Development of Cost Analysis Process based on the Supply Chain Strategy

Vladimir Nikolaevich Nesterov[1], Dina Gennadevna Yankovskaya[2], Natalia Nikolaevna Kozlova[3]

[1,2]*Institute of Management, Economics and Finance, Kazan Federal University*
[3]*Analysis and Audit department at the Institute of Management, Economics and Finance, Kazan Federal University*

***Abstract*— This paper discusses the methodology of research and development costs analysis through the supply chain management. Peculiarities of costs formation at early stages of development life cycle are defined, aims and tasks of analysis, method of cost budget analysis in terms of responsibility centers, individual projects and cost items are disclosed. The supply chain management discipline suggests that information sharing is paramount when attempting to achieve cost reductions and quality improvements. Factors have been identified and impact of such factors on costs assessed. Special attention is devoted to the ratio between costs and results and to the ratio between costs and work duration. The analysis of plan and fact costs of separate projects is carried out in supply chain process and by examples of projects creation is considered. Besides that, the algorithm of average costs estimation through the determination of dependence between costs and work duration are presented by formula. The research identifies a theoretical model that can be used to explain the relationships and themes associated with supply chain costing and strategic decision making. Evidence suggests that there is some movement to implement managerial accounting techniques within these two industries to capture supply chain costing information. The results of this study allow to make decisions by supply chain managers for increasing of research and development work efficiency and for cost reduction.**

***Keywords*—** *supply chain strategy, research and development, cost analysis, center of responsibility, projects, factor analysis.*

1. Introduction

One of the important functions that manufacturing companies deal with in the field of supply chain management and related decisions that have a significant impact on their competitiveness is "supply chain order management". But in this direction, managers face issues such as a) choosing the best combination of orders received in the supply chain and b) determining the exact cost of an order. Due to these two important, in this research, two approaches of robust optimization and dynamic simulation are used to design a mathematical model of supply chain management of two parts used in the supply chain of cost management in company. The amount of production preparation costs is an integral part of the total costs required to create a product with certain consumer properties and bring it to the industrial stage of production. The cost-effectiveness of product lifecycle depends on the quality of this stage.

Innovation must be created by the most economical way. Therefore, this stage requires not only technical and economic analysis aimed at creating the most economical object of development, but also analysis of costs related to research processes and development of innovative products. Finding reserves to reduce costs at the stage of research and development of innovation, more rational use of all types of resources, reduction of time for preparation and development of production with achievement of specified qualitative parameters will be the tasks of such analysis.

Existing methods of enterprise's costs analysis are mainly limited to the costs of the production stage. The absence of a comprehensive cost analysis at the preparatory stage does not allow to justify the amount of cost in planning, to objectively assess the loss of resources or misallocation at certain stages of development, to identify factors and reasons that influence the costs formation and to make the necessary management decisions [1-3].

2. Research Methods

Research and development processes are the initial stage of value chain creation. It is reasonable to identify this stage as a relative independent functional area of the enterprise, as it is characterized by several features that influence on the cost's formation and the use efficiency of it. Such characteristics are:

the end result is shown later in the production and operation process; lack of a direct connection with process of production at the planned period; mediation of communications between plans of research and development and plans for other fields of activity; uncertainty concerning a ratio of "expense and results".

A close link and dependence between development costs, quality and subsequent cost generation requires special approaches to minimize product development and implementation costs, which should not lead to disproportionate cost increases at the other stages or

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

reduce product competitiveness. Therefore, it is necessary to say not only about minimizing costs, but about optimizing such costs for the target function, i.e. it is necessary to take into account the costs of subsequent stages of product life cycle and minimize the total costs for the product life cycle [4-8].

Innovation goals and activities are planned through budgeting. The features of R & D work planning are following:

quantitative ratios between expenses and results are rather not certain. R & D work costs are driven solely by decisions and most costs often unable to change over the long term;

control of expenses by the "expenses and results" method cannot fully be used for the current assessment of activity efficiency in the sphere of research and development owing to its special character. The result at this stage is generally not apparent or cannot be quantified. Therefore, monitoring should focus primarily on budget implementation.

