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AN APPROACH TO OPTIMIZATION OF AN ENTERPRISE'S ACTIVITY

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Abstract

The paper presents an approach to optimization of an enterprise's activity based on cybernetics and the theory of systems. The method proposed is based on the model describing optimum activity of an enterprise in a changing environment. The method assumes identification of the immanent objective of an enterprise's activity and conditions of this activity, as well as definition of the objective function in the form of optimisation criteria. The model facilitates proper identification of problems related to activity of an enterprise, their hierarchisation and evaluation as well as coordination of the optimisation ventures.

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Introduction

The answer to the question if and when the activity of an enterprise can be considered optimal – in the sense of the best of all possible options under the existing conditions – raises certain difficulties to both theoreticians and practitioners of management. The aim of the approach proposed in this paper is to present a cyclic optimisation strategy model, which allows evaluation of the efficiency of an enterprise's activity in a changing environment.

Most frequently, the basis for practitioners' evaluations and beliefs about the optimum activity of their enterprise is the use of benchmarking – economic performance of their enterprise is evaluated against its peers in the same sector. Conclusions as to the optimum activity based on benchmarking raises, however, certain doubts, as it does not explain whether the results are the best of all the options nor if the economic measures selected are sufficient to evaluate if enterprise's activity is optimal.

Similar doubts arise with respect to theoretical proposals, when the performance of the enterprise is evaluated against a plan. This approach assumes indirectly that there is an optimum plan at all – a plan that describes the best way to achieve the best way to operate the enterprise. Meanwhile, every enterprise has a variety of plans (for supply, production, employment, sales, etc.), which are sometimes contradictory and which can hardly be perceived as optimal when there is no method to develop optimal plans. Moreover, the dynamics of changes in internal and external determinants of activity excludes the applicability of most plan optimisation models, *ceteris paribus*.

Those difficulties indicate that the key factor relevant to the identification of problems of an enterprise's activity is the definition of the reference system; the model describing the enterprise's activity under changing conditions; the pattern which enables identifying if and to what extent the way an enterprise operates diverges from its potential optimum, and how to define that optimum.

1. Model of an Enterprise's Activity

Methodological premises for constructing a model of an enterprise's activity have been described by L. von Bertalanffy's in his theory of systems[1]. In this approach, an enterprise should be presented as a *system* based on a defined class of definitions of systems. The selection of definitions determines the methods and tools used to explore the system,

which are characteristic of the class. An analysis of the problem of an enterprise's activity allows assuming that:

An enterprise is an open and complex system, whose integral element is the human, who ensures that this wholeness separated from the environment, operates in a conscious and goal-oriented way. Goal-oriented activity of an enterprise is reflected in the processing of information, energy, fixed and financial assets and human labour into a flow of products and services expected by the environment.

The definition of an enterprise as a system allows identification of the problem of its activity in the class of complex systems such as an *organised complexity, where fluctuations and inconsistencies with the theory occur more or less regularly*[2].

The analysis of this definition enables us to observe important – from the viewpoint of modelling – features of a complex system:

1. A complex system is integrity, a set of relationships between the features of its components. The set of interrelations among those features describes the activity characteristic of this integrity.
2. Activity plays an important part in the development of systems of this class. And new goals are the key factors to the activity; they are followed by new skills and competence, whereas structural changes are ranked as third[3].
3. A system-related feature of the activity of complex systems is interrelations between quality, intensity and costs of processes carried out in the system[4].
4. A complex system, which exchanges energy, matter and information with the environment, is an open system, which under constant changes of qualities assures a quasi-dynamical balance (the so-called stability, homeostasis).
5. Keeping the dynamical balance is controlled by information exchange and its processing. The information prevents the increase of the entropy of the system.

According to the postulate of M. Mesarović, the only appropriate approach to analyse this class of complex systems is the *teleological approach*. When developing a model with the *teleological method*, the input-output algorithm is substituted for by presentation of the system as a process aimed at achievement of a specific goal[5].

Development of the method of complex system modelling will require:

- defining the aim of research and general objective of the enterprise,
- defining the objective function in form of activity optimisation criteria,
- defining the constraints to the achievement of the objectives.

Definition of the aim of research and general objective of the system

Definition of the aim of research in complex system modelling is usually ignored. The basic question concerning the sense of exploring the system seems to be rhetoric. The aim of exploring the system results from the adopted definition of the system, and in this case: *the aim of research into the system is optimisation of an enterprise's activity*.

A system identification of the aim of the research into a system requires also justification: *what for should the enterprise's activity be optimised*? The most frequent aim of optimisation is "profit maximisation" or "maximum degree of satisfaction of social needs".

Definition of the aim of optimisation of activity in economic or social categories is here a methodological mistake. It suggests that the objective of a given enterprise is known (profit maximisation or satisfaction of social needs) and the problem of analysing an enterprise is reduced to economic or social aspects of its activity.

