



ECONOMIC ASPECTS OF PREPARING THE PRODUCTION OF A NEW PRODUCT

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Abstract:

Implementation of works on preparing production of new product should be justified by the positive evaluation of purposefulness, and structural, technological, organizational feasibility, as well as economic efficiency. The results of the latest evaluation are critical. Preparation of production of new product, even it is expedient and feasible, it should not be implemented if it is economically inefficient or has high risk of failure. In the article set out guidelines for the evaluation of economic efficiency and risk according to the features which are characteristic for preparation of production of new product. These features are related to the scope of work of construction, technological and organizational preparation, their duration and time of product life, as well as capital expenditure.

***Key words:** preparing the production of new product, evaluation of economic effectiveness and risk*

INTRODUCTION

Preparation the production of a new product, which relates to the work prior to the start of production and implementation of the manufacturing process, has the highest importance in whole production process, and it decide on the future of the product, as well as the cusscess of the company [4]. One of the primary determinants of this success is the economic efficiency of the implementation of the product to the production. As the preparation of production of a new product requires significant capital expenditures, the evaluation of the efficiency should be carried out as soon as possible, during the proper construction of production preparation, within technical and economic assumptions, and preliminary technical project [5]. The aim of this assessment is to check, whether as a result of the sale of the product will be obtained revenues that will cover current cost of production, but, which is most important, capital expenditures incurred in preparing of the production. In addition, important is to analyze, whether the economic effects delivered from the sale of goods will be proper to investments, at a certain level of risk. The results of the evaluation of the economic effects and the risk of their failure, are critical to continuing work on the preparation of a new product. Even in situations where the preparation of this production is expedient and feasible from technological, organisational point of view, it should not be implemented if the production of the product is economically inefficient or accompanied by a very high risk of losses and non-recovery of invested resources.

Evaluation of economic efficiency and risk, including the problem of selecting proper methods and evaluation criterias, were not described in literature. The article presents the considerations in this regards, which are the part of research directed to developing a model of preparation the

production of a new product in small and medium enterprises. Indicated solutions are the result of the literatures study and authors' own experience in the area of economic effectiveness evaluation and risk of project of preparation the production of a new product.

EVALUATION OF ECONOMIC EFFECTIVENESS AND RISK OF PREPARATION THE PRODUCTION OF A NEW PRODUCT

In the evaluation of economic effectiveness and the economic risk associated with the preparation the production of a new product, it is necessary to take into account the cash flow, which includes (Fig. 1):

1. Expenditures (capital expenditures and costs) incurred in the various stages of preparation the production of product [6], i.e.:
 - at the stage of preparation the construction of a new product, which includes scientific work and research in terms of product development, description of construction documentation, prototype preparing, a trial production, mass production, as well as supervision of the launch of mass production,
 - at the stage of technological preparation, which includes scientific work and research in terms of development of technological process, description of technological documentation, technological preparation of the prototype, a trial production, mass production, as well as technological supervision of launch of mass production,
 - at the stage of organizational preparation, which includes scientific work and research in terms of development of organizational methods, description of organizational documentation, and coordination and monitoring conduct of construction and technological preparation the production.

