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Managing the Costs of Constant Changes in the Activities of High-Tech Enterprises

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ABSTRACT

This article considers the solution of the actual scientific and practical task of managing the costs of planning and implementing organizational and production changes at enterprises from high-tech industries. The authors present a modification of M. Porter's model of competitive forces for high-tech industries and single out a separate managerial function — constant management of timely changes. The article considers the function of cost management, compares two approaches to change management and gives recommendations for optimization of corresponding costs taking into account the cost of management errors.

Keywords: change management; cost optimization; error cost; management function

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INTRODUCTION AND PROBLEM STATEMENT

Commercial success of enterprises in the 6th and 7th technological orders requires major changes in management models. High capital costs of the organization (and necessary continuous modernization) enterprises with high operational salary costs for highly qualified specialists and managers lead to a constant search for cost optimization methods as one of the key functions of enterprise management [1]. On the other hand, technological pressures and uncertainty of the environment in the context of the globalization of competition are additional factors complicating both business–planning and adequate assessment of investment in enterprise development. The need for constant management of successful changes in the management of technology companies became an appropriate response to the disturbances of the external environment and an independent competitive force, analysis of which allows building the optimal competitive strategy in the technological industries.

Mathematical models of management of economic systems are indeed often fairly criticized due to their excessive mechanicalness, inability to take into account psychological and social factors in the organization of work, for the irrationality of managers, insufficient flexibility to respond to market and geopolitical uncertainties [2, 3]. Sometimes such models are better adapted to describe the real world of the economy through the use of special mathematical devices (for example, fuzzy logic or elements of self–learning expert systems), but even in such cases their practical application is rather limited. The opposite of systemic economic theories, emphasizing the permanent indeterminacy of everything, such as the "black swan" [4] or "orderly chaos" [5], although replete with striking practical example, it is rather difficult to adapt to the creation of successful competitive strategies

of enterprises, and therefore lose much of their value to entrepreneurs.

In this article, as a hypothesis, it is assumed that in each economic system there is a parameter, the management of which is transparent and has a significant impact on the success of business — "costs on the managerial function of enterprise". Optimization is an important scientific and practical problem and cannot be universal for every industry or segment of the economy. Optimization of individual components of the enterprise management function seems to be a more promising. The proposed hypothesis asserts that the allocation of the function of permanent management of changes in the management of enterprises is economically justified in terms of view of minimizing the total costs. The main principle of this hypothesis is the theoretical provision on modification of the model of competitive forces by M. Porter, describing the fundamentals of industry competitive analysis.

FEATURES OF CHANGE MANAGEMENT IN THE ACTIVITY OF ENTERPRISES IN HIGH-TECH INDUSTRIES

Change management has a solid history of development, but for high-tech digital economy industries, the usual models E. Deming [6] and I. Adizes [7] required were more modification. Moreover, change management, from a management practice to solve a class of problems, has become a driving force for obtaining competitive advantages [8].

The hypothesis of separation of an independent function of change management from the structure of all management impacts (on the enterprise by management) is based on the idea of the value of permanent management of timely changes as a driving force of competition. The simplest visualization of industry analysis of competitive forces is the Michael Porter model [9]. As part of the author's idea, it is proposed to make a significant modification to this model [8]. It involves avoiding the influence of substitute products and replacing this type of competitive forces with risks associated with managing timely changes in the IT–business (see *Fig.*).

The proposed modification of classical industry analysis is connected with the following circumstances [8]:

1. On the one hand, the concept of "substitute products" and the sources of their appearance have changed in technological industries. Economic sectors of 6th and 7th technological orders and products of related enterprises are based on application of global economic trends: informatization, automation and digitalization. Almost any manual labor, paperwork and approximate qualitative estimates of business parameters applied instead of management approaches based on electronic processing and operation with precise numerical parameters, are outdated and often economically inefficient.

