the portfolio organization of work, in euro/hours;
– n'_j is the number of respective steps of work being done, in units;
– $\Delta T'$ is the increase in time it takes to develop projects under a given organization of work.

F. The effect resulting from an improved level of unification and standardization of elements when developing portfolio of projects. It leads to a reduction in time while developing respective elements of a construction.

In addition to a decrease in wedges with extra charges, such a process involves the saving of energy and reduction in depreciation costs and fixed costs per unit of products. Savings take also place in developing production tools meant for making innovative devices.

However, some additional expenses will take place in developing a portfolio of projects, with a consequent decrease in the value of the above-mentioned effect due to the availability of additional work as compared to the

development of individual non-interrelated projects.
These expenses are caused by an increase in time with the following components involved:

1. More comprehensive marketing research to learn market needs for products under a portfolio of projects made by interrelation of individual projects. Expenses involved may be calculated by the same formulas as above and partly compensated by introducing incidental expenses at the rate of about 15-20% into a budget of the projects, as is implemented in practice in some countries.
2. Expenses on more sophisticated organization of work – the development of additional computer programs, planning of objectives, team work under the dual subordination in the case of a matrix system of management.

Losses incurred from non-implementation or delayed implementation of other projects

These will occur for projects that have not been included in the set of portfolio projects or for projects to be implemented later. The principal disadvantage will be observed in the loss of income due to non-implementation of such projects and non-availability of the sales volume. In this context, all the calculations are made with regard to probabilistic factors, the degree of risks in attaining desirable results, and the value of expenses.

The best results for developing the portfolio of projects will be identified through its optimization under the principle “profit-expenses”. The objective function of the optimization model determining the effectiveness of a portfolio of projects will look like

$$\sum_{j=1}^{m} \cdot \sum_{i=1}^{T} \frac{NCV_j}{(1+E_t)^t} \rightarrow max, \qquad (4)$$

where NCV_i is the net current value of the development and implementation of the portfolio of project in the i^{th} year, euro/year.
When constraints,

$$\sum_{i=1}^{T} \sum_{i=1}^{m} \frac{Д_t}{(1+E_T)^t} > Д_{лім} \qquad (5)$$

where $Д_i$ - the amount of money needed for the project in the i^{th} year, euro/year; $Д_{лім}$ - the maximum possible amount (limit money) to implement portfolio of projects, euro.

$$\sum_{i=1}^{T} \sum_{i=1}^{m} T_i > T_{\lim} \qquad (6)$$

where T_i – deadline (term) of the i^{th} project, years; T_{lim} – maximum permissible (limited) deadline of portfolio projects, years.

Social and economic factors are taken into account along with financial factors when selecting projects. Only on this basis, the overall project selection is performed when forming the portfolio. Efficiency of social and environmental criteria, as well as financial and economic efficiency, the degree of compliance with the final results of the process of achieving this goal. These criteria describe how far the implementation of innovations moves the society towards achieving social and economic goals of development. In value measurement, evaluation of social and environmental effectiveness is similar to financial and economic efficiency, but the social-environmental effect is wider. It also includes the impact of working conditions on the performance of companies and organizations, both production and non-production. The difficulty is that categories such as health of workers, their performance, content and attractiveness of work performed by labors cannot always be directly measured in value terms.

In this regard, social and environmental results may be expressed in terms of cost parameters indirectly using natural indicators. The economic effect of the social and environmental measures in the sphere of material production is the growth of net production or profits. For example, the growth of net production $\Delta ЧП$ by improving efficiency of workers is calculated by the formula:

$$\Delta ЧП = n_p \Delta B \cdot B_r \qquad (7)$$

where n_p - number of employees that influenced the improvement of social factors on productivity growth for the year; ΔB - the average individual increase output per worker by raising its efficiency, relative units; B_r - the annual output per worker, thousand UAH.

