The Social Sciences 12 (2): 191-195, 2017
ISSN: 1818-5800
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# Management Analysis of Research and Development Costs

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**Abstract:** The study discusses the techniques of management analysis of research and development expenditures. It determinesthe features of the costsat the early stages of the product life cycle, discloses goals and objectives of the analysis, the analysis techniquesof budget costs in the context of responsibility centers, separate projects and cost items. The factors and the evaluation of their impact on the amount of costs are identified.

**Key words:** Expenses, research and development, cost analysis, preparation of production, responsibility center, projects, factor analysis

## INTRODUCTION

The costs of preparation of production are an integral part of total costs that is necessary to create a product with specific consumer characteristics and to bring it to the stage of industrial production. Efficiency of the product lifecycle depends on the quality of this stage (Fama and French, 1997).

Innovative product should be created in the most economical way. Therefore, at this stage it is necessary to conduct not only technical and economic analysis aimed at creating the most economical development object, but analysis of the costs forpreparation of production itself (Ford and Peng, 2015). Finding reserves to reduce costs at the stage of preparation of production, more efficient use of all resources, reducing the time of preparation and development of production while keeping to specified quality parameters of the object will be the goals of such analysis.

Existing methods of cost analysis of the enterprise are mainly limited to the costs at the production stage. Lack of comprehensive analysis of the costs at the preparatory stage does not allow to justify their value in planning, to objectively assess the loss of resources or their irrational use at various stages of development, to identify the factors and causes that influence the costs and to take necessary management decisions.

## MATERIALS AND METHODS

The preparation of production represents the initial stage of value creation which is advisable to allocate to a relatively independent functional area of the company as it has a number of features that influence the formation of the costs and effectiveness of their use:

- The end result is shown later in the process of production and operation
- No direct connection between the production and the planning period
- Mediating of links between R&D plans and plans for other areas of activity
- Uncertainty about "costs-benefit" ratio (Bagautdinova *et al*., 2014)

The close relationship and dependence between development costs, quality and the formation of the subsequent costs require special approaches to minimizing the cost of development and deployment of a product which should not lead to a disproportionate increase in costs at other stages or reduce the competitiveness of products. Therefore, we should not focus on minimizing costs but focus on optimization of the target function, i.e., it is necessary to take into account the costs of the subsequent stages of the product life cycle and to minimize the total costs for the entire product lifecycle (Wang, 2013).

Objectives and activities ininnovatingare planned in the process of budgeting. Peculiarities of R&D planning are shown in the following. Quantitative ratio between inputs and outputs are rather vague. R&D costs are determined solely by the decisions madewhile the majority of the costs cannot be often changed in the long term; controlling costs on a "cost-benefit" basis cannot be fully used for the ongoing assessment of the effectiveness of R&D because of its special nature. The result at this step is usually not seen or cannot be measured quantitatively. Therefore, control should be directed primarily to the implementation of the budget (Nesterov *et al*., 2015).

At the stage of budget preparation the analysis should include economic justification of activities to

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choose the most appropriate from them. Cost analysis of preparation of production is designed to evaluate the effectiveness of operations on creation and development of new products and the degree of R&D budget implementation by type of costs, milestones and divisions. The analysis should address the following challenges:

- Assessing costs for preparation of production for the whole company and separate projects
- Defining the cost structure of separate design stages
- Identifying deviations of actual costs from the planned level indicating the possible causes
- Performance assessment of the units that are responsible for creation and development of new products
- Determining the influence of innovation activities on company performance and its strategy

An independent object of analysis should be the consumption of resources at every stage of the project. There is a close relationship and interdependence between the steps that must be taken into account in the analysis of costs. For example, cost overruns at one stage could lead to lowering costs of the subsequent stages which will require reallocation of funds so "sliding" planning must be applied which takes into account the results of previous stages. Results evaluation of each stage must be attended with the previous stage results and the total cost of the product lifecycle. It is necessary to evaluate the implementation of the budget and the results obtained at each stage in order to make timely adjustments in the estimates of subsequent stages, avoiding the excess of funds for R&D as a whole. Moreover such an analysis is needed to identify the causes of budget deviations of actual expenses and evaluation of the results of each cost center and responsible executives.

