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Theory of Constraints in Value Based Cost Management

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Abstract: This article highlights the problem of setting value-focused cost management and implementation of Theory of Constraints in enterprise management. To do this, analysis statements of theory of constraints within the concept of relevance is made and pre-requisites for implementation of such statements are formulated. From the perspective of the value-based management, business process optimization mechanism is analyzed and an alternative model for calculating relevant costs is proposed. This study was made on the example of oil fields development process.

Key words: Theory of constraints · Value-oriented management · Concept of relevancy · Relevant alternative costs · Workflow

INTRODUCTION

Cost management is an important part of modern enterprise management and, as such, it should correspond to integrity concept. In other words, if management in whole aims to maximize enterprise value, then cost management should be value-oriented. Abstracting from the problems of choice of the value-oriented management model, in this study we will stick to the approaches of Solomon, Stern, Stewart and other adherents to residual income [1-3]. In this model one should pay attention to the fact that value maximization is possible by minimizing gross relevant costs at the same level of income. For simulation of such a function, particular interest has Theory of Constraints, the idea of which was presented in works of Goldratt, Fox and other great scholars [4-7].

Analysis of Statements of Theory of Constraints and Concept of Relevance: According to this theory, in every economic process, some resource (economic factor) is always scarce and all other resources are in excess. After eliminating scarceness of limiting resource, scarceness of other economic factors appears. The goal of management decisions using theory of constraints postulates is to optimize economic cycle. Unfortunately, cost characteristics of the optimization results are not yet defined clearly enough. Resolving this issue seems extremely important to us, as any methodology can be effectively adapted to costs management only after updating evaluation procedures to practical level. By analyzing theory of constraints from the perspective of the concept of relevance, we would like to draw attention to the fact that solutions offered within the framework of steps presented relate to production volumes. Relying on this fact as well as contents of the theory of constraints, let's generalize some of its conceptual statements that are essential from the point of view of this study:

In the first place, parameters relevance is expressed by their functional dependence on production volume. In other words, under this theory, important will be division of costs into fixed and variable values;

in the second place, production volumes are defined for each stage of the economic process. To do this, a business process is represented as an additive model, composed of individual production factors (sub-processes);

In the third place, each successive factor of an additive model has cumulative effect, directly and functionally dependent on operation of both factor and sub-processes preceding it;

In the fourth place, final maximum cumulative effect will have direct functional dependence on the power of the limiting factor, most often expressed in the form of production function (equation 1).

$$R_{\max} = f(x_{const}) \quad (1)$$

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Table 1: Conditional characteristics of stages of oil well the development

Stage No.	Content of stage, sub-process	Intermediate result of the process	Expected cost of the process, c.u.		Maximum power of the process in one planning period, units.
			Common constant value	Specific variable value	
1	Exploration of old and search for new oil fields	Petrolic sites	2,400,000	1,200,000	10
2	Preparation for drilling	Prepared drill site	1,000,000	800,000	6
3	Drilling	Wellbore	2,600,000	1,200,000	3
4	Well infrastructure development	Not perforated well	1,200,000	1,800,000	6
5	Well perforation	Perforated unprepared well	20,000	600,000	12
6	Well development and commissioning	Finished production well	300,000	100,000	12

whereas
Rmax is maximum final result;
f (xconst) is function of dependence of result on performance of limiting factor (xconst)

Such prerequisites should be implemented in cost management. However, many authors in cost management offer to start planning with determination of sales volume, i.e., make expected maximum final result dependent on sales volume (equation 2).

$$R_{\max} = f(x_{sales}) \tag{2}$$

whereas xsales is expected sales volume

Justification of this planning scheme they see in the fact that sales volume, the only obvious factor that is extremely difficult to influence and on which, in turn, directly and functionally depend all other economic cycle indicators, namely, the finished product manufacturing and storage volumes, volume of stored raw materials and stocks of material resources, personnel and equipment workload, income of the enterprise and many more that are the subject to budgeting. It seems necessary to us to clarify this rationale by the fact that volume of production in given setup of budgeting procedure is a "bottleneck" used for management of the results of all preceding factors in the cycle: provision, production, etc. Such formulation of the question makes it possible to pay attention to the fact that budgeting based on sales volume is a special case. Consequently, there may be situations where it is more useful not to proceed from sales volume, but from some other limiting factor.