The task of analysis at the budget preparation stage should be to justify the activities economically in order to select the best ones. The analysis of production preparation costs is intended to assess the work efficiency on creation and development of new products and the degree of implementation of the R & D budget in terms of individual projects, cost elements, stages and divisions. The analysis should meet the following challenges:

assessment of costs level of production preparation in general on the enterprise and separate projects;

determination of expenses structure on separate designing stages; identification of actual expenses deviations from planned level with the indication of the possible reasons of its emergence;

assessment of divisions' activity results, that responsible for works on creation and development of new products; determination of innovative actions influence on enterprise's activity results and achievement of its strategy.

The independent object of analysis should be the consumption of resources at each designing stage. There is a close correlation between phases that must be considered in the cost analysis process. For example, over expenditure at one stage can lead to lower costs at a later stage, that will require a reallocation of funds, therefore the moving planning that considers the previous stages results should be used here. The results evaluation of each stage should include the results of the previous stage and the product life cycle total costs. Budget implementation and results of each stage should be assessed in order to make timely amendments to the estimates for subsequent stages without exceeding the overall R & D work. In addition, such analysis is necessary to identify the causes of actual expenditure deviations from the budget and to assess the results of each cost center work and responsible employees [9].

3. Research part

Each center plans its own cost budget based on the planned works in this center for a calendar period, considering the limitations set by the R & D budget. The analysis of cost budget execution by cost center and standard stages is presented by Table 1.

Table 1. The analysis of cost budget execution

Responsibility center (stage)	Budget		The facts		Deviation	
	thousand rubles	%	thousand rubles	%	thousand rubles	%
Total research and development costs,	1000	100,0	1200	100,0	200	20,0
including:	100	10,0	100	8,3	-	-
Research	400	40,0	470	39,2	70	17,5
engineering	250	25,0	280	23,3	30	12,0
Development project	200	20,0	260	21,7	60	30,0
Model shop	50	5,0	90	7,5	40	80,0
Production tooling						
Plant development						

The analysis of cost deviations by cost centers and stages should be detailed by individual projects and activities performed in the analyzed period. This will allow to identify projects and types of expenditure for

which over expenditure or savings have been made, consequently, to identify more specifically the causes of deviations and possible cost reduction reserves. Such analysis should be carried out as a part of operational budget analysis for each responsibility center. The cost analysis for individual projects is shown by Table 2.

Table 2. The cost analysis for individual projects

Indicators	Budget		The facts		Deviation	
	During the reporting period	Since the beginning of development	During the reporting period	Since the beginning of development	During the reporting period	Since the beginning of development
Total R&D costs,	1000	1540	1200	1760	200	220
including:	200	350	200	380	-	30
Project 1	250	400	280	410	30	10
Project 2	120	220	150	250	30	30
Project 3	170	250	230	320	60	70
Project 4	230	320	310	400	80	80
Project 5						

Since the development of projects can last more than a year, the costs should be shown for the current period and as a cumulative result from the beginning of the project development. Comparing deviations during the reporting period and since the beginning of development, it can be noted the undesirable increase of negative deviations [10].

Project cost analysis allows, on the one hand, to identify the over-expenditure or savings of scheduled cost parameters and, on the other hand, to identify the best practices of draft on available funds, i.e. the projects that are assessed as the most successful from an enterprise perspective at the appropriate level of information [11].

Total costs should also be analyzed for individual cost items. During the analysis process it is necessary to characterize the composition and structure of costs, identify changes in sum and percentage, and to determine the causes that have influence on these changes.

The value and structure of costs changes due to the improvement of the material and technical base, organizational structure of the science sphere and the labor processes. Therefore, the analysis focuses on the cost structure and identifies the absolute deviations of actual costs from the budget as a whole and for each cost item (Table 3)

Table 3. Cost structure analysis

Cost items	Budget		The facts		Deviation	
	thousand rubles	%	thousand rubles	%	thousand rubles	%
1. Materials	150	15,0	150	12,5	-	-
2. Special equipment for scientific and experimental works	250	25,0	270	22,5	20	8,0
3. Remuneration of workers directly engaged in creation of scientific and technical products	370	37,0	500	41,7	130	35,1
4. Social contributions	140	14,0	185	15,0	45	32,1
5. Works performed by third parties						
6. Other direct costs	60	6,0	60	5,0	-	-
7. Overhead costs	10	1,0	15	1,3	5	50,0
	20	2,0	20	1,7	-	-
Total cost	1000	100	1200	100	200	20

During the analysis, the factors that have influence on the number of actual costs deviations from the budget as a whole and for each element are determined. Such immediate factors can be the degree of project development and compliance with the established deadlines, change of specific costs for the project, organizational and technical level of R & D work, etc.