## RESULTS AND DISCUSSION

Each center plans its budget based on the costs of the planned work in the center for calendar yearwith the restrictions that are put by R&D budget for the whole company. The analysis of the implementation of the expenses budget according to responsibility centers and typical phases is presented in Table 1.

Analysis of costs deviationsby the responsibility centers and steps should be detailedaccording toseparate projects and the work performed in the analyzed period and cost items. This will help to identify projects and types of expenditure which overspent or saved the budget and consequently to identify more specifically the causes of possible deviations and reserves to reduce costs. Such an analysis should be carried out during the operational budget analysis for each responsibility center. Cost analysis for separate projects is presented in Table 2.

Since projects development could last more than a year, the costs should be shown for the current period and cumulatively since the beginning of the project development (Safiullin *et al*., 2014). Comparing deviations during the reporting period and since the start of development, we can state undesirable trends in the growth of negative deviations.

Cost analysis of project allows, on the one hand, to determine the excess expenditure or savings with regard to planned cost parameters and on the other hand, it should identify best practices for the use of available

Table 1: The analysis of the implementation of the expenses budget

| | Budget | | Actual | | Deviation | |
|---|---|---|---|---|---|---|
| Responsibility center (stage) | Thousand (rub.) | Percentage | Thousand (rub.) | Percentage | Thousand (rub.) | Percentage |
| Total costs for R&D including: | 1000 | 100 | 1200 | 100.0 | 200 | 20.0 |
| Research | 100 | 10 | 100 | 8.3 | - | - |
| Development | 400 | 40 | 470 | 39.2 | 70 | 17.5 |
| Pilot production | 250 | 25 | 280 | 23.3 | 30 | 12.0 |
| Technologic preparation | 200 | 20 | 260 | 21.7 | 60 | 30.0 |
| Development of production | 50 | 5 | 90 | 7.5 | 40 | 80.0 |

Table 2: Cost analysis for separate projects

| | Budget (rub.) | | Actual (rub.) | | Deviation (rub.) | |
|---|---|---|---|---|---|---|
| Indicators | For the reporting period | From the start of development | For the reporting period | From the start of development | For the reporting period | From the start of development |
| R&D costs in total including | 1000 | 1540 | 1200 | 1760 | 200 | 220 |
| Project 1 | 200 | 350 | 200 | 380 | - | 30 |
| Project 2 | 250 | 400 | 280 | 410 | 30 | 10 |
| Project 3 | 120 | 220 | 150 | 250 | 30 | 30 |
| Project 4 | 170 | 250 | 230 | 320 | 60 | 70 |
| Project 5 | 230 | 320 | 310 | 400 | 80 | 80 |

Table 3: The absolute budget deviation of the actual costs

| | Budget | | Actual | | Deviation | |
|---|---|---|---|---|---|---|
| Items of costs | Thousand (rub.) | Percentage | Thousand (rub.) | Percentage | Thousand (rub.) | Percentage |
| Materials | 150 | 15 | 150 | 12.5 | - | - |
| Special equipment for scientific and experimental work | 250 | 25 | 270 | 22.5 | 20 | 8.0 |
| Remuneration of employees directly engaged in the creation of scientific-technical products | 370 | 37 | 500 | 41.7 | 130 | 35.1 |
| Deductions for social needs | 140 | 14 | 185 | 15.0 | 45 | 32.1 |
| Operations outsourced | 60 | 6 | 60 | 5.0 | - | - |
| Other direct expenses | 10 | 1 | 15 | 1.3 | 5 | 50.0 |
| Overheads | 20 | 2 | 20 | 1.7 | - | - |
| Expenses in total | 1000 | 100 | 1200 | 100.0 | 200 | 20.0 |