Another, usually implicit, objective of optimisation of activity of an enterprise considered as a system, is assuring its survival and development in a changing environment. Nevertheless, such a general definition of the aim of optimisation with reference to artificial systems, *created for and by the human*, is insufficient. Unlike natural systems, they tend to develop according to their own mechanistic principles and regulations, which are sometimes inconsistent with human principles[6]. This tendency is a certain consequence of creating artificial systems as mechanisms where the human is treated as an object, in terms of usefulness.

In the light of system research, development and enhancement of operations of an enterprise considered as a system makes sense only if its activity contributes to a better standard of living of the human. In the approach proposed it is therefore assumed that:

The aim of analysing enterprises as open complex systems is to optimise their activity so as to raise the quality of living in those systems and their environment.

To define the *objective of an enterprise* it is necessary to identify its immanent (primary) objective among the whole set of objectives, which justifies the existence of the artificial system in a natural environment, and to distinguish it from other interrelated and subordinate secondary objectives[7]. In the class of complex systems, an immanent objective of functioning of a system is a specific product and/or service. Achievement of the immanent objective is essential to achieve secondary objectives. In other words, to achieve secondary objectives (economic, social goals), the company needs first to achieve its immanent

objective. Identification of the immanent and secondary objectives determines the quality of research.

The immanent objective of a system is defined in a specific form by tasks that are addressed at this system. The tasks are *spiritus movens* of the system; without them, the system's existence in the environment is pointless. The basic condition of receiving tasks is informing the environment about the objective of the system's functioning as well as its products, services, competence and conditions of delivering them.

The tasks, usually in form of agreements, orders, obligations, needs, etc. define:

- object of activity: what and for whom should be done,
- time: when the task is to be done, what deadline is set,
- price: how much the task will cost,
- quality requirements: quality expected from the product or service.

The tasks define on the one hand the time and space of the system's functioning, as well as demand for its outputs and their structure, and on the other they determine the executive potential which is essential for completing them. The confrontation of tasks with the executive potential of the system allows definition of the general objective of the analysed enterprise's activity.

The tasks are performed through processes. The aim of processes is a specific output. Processes describe the activity of an enterprise as objective-oriented changes of the system's relevant features over time. Identification of processes is one of the most important phases when analysing a system.

In the approach proposed in this paper, processes are identified according to selected objectives of the organisation's activity, classified into the immanent objective and secondary objectives, which in turn allow identification of:

- basic processes, which lead directly to achievement of the immanent objective,
- secondary processes related to achievement of secondary objectives.

Identification of basic and secondary processes in a complex system is based on observation (simulation) and analysis of performance of typical tasks addressed at the system; from the decision on their execution (acceptance of the order, winning of the tender, signing of the agreement) to their execution, delivery of the product or service to the customer and settlement of the costs.

Basic processes are determined by the technology used to perform the task. The technology defines precisely the conditions and course of individual operations making up the

whole process (e.g. sequence of individual operations, qualifications required from operators, supply resources, posts and their equipment, start and finish times for operations, final and intermediate output). The product or service defined in the task will be a direct result of the selected technology. The observation of the course of processes determined by the selected technology, from the start to the end, allows identification of those processes as basic ones, related directly to the achievement of the immanent objective of the system.

Conditions of activity

Execution of basic processes, defined by the sets of technologies used in the system, is determined by execution of secondary processes and their harmonisation. Any interference threatens the continuity of basic processes. Among the secondary processes the following ones can be identified: information and decision-making processes, providing for and development of human resources, logistics, continuity of operations, marketing, finance, accounting.

Output of secondary processes is defined by the *conditions of activity*. Those processes are also identified through observation and analysis of tasks addressed at the system: from registration of specific needs (output of information and marketing processes) to satisfying them (information, logistic, financial, bookkeeping, accounting and marketing processes).

Description of the processes and determinants create a *model* of the analysed system, which constitutes a basis for seeking solutions optimising its activity and verifying them.

2. Model of Optimisation of an Enterprise's Activity

The criteria for optimising the activity of an enterprise considered as a system are identified basing on the following statement[8]:

> *In each complex system, a set of solutions optimising activity can be defined where the improvement in quality of one out of three objective functions controlling the processes (i.e. efficiency, quality or costs) leads to deterioration in the value of at least one out of the remaining two.*

The criteria selected: efficiency (intensity), quality and cost of processes meet the condition of the objective function; their values can be maximised or minimised, and they define a set of criteria optimising the activity of the organisation as a system. Those criteria are interrelated, which means that in given time interval one and only one objective function

defines the direction of a system's activity optimisation while the other two set the constraints. Only those optimisation solutions are accepted which raise the quality of human life in the organisation and its environment.

This approach allows reducing the problem of multicriteria optimisation of activity to a search for compromise solutions for the selected three variables describing the components of the vector of the enterprise's condition.