2. On the other hand, the products and services of the technology industries themselves are developing rapidly, primarily because of the intense and global competition among the technology companies themselves. For example, in the 80s of the last century, personal computers replaced mini–computers, and, in turn, they were driven out of the market by modern laptops, tablets and monoblocks. However, such modernization, which involves the introduction of new hardware models and software versions, from the perspective of M. Porter's theory, can be attributed to competition among technology companies rather than to the emergence of substitute products.

3. Managing timely changes in technology industries — is a condition for survival in the market, requires significant resources and carries significant risks. The whole history of mergers and acquisitions of technology companies shows that delay in responding to competitive challenges or ignoring the constant pressure of new technologies in such industries quickly lead to loss of market

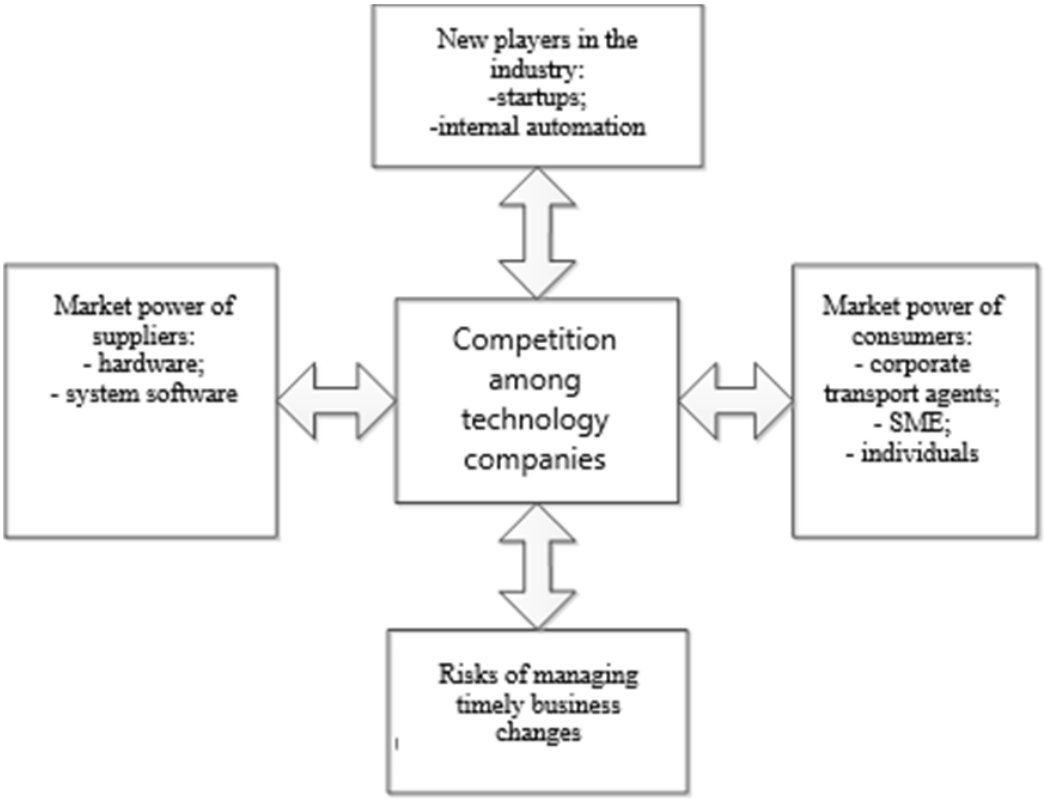

Fig. **Modification of the model of competitive forces of M. Porter for technological industries**

Source: compiled by the authors.

shares, decrease of product margins, outflow of talented professionals and managers [8].

The market power of suppliers in the technology industries — is not only hardware and telecommunications, but also basic system technologies (communication, energy, etc.). It has been declining for decades due to the emergence of Chinese production analogues and the constant growth of supply from manufacturers from around the world in the conditions of cheaper logistics. Decline in the power of supplier's leads to higher profitability in some industries, making entry more affordable for new players.