Table 4: Total deviation from planned costs

| | | | | | | Including | |
|---|---|---|---|---|---|---|---|
| Projects | Planned costs (rub.) | Level of projects development (%) | Costsdue to development (rub.) | Actual costs (rub.) | Deviations from the plan (rubles) | Due to resource use (rub.) | Due to development (rub.) |
| 1 | 80 | 100 | 80 | 85 | 5 | 5 | - |
| 2 | 120 | 90 | 108 | 110 | -10 | 2 | -12 |
| 3 | 150 | 50 | 75 | 90 | -60 | 15 | -75 |
| Total | 350 | x | 263 | 285 | -65 | 22 | -87 |

resources, that is, projects with the appropriate level of information are estimated as the most successful from the point of view of the enterprise.

The total costsfor preparation of productionare necessary to analyzeby certain items of expenditure. Analysis should characterize the composition and structure of costs, identify their change in amount and in percentage as well as identify factors that influenced these changes (Sungatullina and Sokolov, 2015).

The composition and structure of costs is constantly changing under the influence of material and technical base, the organizational structure of science, labor processes. Therefore, the analysis focuses on the study of the costs structure as well as it reveals the absolute budget deviation of the actual costs as a whole and for each item cost (Table 3).

The analysis determines the factors affecting the value of budget deviations of actual costs as a whole and for each element separately. Such factors may be the degree of projects development and the deadlines, changes in unit costs for the project, the organizational and technical level of R&D and others.

Analysis of factors should begin with an assessment of the action plan by the scope and terms as they largely determine the actual costs as well as production efficiency and achieving development goals. The major objectives of the analysis will be.

Determining the structure of innovative activities, distinguishing the most labor-intensive projects; Assessment of the plan in terms of completed projects and actions, identifying partially completed or not started; Determining the causes of shortfalls in the plan and the development of measures to address them. When analyzing the scope of the planed innovative measures one should define changes in their structure for a number of years. This will determine whether the structure complies with progressive trends of technological progress as well as with the strategic policy of the organization (Bob *et al*., 2014). To conduct such an analysis it is necessary to group the innovative activities by areas. These areas include the degree of products novelty, its competitiveness, market share and other marketing features, innovative policy of the organization.

It is necessary to show the events that were scheduled to be completed in the reporting period but they were not fulfilled. Underfulfillment of the planned operations may be a cause for savings. However, these savings cannot be evaluated positively. This value should reduce budget costs for the coming year. When analyzing the timing of the activities it is important to identify the work done on time, early started, but not completed in time. These activities should determine the percentage of the work done, that is the level of preparedness. It is advisable to carry out such an analysisat separate stages of development as the overtime at one stage may overlap the early completion of work at the other (Zulfakarova and Kundakchyan, 2015).

In analyzing the activities whose implementation requires a relatively detailed timing, especially if they move on tothe next year, it is necessary to assess the implementation of the planned tasks both in real termsand value terms, i.e., in the estimated cost. Both the responsibility centers and the enterprise as a wholecarries out the analysis (Table 3 and 4 ).

Table 5: The change in cost depending on changes in the planned time of work scheme

| Kinds of operation | Duration of operation (days) | | Costs per time unit and plan (rub.) | Planned costs depending on duration of operation (rub.) | | Actual costs (rub.) | Deviations Due to change in the duration of operation (rub.) | Deviations due to the use of expenses (rub.) |
|---|---|---|---|---|---|---|---|---|
| | Plan | Actual | | Plan | Actual | | | |
| A | 20 | 18 | 200 | 4000 | 3600 | 4200 | -400 | 600 |
| B | 10 | 11 | 150 | 1500 | 1650 | 1600 | 150 | -50 |
| C | 13 | 13 | 120 | 1560 | 1560 | 1590 | - | 30 |
| Total | 43 | 42 | x | 7060 | 6810 | 7390 | -250 | 580 |

The analysis shows that the total deviation from planned costs amounted to 65 thousand rub (285-350). This deviation is primarily caused by the failure to perform the planned scope of work which led to savings of 87 thous. rub. (-12)-75). There is an overrun of 22 thous. rub (285-263) in the use of resources.