Relevant Alternative Costs Formation Model: Most clearly this situation is characterized by the economic process associated with oil industry. For this type of business we shall emphasize the fact that a company engaged in deposit development and oil production, no problem exists with sales of finished product. However, not all commercial entities are engaged in this particular activity and those that are, are not considered efficient. The process of increasing oil production and consequently, sales, limits variety of other factors. To illustrate possibilities of identifying such limiting factors, let's consider one of commercial kinds of activities in oilfield engineering, i.e., oil fields exploration and development.

Following the logic of this study, let's represent the activity not as just a homogeneous sales process, but as a complex set of consecutive events (Table 2).

Describing this process, it should be noted that completion of each subsequent event (process step) is a prerequisite for start of the next stage. For example, it makes no sense to start test drilling without completing thorough geochemical analysis. Even if structure map of possible oil traps is made and significant funds have been spent on geophysical exploration, potential oilfields may contain no ail at all and in this case losses caused by test drilling that did not occur will be many times higher than costs of missed geochemical study. The same can be said in respect to all other stages of oilfield development. Besides, the processes of drilling and well completion with omission of any operations are not even technically impossible.

Thus, economic activity aimed at exploration and development of oil fields is characterized by dynamism of the process and it may be a limiting factor in any of its phases. In this study, this condition is important because it makes it possible to clearly illustrate effectiveness of some of principal provisions of theory of constraints and thus ignore the many methodological intricacies of costs classification, occurring in more complex business processes.

In order to illustrate the model we will take into account the following conditional numeric data (Tables 1 and 2)

In addition to above conditional data, let's assume that oilfield development is carried out by drilling lateral horizontal wells, which makes it possible to explore untouched layers in exhausted old wells and hard to reach

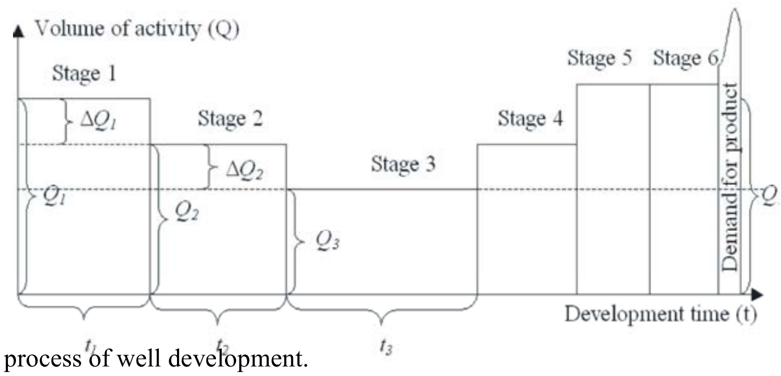

Fig. 1: Manufacturing process of well development.

Table 2: Conventional numerical indicators of economic process

Indicator	Value
Cost of capital,%	12
Average market price of finished well, c.u.	9,000,000

oilfields. Since there are many such exhausted old wells, the area of development is no longer a limiting factor, but at the same time, many companies get a new restriction - drilling equipment that makes new drilling method possible. As shown in Table 1, availability of appropriate drilling equipment allows to drill only three wells within budget period, while all other production factors are characterized by excessive capacity.

In terms of linear sequence of oil wells development stages, the situation can be illustrated as follows (Figure 1).

In Figure 1, the process of well development is shown in form expanded over periods of time. It would be logical to assume that simultaneously possible are processes of developing the oilfield during development of well No. 3, preparation of drill site during development of well No. 2, drilling of well No. 1. However, it should be noted that simultaneous execution of all possible processes for development of individual oil wells No. 1, No. 2 etc. In other words, prepared drill site No. 2 will be introduced into the process only after drilling at site is started and researched well No. 3 will be introduced together with preparation of drill site. Until further development, each of intermediate results of successive steps will be in the state of preservation. The same can be said about the cost of obtaining each of the intermediate results as well. Resources spent on research and preparation for drilling the well will be withdrawn from circulation before start of drilling and resources spent on research, before start of preparation for drilling. At the same time, as shown in Figure 1, total, not optimally planned loading of relevant processes is bound to cause withdrawal of such resources from circulation. With that, size of resources withdrawn from circulation will increase with each new economic cycle and remain for the entire period of wells development.