It should be noted that there are thousands of new players in the technology industry each year (especially in IT, Fintech and biotechnology), although the threshold for capital investment is constantly increasing. Despite the fact that the leading position of well-known American corporations is undeniable, the constantly growing market is opening new niches that are occupied by emerging players. Part of these companies — are start–ups creating completely new technological solutions, usually niche. Another part — is a team of engineers from the traditional business, whose management decided to transfer the positive experience of internal business initiatives to the foreign market. Such "start–up companies" as a rule are not able to create a competitive product for a long time, and in terms of production, management and marketing processes they are lose hopelessly to competitors [10].

Market power of consumers in technological industries is ambiguous. On the one hand, for common and easily repeated services and products, the pressure of corporate customers is quite significant: they expect continuous improvement in the quality of services while reducing their cost to consumers. Corporate customers (banks, network retails, mobile operators, etc.) do force manufacturers to work on product

quality, significantly improving it. In a similar way, individuals, small and medium enterprises exert considerable pressure on whole classes of products (services): gadgets, communication and Internet services, etc.

On the other hand, if it is an innovative or best–in–class product with an almost monopolistic market position, consumer power is extremely weak. Before the appearance and distribution of competitive analogues, the manufacturer always successfully sells the product (service) on advantageous terms and with the level of quality, which itself may choose to provide.

Competition among technology companies is different in the degree of intensity depending on the industry: different level of capital intensity of manufacturing, logistics complexity and regulatory requirements. However, should be allocated a common feature for the industries of the 6th and 7th technological orders: representatives of the "new economy" seek to create "blue oceans" [11], automate new areas and develop the needs of their consumers [12].

Equally important is the gradual erosion of the industry sector of technology companies. On the one hand, this is due to the emergence of new industries and specializations: Fintech (technological financial services), Edtech (technological education services), bio — and pharmaceutical (technological developments in health care, veterinary medicine, etc.). In such companies, it is technology (software and hardware, know–how, digital business models) that determines competitive opportunities in a certain area of activity.

On the other hand, the quality of products, technologies and the competitive opportunities that they create bring technology firms together, regardless of their industry affiliation [13]. So, IT companies specializing in automation, for example, the engineering industry, and high–tech and knowledge–intensive engineering enterprises, creating products whose competitive capabilities are determined by information technologies, significantly more like each other than similar from other applied field (for example, in mining industries and IT companies involved in the automation of accounting, respectively).

The shift in competitive analysis for the technological industries shown in this section makes it possible to consider the management of changes in the management of the company as a driving force for the commercial success of the enterprise. This means that it is possible to separate it from the general function of management and sets the vector of searching for directions of its optimization. Both time and cost can be a key parameter when considering such a function. However, reactivity of employees' thinking and psychological aspects of work organization (organizational resistance, combination of rational and irrational, prepared and spontaneous management decisions, negative unemployment in high–tech industries) [14] allow you to choose in favor of consideration of the function of financial expenses, in which the mathematical argument is the parameter of time.

COST FUNCTION FOR CHANGE MANAGEMENT AND PRICE OPTIMIZATION OF EACH ERROR

The calculation of costs directly for enterprise management includes several key aspects and depends on the selected corporate model (board structure, shareholder participation, decision–making style, etc.). Taking into account the above justification of expediency of allocation of the function for management changes in the company, consider only the necessary aspects relevant for this management function:

- Corporate coefficients — multipliers to determine how much real money a company spends per unit of work on an arbitrary number of employees (one person, project team, groups of related employees, such as a board of directors) per unit time. They

are calculated individually for companies and include the full list of costs — from wages and taxes to electricity consumption, equipment depreciation and office rent. In the "new economy" industries, corporate coefficients are the basis of calculation of variable operating expenses of business.

• Capital costs for the start–up of a particular management activity can be evaluated both for ongoing operations and for the launch of related projects.

• Financial reserves — risk management cash reserves (characterized by Fintech and pharmaceutical companies as simple way to mitigation risks and uncertainties of the environment).

The actual organization of the management of changes in the management of technological enterprises can be realized as an internal project [15].