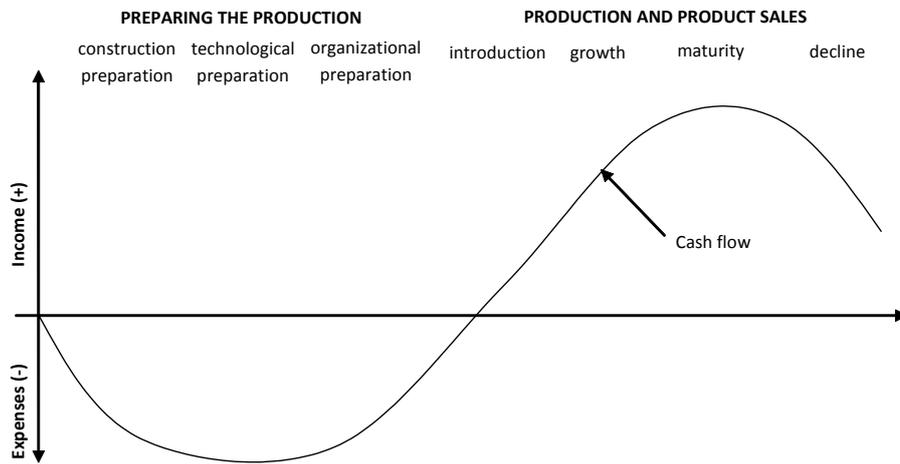


Fig. 1 Typical cash flow in the stages of preparation of production of new product and its life cycle

2. Expenses (costs) and revenues (revenues) resulting from the production and sale of the product, in particular stages of its the life cycle [3], i.e.:

- at the market introduction stage, which include the period of acceptance of the product and slow growth of its sales, where, at the beginning, costs may be slightly higher than revenues,
- at the growth stage, which include the period of sales increase, where profit growth,
- at the maturity stage, which include the period of slowing growth of sales and profits,
- at the decline stage, which include the period of significant decline in sales and profits.

Presented considerations are simplified, because only the basic elements of revenue and expenditure were included. In addition it is assumed, that capital expenditures are incurred only during the preparing of production of a new product, and in practice it may happen that they are also spend later – in a mass production and in sales, eg. for repair used/depreciated equipment, which are necessary for production.

In order to determine how to evaluate the economic effectiveness and risk should be indicated the features of preparing the production of a new product and the life cycle. These features are related to nature, scope, size of necessary capital expenditures and sources of financing of preparing the production of new product, as well as the length of the period of its implementation and life of product on the market. Because of these features, two types of preparing the production of new product, were pointed out:

1. Characterised by:

- low level of innovation of preparing the production of a new product (modernization – a slight upgrading of product structure, technology of its production or organizational improvements), which does not require research and development work,
- a small range of work on the preparation of construction, technology and organizational,
- a relatively short period of preparing the production and life of the new product,
- low capital expenditure for preparing the production, which are financed mainly by own capital.

2. Characterised by:

- high level of innovation of preparing the production of a new product (in terms of construction of product, technology of its production and organizational

improvements), which require research and development work,

- significant scope, involving many interrelated construction, technological and organizational work,
- long (even few years) period of preparation the production and life of product,
- the necessity of spending relatively high capital expenditures, which can be funded from many own and foreign sources.

Generally it can be said, that highlighted types of preparation the production are related to the size of enterprises [6]. The smaller enterprise, the less often research and development work is done, and innovation are from owner and employees intuition, from the fairs and exhibitions, and the customer needs. Launching a new product in small enterprises, usually is a result from a specific customer order, characterized by short-term contract, which affect to relatively small scope of work and short period of preparation the production, and life cycle. Capabilities of production of product with a very high level of innovation in a small enterprises, often are limited by owned production capacity (available machines and tools – including IT technology), as well as financial capital. This financial capital is mostly limited to two sources – dominated by own capital, which is often supplemented by lease or loan. Average, and large enterprises have the financial and human resources (special organizational departments) to carry out research and development work, which are the main source of innovations, not only in construction, but also in preparing a prototype or mass production, and a new methods, which supports organizational preparation of production. Access to many financial sources allows these enterprises to buy modern machines and tools, needed to produce innovative product. The significant scope of construction, technological and organizational work, prolonging preparation the production of new product, and sales of product is a result of long-term contracts – for a long life of the product.

Pointed out features of preparing the production of a new product determine the choice of methods and criteria of evaluation of economic effectiveness and risk. In general it can be said, that 1 type of preparation the production of a new product, realized mainly in a small enterprises, should be evaluated by simple methods. These methods, called static, are based on the nominal values of cash flows from the selected period of time (e.g. one year) and do not take into account the change of value of money over time.

There is a lot of static methods, which have different conditions of use [1]. Taking into account conditions and features assigned to 1 type of preparation the production, assumed that to its evaluation, the best is to use the account of profit and profitability.