Based on the above circumstances, it would be legitimate to ask about amount of relevant alternative costs. To do this, let's clearly define relevant calculated parameters, including following:

- Amount of the excessive result of relevant process (Δqi);
- Specific amount of preserved resources (ri) - sum of costs required to obtain each of intermediate preserved results. In relation to this indicator it should be noted that it is cumulative, that is, is calculated by accrued total for each subsequent stage; relevant to changes in production volume, i.e., represents the sum of variables, more frequently direct costs of total relevant processes;
- Period of costs conservation (Δtx) is the period during which preserved resources of relevant process x are withdrawn from circulation. Obviously, each of redundant preserved resources is withdrawn from the circulation for the whole period of oil well development (Σt), minus the period of relevant processes, calculated as accrued total (tj):

$$\Delta t_x = \sum_{i=1}^{N} t_i - \sum_{j=1}^{x} t_j \qquad (3)$$

whereas

- *N is number of processes;*
- *x is number of final relevant process.*
- capital cost (n) is rate of return required by investors and creditors from involving capital into this process.

Using above estimates and designations assigned to them, relevant alternative costs calculation model can be represented as follows:

$$R_{рел} = \Delta Q_1 \times r_1 \times (\sqrt[\frac{12}{\Delta t_1}]{n+1} - 1) + \Delta Q_2 \times (r_2 + r_1) \times (\sqrt[\frac{12}{\Delta t_2}]{n+1} - 1) + \\ + \Delta Q_3 \times (r_1 + r_2 + r_3) \times (\sqrt[\frac{12}{\Delta t_3}]{n+1} - 1) + ... + \Delta Q_n \times (\sum_{i=1}^{N} r_i) \times (\sqrt[\frac{12}{\Delta t_n}]{n+1} - 1) \quad (4)$$

whereas

Rrel is the sum of alternative costs relevant for optimizing business process.

Analyzing the model for calculating relevant alternative costs, one can define the following fundamental property of this indicator. It should be calculated annually and, therefore, despite the fact that it is relevant to the scope of production, loss of relevant processes optimizing events characterize it as permanent calculation cost item for maintaining additional reserve included into the limiting factor of resources.

in respect to out example the indicator takes the following value:

$$R_{рел} = 4 \times 1200000 \times (\sqrt[\frac{12}{8}]{0,12+1} - 1) + \\ + 3 \times (1200000 + 800000) \times (\sqrt[\frac{12}{6}]{0,12+1} - 1) = 726506,20(y.e) \quad (5)$$

Thus, the calculations show that each year during planning of the full utilization of production capacities, the enterprise will bear relevant alternative costs equal to 726506,20 c.u.

Even more detrimental to businesses can be consequences of omitting limitations in budgeting of stages No. 4, 5, 6 and orders scheduling.

To illustrate this fact, suppose that during the budget period the company has the ability to make contracts for development of 12 oil wells. In this case, if budgeting is based on sales volume using conventional calculation algorithms, expected evident profit will be as follows:

$$\Pr = (9000000 - 5700000) \times 12 - 7520000 = 32080000(y.e.) \quad (6)$$

However, in reality, during the fiscal period the company will only be able to execute 3 orders and, accordingly, will receive the following amount of explicit actual profit:

$$\Pr = (9000000 - 5700000) \times 3 - 7520000 = 2380000(y.e.) \quad (7)$$

It is obvious that deviation equal to 29.7 million c.u. of evident actual profit will cause such a negative consequence as improper punishment of persons responsible for 3, 4, 5 and 6 stages of the process, while total economic loss caused by results of relevant processes will not be seen. In addition, the company will retain excess production capacities and, accordingly, significant amount of alternative and redundant constant costs and, just as important, it will lose reputation in consumer, investment markets, etc.

All these strongly manifested negative issues lead to the conclusion that, in comparison with traditional method of cost management, a more reasonable method would be built on the theory of constraints, because: it expresses more reliable expected result, it contains measures to optimize the business process that allow users to objectively assess contribution of each factor into achieving the end result of economic activities.

CONCLUSION

Summarizing the present study, we would like to make the following basic conclusions for common methods for cost management: in the first place, the economic budgeting process should begin with the search, research and planning of limiting factors; in the second place, calculation of the planned volume of activity, volume of consumed incoming resources and final result of the economic process should be carried out with regard to maximum power of limiting factor; in the third place, along with obvious costs, one can as well calculate relevant alternative cost of maintaining excess results of relevant processes, in the fourth place, during calculation and analysis of results variations for each individual factor of management one should take into account production volumes of each previous process; and in the fifth place, with capital budgets it is rational to implement solutions to improve performance of a limiting factor.

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