If $F_{opt}(t)$ — enterprise cost function with optimal change management from time spent, i.e. the expression of costs associated with the timely change of business and technological processes, including the monitoring of the external environment (consumers, competitors, regulators, etc.), then:

$$F_{opt}(t) = \left(a \times t + C_{pro} + R_{pro}\right) + \left(b \times t + R_{corp}\right), \quad (1)$$

where $\left(a \times t + C_{pro} + R_{pro}\right)$ — Part of the cost function related to regular project activities in the area of managing timely changes in the cycle: research– analysis–implementation–consolidation;

a — corporate cost rate per unit of project time;

C_{pro} — capital costs for managing timely changes;

R_{pro} — financial reserves for risk management (for simplification without function parameter);

$a\left(b \times t + R_{corp}\right)$ — part of the cost function related to the reactive management of urgent changes in emergency operating mode, requiring the emergency intervention of the top management of the company, where:

b — this is the corporate cost rate per unit of work cost of all employees and top managers involved in emergency management;

R_{corp} — corporate financial reserves for general risk management in the enterprise (for simplification — without reference to function parameter).

Consider these corporate coefficients in more detail:

1. The corporate coefficient a can be expressed as:

$$a = Sal_T \times \left(\frac{Exp_{CC}}{N_{CC}}\right),$$

where: Sal_T — costs (including fees and taxes) on the wage fund for professionals engaged in timely change management;

Exp_{CC} — operating costs of the respective Cost Center in which these specialists work;

N_{CC} — number of specialists in this Cost Center.

2. The corporate coefficient b can be expressed as:

$$b = Sal_{CL} \times \frac{Exp_{CC}}{N_{CC}} + Er + SP,$$

where: Sal_{CL} — costs (including fees and taxes) on the wage fund of top managers of the company engaged in urgent works (in "emergency" mode) on the management of urgent changes;

Exp_{TM} — operating costs corresponding to the work of top managers in their Cost Center;

N_{CC} — number of top managers in the company, covered by the Cost Center;

Er — costs associated with the forced downtime of enterprise specialists due to the emergency operational management of urgent changes;

SP — costs associated with the forced downtime of enterprise specialists due to the emergency operational management of urgent changes.

Lead a logical inequality:

$$a < b, \quad (2)$$

Having economic sense into force of significant differences in the following indicators:

• remuneration of top management and middle management;

• the presence of forced stops of regular business processes when operating in "emergency" mode, which means — the growth of the corporate coefficient due to these costs;

• duplication of executable activities at work in "emergency" mode, reduction of motivation (and leaving — with the need to search and replace) of employees and other suboptimal processes that occur at unprepared large-scale changes in operational activities [16].

It follows from the previous section of the article that modern technology companies seek to minimize part $\left(b \times t + R_{corp}\right)$:

$$\left(b \times t + R_{corp}\right) \to min, \quad (3)$$

Thus, the cost function $F_{opt}(t)$ depends largely on $\left(a \times t + C_{pro} + R_{pro}\right)$, i.e. regular activities in the area of managing timely changes. Such activities may be organized as special projects or regular operational activities.

In the opposite approach, typical of companies with low maturity of management processes and managerial competencies to manage a modern high-tech enterprise, a similar function $F_1(t)$ should be considered. It also determines the costs of the enterprise in managing changes from the time spent, including reactive monitoring of the external environment (consumers, competitors, regulators, etc.):

$$F_1(t) = \left(b \times t^2 + R_{corp}\right), \quad (4)$$

where the enterprise refuses to some of the costs (notionally zero) associated with regular project activities to manage timely change $\left(a \times t + C_{pro} + R_{pro}\right)$, a uses only part of function (1).

In (4) formula expression $\left(b \times t^2 + R_{corp}\right)$ defines the enterprise cost function related to reactive management of urgent changes in the "emergency" mode, which requires direct intervention of top management of the company in its operational activities.