The profit account allows to evaluate economical effectiveness of preparing the production of a new product in cash, in established period of time (e.g. PLN/year), based on account:

$$Z = E - K \quad (1)$$

where:

Z – profit from sales of product in period of time,

E – revenues from sale,

K – total costs.

Revenues from sale should be calculated by using:

$$E = C \cdot P \quad (2)$$

where:

C – unit selling price,

P – volume of unit sales.

Total costs should be calculated by using:

$$K = K_k + K_o \quad (3)$$

where:

K_k – costs of capital,

K_o – operating costs.

Costs of capital should be calculated by using:

$$K_k = \frac{N - R}{n} \quad (4)$$

where:

N – capital expenditures to preparing the production of a new product, together with expenditure on the purchase of necessary machines and tools,

R – final value of machines and tools,

n – established period of product preparation and the life of product.

Operating costs should be calculated by using:

$$K_{op} = k_{wyn} + k_{mat} + k_{en} + k_{rem} + k_{poz} \quad (5)$$

where:

k_{wyn} – cost of salary with overheads,

k_{mat} – cost of materials, e.g. spare parts for machines, preservatives,

k_{en} – electricity costs, calculated based on installed capacity, effective working time of machines, unit price of electricity,

k_{rem} – cost of repairs,

k_{poz} – other costs, e.g. leasing/loan.

Implementation of work on preparation the production, is economically justified if $Z > 0$. When comparing alternative construction or technological scenario, the option with highest level of profit should be chosen.

Profitability account allows to evaluate economical effectiveness of preparing the production of a new product in percentage, based on account:

$$ROI = \frac{Z}{K_k} 100\% \quad (6)$$

where:

ROI – profitability indicator, other elements as earlier.

Implementation of work on preparation the production is economically justified if ROI is higher than required minimum level (e.g. the cost of capital, which finance the preparing the production). When comparing alternative construction or technological scenario, the option with highest ROI should be chosen.

2 type of preparing the production of a new product, implemented mainly in large enterprises, should be evaluated by using complex methods. These methods, called

dynamic, takes into account the changing value of money over time, i.e. based on real, updated value of cash flows. From many dynamic methods [1], [2] to evaluate 2 type of preparation the production of a new product, the best is to use method of net present value or internal rate of return. Due to the high level of innovation, high capital expenditure, and long term of preparation the production and product life, besides of economic effectiveness, should be also evaluate the risk of not receiving expected economic effects.

Net present value method, allows to evaluate economic effectiveness of preparation the production of a new product in cash units, based on updated net cash flows, associated with different stages of preparation the production and product life cycle, according to account:

$$NPV = NCF_0 + (NCF_1 \cdot a_1) + (NCF_i \cdot a_i) + \dots + NCF_n \cdot a_n \quad (7)$$

where:

NPV – net present value,

NCF_t – net cash flows (expenditure and cash flows),

a_t – updating factor,

t = 0, 1, ..., n – calculation period (in years), covering the period of preparation and life of product.

Updating factor, which show relative decline in the value of cash flow in the calculation period, should be calculated by using:

$$a_t = (1 + i)^{-t} \quad (8)$$

where:

i – discount rate, determined based on the cost of capital, which finance preparing the production of a new product, other elements, as earlier.

Decision to continue work on preparation the production is subject to the condition: $NPV > 0$. When comparing alternative construction or technological scenario, the option with highest NPV should be chosen. The exception is a situation, when evaluated options required different (value and period of time point). In such a situation, when comparing alternative construction or technological scenarios, the option with highest net present value should be chosen. It is calculated by using:

$$NPVR = \frac{NPV}{PVI} \quad (9)$$

where:

NPVR – Net Present Value Ratio,

PVI – discounted value of capital investments.