The analysis of factors should begin with the assessment of execution of plan by volume and time because these indicators largely determine actual costs, as well as the achievement of production efficiency and development goals. At the same time, the main tasks of the analysis will be:

- determination of innovative actions structure and the most labor-consuming projects;
- assessment of plan execution by volume of the executed projects and actions, identification partially executed and unbegun projects;
- determination of underfulfilment of plan reasons and development of measures for elimination such reasons.

Analyzing the scope of innovation plan, it is necessary to identify changes in its structure over a few years. This will make it possible to determine the conformity of the structure with progressive trends in technological

progress, as well as with the organization's strategic policy. In order to carry out such analysis, it is necessary to provide a grouping of innovative measures by direction. Such directions may be the novelty degree of product, its competitiveness, market share, other marketing signs and directions of organization's innovation policy [4].

It is necessary to show the events that were planned for completion in the reporting period but remained underperformed. Underfulfilment of planned works can lead to savings. However, these savings cannot be assessed positively. The cost budget for the coming year should be reduced by this amount. When analyzing the due dates of actions, the works performed on time, ahead of schedule, but not completed on time are allocated. For these activities, it is essential to determine the percentage of work completed, i.e. the level of readiness. It is useful to carry out such analysis on separate stages of development, as the excess of time at one stage can be covered by early performance of works at the other stage [5].

4. Results

During the analysis of actions, the implementation of supply chain requires relatively detailed calculation of time, first of all moving to the next year, it is necessary to assess the progress of planned tasks not only in physical terms, but also in value terms, that is, at the estimated cost. This analysis should be carried out both for the responsibility centers and for the enterprise (Table 4).

Table 4. The assessment of plan execution

Projects	Planned costs	Project development level (%)	Costs including development	Actual costs	Deviation from plan	including	
						by resources	by development level
Project 1	80	100	80	85	5	5	-
Project 2	120	90	108	110	-10	2	-12
Project 3	150	50	75	90	-60	15	-75
Total	350	x	263	285	-65	22	-87

The analysis shows that the total deviation of -65 thousand rubles is caused by the failure the planned works, due to this fact the savings amounted to 87 thousand rubles, due to the use of project resources the over expenditure amounted to 22 thousand rubles.

In justifying the costs of individual projects, the time aspect plays a major role. The time parameters of development process and development of new products largely determine the value of costs at this stage and the economic efficiency of development. The best way to manage time and cost parameters is to use the supply chain networks. It is appropriate for planning and monitoring projects in terms of time, cost and profit objectives [2].

Time-dependent cost data is particularly important for the evaluation of projects by network planning methods. The work costs are summarized according to its structure. In this way, the cost function for one activity sequence is derived from the activity parameters. Depending on the early or late start work the cost function curve will take a different form. Consequently, there is a problem of ratio between time and costs and the need to determine the optimal cost duration of the project [6].

From a perspective of the ratio between costs per work and its duration, two cases can be distinguished: constant co-availability of time and costs per work and variable dependence of time and costs per work. The first case determines a constant duration and a fixed cost according to that duration. The figure 1 illustrates this ratio.

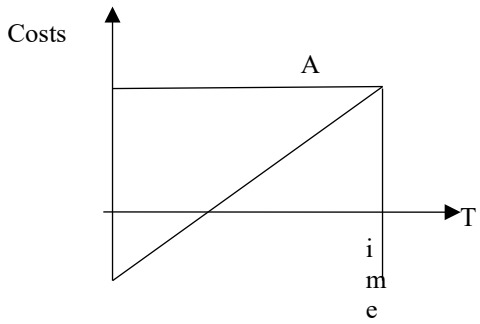

Figure 1. A graph of the constant ratio between time and costs per work

Based on the constant cost-to-time ratio per work we can determine the cost change depending on the change in the planned work time (Table 5).

Table 5. Cost changes depending on the planned work time change

Types of activity	Timing of works (days)		Plan costs per unit time	Plan costs based on activity duration		Actual costs	Deviations by changing activity duration	Deviations by using expenses
	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 data in table 5 show that the reduction of the planned due dates of works complex resulted in cost savings of 250 thousand rubles, while due to cost efficiency over expenditure of 580 thousand rubles was allowed.

Variable time-to-cost ratio per one work means various costs for different duration. The second case can be presented as a graph (Figure 2).