In this area as well, the effect is found as a reduction in production costs. In the non-production sphere, it is a saving economy on implementation and services provision, while in the private consumption area it is a reduction of cost from personal funds of the population. Monetary indicators may be used to calculated the effects of such an important social task as the creation of new jobs. It will occur at the expense of the following components for entrepreneurship and business entities.

The increase in profit per employee is calculated by the formula:

$$ПР_1 = \sum_{t=1}^{T} \frac{ПР_t}{n_t}, \qquad (8)$$

where $ПР_t$ - the total value of profit collected by entrepreneurship entity in the t^{th} year, thousand UAH; n_t - number of employees in the t^{th} year.

Reducing the value conditionally-constant costs per unit $\Delta C_{УП1}$ because of the work of one laborer at a newly created working place is defined as

$$\Delta C_{УП1} = \sum_{t=1}^{T} \frac{Д_{УП} B_{Pt} (1-P) B_{P1t}}{B_{Pt}} \quad (9)$$

where $Д_{УП}$ - the proportion of conditionally-constant costs in production costs, %; B_{Pt} - output (sales volume) business entity, thousand UAH; P - the profitability of production at the enterprise, the company, %; B_{P1t} - output per worker in the t^{th} year, thousand UAH per person. The last value is determined by the formula

$$B_{P1t} = \frac{B_{Pt}}{n_t} \quad (10)$$

In general, the benefits of creating one working place are $B_{P1} = П_{P1} + \Delta C_{УП1}$.

The costs involve calculating the value of the funds needed to create one working place. Their determination has some difficulties, because Ukraine does not have relevant standards. According to the study of foreign sources, it was found that the average cost of creating one working place K_1 in the EU countries is 15,000 euro. Given the specific reliability of this value, which was obtained from a representative sample over a period, it may be used in Ukraine. Under the current exchange rate in Ukraine (EUR 1 = UAH 29.4), it will be UAH 453,000.

Accordingly, the effect of creating a working place E_1 will be:

$$E_{1t} = B_{1t} - K_{1t} \quad (11)$$

The total value of the effect of working place creation in the t^{th} year, E_{Pt}, is defined as a range of effect of creating one working place on the number created in the t^{th} year. That is:

$$E_{Pt} = E_{1t} \cdot N_{Pt} \quad (12)$$

where N_{Pt} is the number of working places created in the t^{th} year.

In general, the valuation of social and environmental results caused by implementation of investments or innovation is defined as:

$$\Delta Э_i^t = R_{jt} \cdot a_{1jt} \quad (13)$$

where R_{jt} - value of individual j^{th} result in physical measurement of the scale of its implementation in the t^{th} year, relative units; a_{1jt} - valuation of units of individual i^{th} result in the t^{th} year, thousand UAH; $\Delta Э_i^t$ - valuation of a particular social result in the t^{th} year/thousand UAH.

When modifying several results (indicators) of the group:

$$Э_i^t = \sum_{j=1}^{K} \Delta Э_i^t \quad (14)$$

where k - number of indicators of social and environmental groups, relative units; $Э_i^t$ - total economic evaluation of social and environmental results for the j^{th} group of values (growth of net production, cost savings of the state social insurance budget, savings costs of the occupational safety and health budget, saving costs of the companies, etc.), UAH.

Overall, the integral evaluation of social and environmental results in the t^{th} year is determined as:

$$Э_{сэ}^t = \sum_{j=1}^{K} \sum_{i=1}^{m} Э_i^t \quad (15)$$

where m - number of groups used for calculation of social and environmental effect. Monetary value of the social effect $E_{соц}$ is also defined as:

$$E_{соц} = З_0 - З_2 \quad (16)$$

where $З_0$, $З_2$ - allowable expenses providing consumption of goods and services, with and without social benefits of the project implementation.

CONCLUSION

The above ideas are of a comprehensive character, contributing to an increase in the efficiency of innovative processes not only for specific organizations and businesses, but also for regions, industries and country as a whole, by choosing more rational methods of using the investment opportunities under conditions of limited resources.

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