In justifying the cost of separate projects, great importance is given to time. Time parameters of the development process and development of new products largely determine the amount of costs at this stage and economic efficiency of the development. In order to control the parameters of time and expense, it is best to use the method of network planning. It is suitable for planning and monitoring the projects in terms of time, cost and profit (Nesterov and Neizvestnaya, 2014). To evaluate projects using network planning methods, the data on the occurrence of costs depending on the time are very important. Costs by operation are summarized in accordance with their structure. Thus, cost function for a sequence of operations is removed from the parameters of the work. Depending on the timing of the operations early or later start cost function curve will have a different shape. Therefore, there is a problem of time and cost ratioand the need to determine the optimal duration of the project by costs.

In terms of cost per operation and its duration ratio it is possible to distinguish two cases a constant hierarchy of time and expenses forone operation; variable dependence of time and cost per one operation (Ford and Peng, 2015). The first case determines constant duration and constant amount of costs corresponding to this duration. This ratiois illustratedin the graph (Fig. 1).

On the basis of a constant ratio of the cost and work time,one can determine the change in cost depending on changes in the planned time of work scheme (Table 5). Table 5 shows that the reduction in the planned timing of work scheme has led to cost savings of 250 thous. rub. while cost effectiveness caused overspending by 580 thousand rub.

Variable ratio of the time and cost per operationmeans different costs for different duration. The second case can be represented as a graph (Fig. 2).

The graph shows that the cost increases from the normal value ($p_{ij\,nor}$) to a maximum ($p_{ij\,max}$), if the duration is reduced from the normal ($t_{ij\,nor}$) to the minimum ($t_{ij\ min}$). Between these two points, the normal and maximum, costs curve is progressively increasing, for example, due to overtime. To optimize "time-cost" ratio, it is important that this ratio can vary. So, we can make assumptions about how the costs will increase if the duration of operation is reduced. Assuming a linear increase in costs between the points of time,one can calculate the average cost of speeding up of work (Cs):

$$Cs = (p_{ijmax} - p_{ij\,nor}) / (t_{ij\,nor} - t_{ij\,min}) \quad (1)$$

Reduction begins with a critical operation with the lowest average costs for the acceleration and continues until it reaches the lowest duration or a new (additional) operation becomes critical.

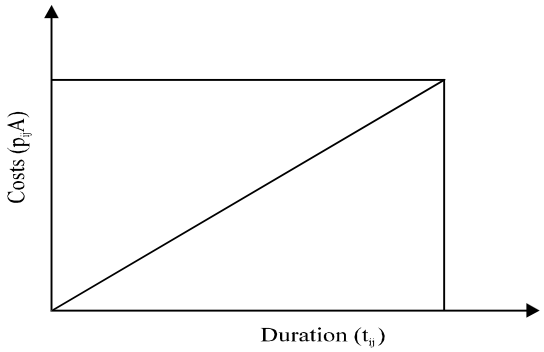


Fig. 1: Constant ratio of the duration and cost per operation

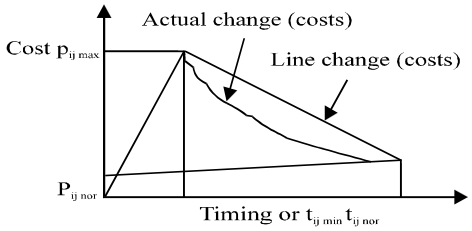


Fig. 2: The variable ratio between the duration of single operation and costs

## CONCLUSION

R&D analysis can justify the budget costs and evaluate its implementation in the context of responsibility centers, the stages of design and development, separate projects and cost items as well as identify the reasons for deviations. Special attention is paid to the impact of the volume of activities and the timing of their implementation on cost indicators. This allows to make management decisions for the effective use of available resources and to improve the efficiency of scientific and technological activities.

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