Activity of an enterprise in given conditions and time interval T will be optimum (satisfactory) if:

$$W^T = aI^T + bJ^T + cK^T = const.$$

where:

W^T – evaluation of enterprise's activity in the time interval T,

I^T , J^T, K^T – evaluation of intensity, quality and costs of processes,

a, b, c – weights for measures of processes.

The condition $W^T = const.$ means that in the time interval T there are no efficient solutions which would either raise the quality or intensity or to reduce costs of operations, without a negative impact on the global appraisal of the organisation's activity.

The W^T measure allows estimation to what extent the operations of the enterprise diverge from their potential optimum and how this optimum should be found provided given circumstances:

In the case when *maximising the quality of processes* is adopted as the optimisation criterion, those solutions will be sought and preferred which raise the quality without implying any significant negative changes in the quality or costs of activity.

As soon as there are no more opportunities for raising the quality of activity left, when any other solution reduces the intensity or increase costs of processes (compensating for effects), the optimisation criterion adapted will be changed.

In the next cycle, the new criterion for the new time interval will be *to maximise intensity*. Those solutions will be sought that raise the intensity of processes (reducing their duration) but neither reduce the level of the quality achieved nor increase significantly the costs of those processes.

If no more such solutions exist, the next optimisation criterion is selected and those solutions are searched for which *minimise costs* of processes while keeping the quality and intensity undisturbed.

If such solutions cannot be found, however, a next optimisation cycle is triggered and new solutions are sought under new circumstances; proposals that either raise quality at given intensity and costs or optimise intensity at given levels of quality and costs.

If in the next optimisation cycle no significant improvement in quality or intensity or cost reduction can be found, it can be concluded that under given circumstances in that time the activity of the organisation is the best possible to be obtained: $W^T = const$.

In practice, the situation in which maximisation or minimisation of one objective function does not affect in any way the other two is an exception. Usually, the solutions raising quality, shortening the duration or reducing the costs of processes simultaneously affect the *conditions of the system's functioning* (implementation of a new technology, layoffs, employment, staff training and development, selection of new suppliers and partners). The changes in conditions can also affect all the three objective functions thus implying the necessity to update the W^T values for the new conditions.

3. Shaping the Conditions of an Enterprise's Activity

The identification and shaping of the conditions of an enterprise's activity involve simultaneous search for optimum solutions:

1. In the sphere of basic processes, which lead to achievement of the immanent objective of activity (e.g. optimisation of technology, selection of components of the executive potential, optimisation of schedules), where the results of optimisation depend mainly on the shaping of enterprise's internal conditions, and
2. In the sphere of secondary processes, which lead to achievement of secondary objectives of activity (e.g. optimisation of supply processes, marketing processes, financial, information and communication processes, which link the organisation with its environment), where the results of optimisation depend mainly on shaping external determinants of enterprise's activity.

In the area of basic processes, it is new technologies of production or services, as well as partners' offers that are subject to constant evaluation. The comparison and contrast of the quality, intensity and costs of new technologies and conditions of their implementation allow proper verification of the solutions applied and justify the sense, scope and dates of introducing changes.

Within secondary processes, evaluation concentrates mainly on the offers of supply components (new technologies, services, supply of materials, media, financial resources,

labour, etc.) which due to their better quality, efficiency or lower costs, may be used in the optimisation of basic and secondary processes and potential extension of the enterprise's executive potential.

It is easy to observe here that it is the increasing needs for fast identification and evaluation of the conditions of activity that define the essential scope and direction of IT application in the enterprise. Progress in the development of information technologies has offered new opportunities for implementing the concepts of enterprises of the following classes: Virtual Organization[9], Concurrent Engineering[10], Agile Manufacturing[11], where fast identification and evaluation of conditions of activity determines competitiveness.

The solutions applied to practice will be usually *compromises* between the output (benefits) generated from the maximisation or minimisation of the leading objective function on the one hand, and the sum of costs and benefits from the remaining two functions on the other. What is essential in those cases is to define which objective function in a given interval is affected at most, and what its impact will be over time on the values of the other two objective functions.

The primary direction of search for optimisation solutions is related here to the definition of the immanent objective of enterprise's activity. The achievement of this objective requires in any case the acceptance of the results of optimisation of the activity by the enterprise's recipients (environment). Optimisation solutions that are sought and accepted create value added for recipients and contribute to raising the quality of life.

Conclusions

Defining the general direction of the search for optimisation solutions allows concentration on the problems regarded as the most relevant to the activity in a given time interval, their proper identification, hierarchisation and coordination of all the optimisation ventures.

Notes

[1] von Bertalanffy (1984).

[2] Weinberg (1979), pp.29-43.

[3] Popper (1998), p.97.

[4] Gomółka (2000).

[5] Mesarović (1997).

[6] Schumacher (1976), p.109.

[7] Bocheński (1993), p.182 and next.

[8] Gomółka (1980), p.34.

[9] Kisielnicki (2002).

[10] Loureiro, Curran (2007).

[11] Kidd (1994).

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