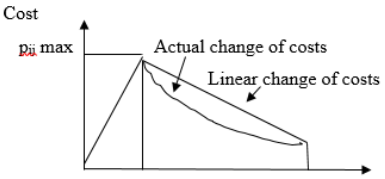

Figure 2. Variable ratio between work duration and cost

The graph shows that costs increase from the normal value (p_{ij} nor) to the maximum value (p_{ij} max) if the duration of operation is reduced from the normal value (t_{ij} nor) to the minimum value (t_{ij} min). Between these two points (normal and maximum) the cost curve increases progressively, for example by overtime work. To optimize the time-cost ratio, it is important that this ratio can change. So, we can make assumptions about how much cost will increase if work time is reduced. If we assume the linearity of cost growth between time points, we can calculate the average cost of accelerating work:

$$\text{Average costs} = (p_{ij}\ \text{max} - p_{ij}\ \text{nor})/(t_{ij}\ \text{nor} - t_{ij}\ \text{min}) \quad (1)$$

The reduction starts with critical work with the lowest average acceleration costs and continues until the lowest duration is reached or the new (additional) work becomes critical.

5. Conclusion

The analysis of research and development costs allows to justify budget costs and evaluate implementation of budget in supply chain process through the terms of response centers, design and development stages, individual projects and costs items. Besides that, such analysis makes it possible to establish the reasons of deviations [7]. Special attention in the methodology is paid to the analysis of the supply chain impact on the cost of such indicators as the volume of activities and the due time. This methodology allows to make supply chain management process that enable to effectively use resources and to increase the effectiveness of scientific and technical activities

6. Acknowledgements

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

References

[1] Dehghani, Nariman L., Yousef Mohammadi Darestani, and Abdollah Shafieezadeh. "Optimal life-cycle resilience enhancement of aging power distribution systems: A MINLP-based preventive maintenance planning." IEEE Access 8 (2020): 22324-22334.

[2] Kirpikov A.N., Atyunkina I.N. (2018). Imitation modeling for the purpose of formation of the optimum assortment sales policy. National academy of managerial staff of culture and arts herald, 2, 187-192.

[3] Kulikova L.I., Vetoshkina E.Yu. Nurgatin R.R. (2017). Intensity and efficiency analysis of assets use when monitoring the goodwill in the controlling system. Journal of Fundamental and Applied Sciences, 9 (1S), 20-31.

[4] Kulikova L.I., Nesterov V.N., Vakhotina D.A., Yakhin I.I. (2015). The Revision of Approaches to Innovative Analysis. Mediterranean Journal of Social Sciences, 6 (1 S2), 421-425.

[5] Neizvestnaya D. V., Kozlova N.N., Prodanova N. A. (2018). Application of CVP-Analysis at the Water Transport Organizations. HELIX, 8 (Is.1),2811-2815.

[6] Sabirova A.I., Khasanova S.F. (2015). Parameter Estimation of the Engel Curve using the Method

of Fuzzy Regression to Assess the Level of Welfare in the Republic of Tatarstan. Procedia Economics and Finance, 24, 550-556.

[7] SHigaev A.I., Sadykova Z.I. (2018). Raschet finansovyh rezul'tatov ot prodazhi produkcii v torgovoj organizacii pri primenenii metodiki upravlencheskogo ucheta avs-kosting. International symposium on management, economics and finance: collection of scientific papers, 135-138.

[8] Sungatullina L.B, Sokolov A.Y, Yankovskaya D.G, Kadochnikova E. I. (2018). Ways of performance improvement in petrochemical enterprise. Journal of Social Sciences Research, Vol.2018 (Is.Special Issue 5), 345-349.

[9] Voloshin, D. A. (2016). Metody raspredeleniya zatrat na peremennye i postoyannye. Ekonomicheskij analiz: teoriya i praktika. Moskva:IC RIOR, NIC INFRA.

[10] Yankovskaya D.G., Bikbulatov A.A., Kushakova A.A. (2019) The role of control procedures in terms of the formation of the income of the enterprise on the example of LLC “Mainfreight Rus”. Nauchnyj zhurnal Evrazijskij Soyuz Uchenyh (ESU), 3 (60),24-28.

[11] Kim, Bitna, and Paul M. Hawkins. "Who’s getting cited: Representation of women and non-white scholars in major American criminology and criminal justice journals between 1986-2005." International Journal of Criminology and Sociology 2 (2013): 306-321.