The IRR method is based on the results of NPV method and allows to evaluate the economic effectiveness of preparing the production of new product in percentage, by using:

$$IRR = i_1 + \frac{NPV_1 + (i_2 - i_1)}{NPV_1 + |NPV_2|} \quad (10)$$

where:

i_1 – level of discount rate, where $NPV > 0$

i_2 – level of discount rate, where $NPV < 0$

NPV_1 – NPV level calculated based on i_1

NPV_2 – NPV level calculated based on i_2

Implementation of works on preparation the production is economically justified if IRR is higher than the required minimum level (e.g. cost of capital), When comparing alternative construction or technological scenario, the option with highest IRR should be chosen.

Study *the scenario analysis* require to identify key risk factors, which are associated with the preparation the production of a new product and its later production and sales, which have impact on economic effects. These factors often determine level of capital expenditure on preparation the

production, operating costs, product price, and sales volume. Quantify the possible impact (favourable and unfavourable) allows to develop scenarios of net cash flow in different stages of preparation the production, and product life cycle.

Procedure of risk evaluation, during the scenario analysis requires the implementation several stages.

In the first one, scenarios are assigned a specified probability of occurrence. In the second one – should be calculated expected value of net cash flow for each unit of time (usually a year) in calculation period, which include stages of preparation the product production, and product life, by using:

$$E_t = \sum_{j=1}^u D_{tj} * P_{tj} \quad (11)$$

where:

E_t – value of expected net cash flow in unit t ,

D_{tj} – i -th level of net cash flow in unit of time t ,

P_{tj} – probability i -th level of net cash flow in period of time t ,

$j=1, 2, \dots, u$ – number of tested levels of cash flow (number of scenarios),

t – calculation period.

As the next step should be set up the level of factor, reflecting economic efficiency (measured by NPV), which is the expected value, calculated based on:

$$\mu NPV = \sum_{t=1}^n \frac{E_t}{(1+i)^t} \quad (12)$$

where:

μNPV – expected value of NPV, other elements as earlier.

It should be also determine the level of risk, characterizing the dispersion of the probability distribution of NPV, which is standard deviation, calculated based on:

$$\sigma NPV = \sqrt{\sum_{t=1}^n \frac{\sigma^2_t}{(1+i)^{2t}}} \quad (13)$$

where:

σNPV – standard deviation NPV,

σ^2_t – net cash flow variance, other elements as earlier.

Net cash flow variance is calculated based on:

$$\sigma^2_t = (D_{tj} - E_t)^2 P_{tj} \quad (14)$$

Decision to continue work on the preparation the production is subject to the condition: $\mu NPV > 0$. σNPV factor shows the level of risk. The higher level of deviation, the higher risk.

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When comparing alternative construction and technological scenarios, can happen situation, when a higher expected value is accompanied by a higher standard deviation. In such a situation, scenario with lowest coefficient of variation should be chosen. It is calculated by using:

$$CV_{NPV} = \frac{\sigma NPV}{\mu NPV} \quad (15)$$

Scenario analyses, is not the only method, which can be used to evaluate the risk. Getting the most accrued results of the evaluation, allows to use Monte Carlo simulation [2], which provides informations regarding expected economic impact (μNPV), the statistics of the distribution (σNPV) and the probability of desired value of effects.

CONCLUSIONS

Presented in this article theoretical guidelines, are the basis for the economic evaluation of the effectiveness and risk of preparation the production of a new product. This evaluation allows, at the stage of construction work, getting answer to two important questions:

1. Whether, as a result of mass production and sales of product, will be obtained revenues, that cover cost of production and capital expenditures, which were incurred for its preparation?
2. Whether the economic effects, which are delivered from the sale of product, will be suitable for invested effort, at the certain level of risk?

Answers to these questions should be considered, when deciding to continue work on preparation the production and expending capital expenditures.

It should be emphasized, that from a theoretical point of view, to evaluate the economic effectiveness and risk is relatively easy, but in practice it is much more difficult, especially if preparing the production is innovative and complex, and takes long period of time, and requires high expenditures. There are relevant spreadsheets and simulation programs, to help evaluation. Examples of evaluation of economic effectiveness and risk of preparing the production of a new product, using these spreadsheets and simulation programs, will be presented in a separate article.

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