In this expression b — is the corporate expenditure factor per unit of work of all employees and managers involved in policy and operational management;

R_{corp} — corporate financial reserves for general risk management in enterprise (for simplification without function parameter).

In this expression, costs rise directly proportional to the square of the time spent by top management due to the significant increase in negative factors:

• forced downtime of regular business processes as large–scale operational changes are deployed;

• sub–optimal management results due to duplication of executable activities, inaccuracies in setting goals and targets, limited source data due to short period of collection;

• additional costs due to the need to overcome organizational resistance and the consequences of the associated risks — reducing motivation and leaving some employees.

Type function (4) inherent in enterprises where:

• reduce the time to changes implemented is largely due to decision procedure and resistance suppression, that knowledge–intensive innovative enterprises is fraught with direct economic losses due to reduced productivity and the departure of the best engineers;

• time parameters are often not kept up with significant changes in business and technological processes, which directly proportional to increases the cost of operating control in functions (1) and (4).

These conclusions show that in the absence of mature change management practices at the corporate level, time spent on change tends to maximize, and the expression (4) takes the form of:

$$F_1(t) = \left(b \times t^2 + R_{corp}\right). \quad (4.1)$$

Comparing the cost function expressions (1) and (4.1) when taking into account the expression (2) leads to the following conclusion No. 1:

• **with a significant increase in time of introduction of changes at enterprises of high-tech industries, in case of use of function (4), their costs increase faster than when using function (1).**

It is equally important to determine opportunities for enterprise cost function management in terms of the impact of operating costs on the implementation of necessary changes. The function of the total cost of enterprise management — $\omega(t)$ — depends on a set of significant factors (management costs, reserves, equity servicing, etc.) in which the operational management costs discussed above are present (5):

$$\omega(t) \sim F(t). \quad (5)$$

Postulate the discrete (rather than continuous) nature of management impacts on changes in transaction costs: every top management decision on additional operating costs changes a company's costs by a specific amount, which can be expressed in money and attached to corporate cost coefficients.

Determine the possibilities of changing the cost function (i.e. the potential controllability of the control cost per unit of time) for both approaches, by differentiating expressions (1) and (4.1). For enterprise cost function with optimal management:

$$\frac{dF_{opt}(t)}{dt} = a + b; \quad (6)$$

with the expression (3), will have:

$$\frac{dF_{opt}(t)}{dt} = a. \quad (7)$$

For cost function with opposite approach:

$$\frac{dF_1(t)}{dt} = 2b. \quad (8)$$

When comparing the expressions (7) and (8), taking into account the inequality (2), we will get conclusion No. 2:

• **each discrete step when selecting a cost function by type (4) is significantly larger than when choosing a type of cost function by type (1). Given the fact that the amount of time spent trying to change to the maximum, this means that any change management error that requires additional time to correct costs the enterprise significantly more when choosing a control function by type (4) than when choosing by type (1).**

Thus, due to the impact of operating costs on change management on total costs (5) and conclusions 1 and 2 for the vast majority of technological and knowledge-intensive enterprises from the "new economy" industries, a function of type (1), involving the organization of ongoing activities on timely change management.

Type function (4) can only be recommended for a small segment of enterprises: small by number of employees or having a clear preference in their corporate culture for a directive and command style of management.

CONCLUSION

The presented function of change management in the management of the company by type (1), taking into account the desire of "emergency" management to minimization, is the basis of the proposed in the work optimization of costs for enterprise management. For technological enterprises from the branches of "new economy", the allocation of an independent function of managing timely changes is economically feasible because it allows:

• save money allocated for the management of the organization;

• save money on correcting management errors in "emergency" management mode.

Moreover, further development of an independent function of managing changes

in enterprise management for part of new industries (Fintech, Farmtech) may be related to the strategic model of risks of the organization, which traditionally requires the allocation of appropriate reserves in the form of cash, that output of working capital (effectively frozen). In the future, with the development of this approach, it is possible to partially compensation the operating costs of this managerial function by reducing the necessary cash reserves associated with major industry risks.

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