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APPLICATION OF AN EARLY WARNING SYSTEM IN THE DYNAMIC MODEL FOR BUSINESS PROCESSES IMPROVEMENT

Abstract

The goal of the present paper is to depict the application of an early warning system as a part of the dynamic model for business processes improvement. The essence of the system is presented, the stages its building passes through, as well as the principle of its functioning.

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Introduction

Each organization is striving to enhance its competitiveness and to increase its revenues. It is a continuous process, which most often leads to modification not only of the production, but also in the management structure. The optimization should be in compliance with the selected strategy and the company structure. Further, the business processes improvement should take into consideration the following aspects: „flexibility” – showing the possibility of the managing bodies to take decisions related to the strategic reorientation or revision of the goals in accordance with the changes in the environment; „wholeness” – the existing and potential relations and interactions among all activities, processes and business processes in the organization to be used in order to achieve the specified common goal; and, „strategic range” – all events related to the business process optimization have to be in conformity with the company strategy. The practice shows that the applied methods of

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optimization would be more efficient, if you take into account the dynamics of the reasons which starts the improvements. The dynamic model of business processes improvement presents the optimization itself like a process, which is developing in time. It examined the reasons of improvements in their development and combines described features. It is constructed of three modules. The first module is functioning as an early warning system and is monitoring the presence of changes in the organizational environment. In the second module, the actual improvement of the processes is done and the third one depicts system of objectives in the organization.

The purpose of the present article is to present the first module of the dynamic model of business processes improvement, which is performing the functions of an early warning system. Also, to be depicted and analyzed the essence, the stages of construction and the specifics of its functioning.

Specifics of the early warning system

The early warning system has been built and functions through the early warning indicators. These are tools, which record changes in the environment of the organization through weak or strong signals (Bedenik, Rausch, Fafaliou & Labaš, 2012). The early warning indicators are divided into absolute – recording the condition as to a given moment and relative (Hopfenbeck, 2002). One of the main tasks of the indicators is to show where to look for changes in the environment, even it can't indicate when they will occur (Bedenik et al., 2012). „Weak signal” is understood as the presence of ambiguous and inaccurate information for pending changes in the environment that could lead to negative consequences for the organization (Ansoff and McDonnell, 1990). In contrast to them, „the strong signals” are carriers of clear and accurate information (Ansoff, 1979). The main function of the early warning system is aimed at monitoring and recording of the weak signals emitted by the environment (Figure 1). The presence of a deviation thereof is a signal for the company management to undertake actions and/or measures, whereby to carry out the necessary corrections (Hahn, 1979). Reading the changes of the early warning indicators parameters gives the companies the opportunity in due time:

- to identify the possible risks they are facing;
- to reveal hidden potential (Krystek and Müller-Stewens, 1993);
- to identify their strengths and weaknesses.

That way, each organization has the possibility/chance to avoid or prevent dangers, consequence of its existence (Gomez, 1983). Further, it acquires flexibility towards the occurrence of adverse events and the actions in order to deal with them should be in conformity with the selected strategy (Bedenic et al., 2012). The timely reporting of the weak signals, as well as their accurate analysis, are key factors for undertaking the correct measures of overcoming the approaching crisis (Barry and Elmes, 1997). The information received from the indicators is presented to the man-

agers, who take the decision for preventive actions for conformity with the environmental changes (Bedenic et al., 2012). Moreover, the early warning system analyzes the reasons of occurrence of the changes and evaluates the probable trends of their future development (Bedenic et al., 2012).

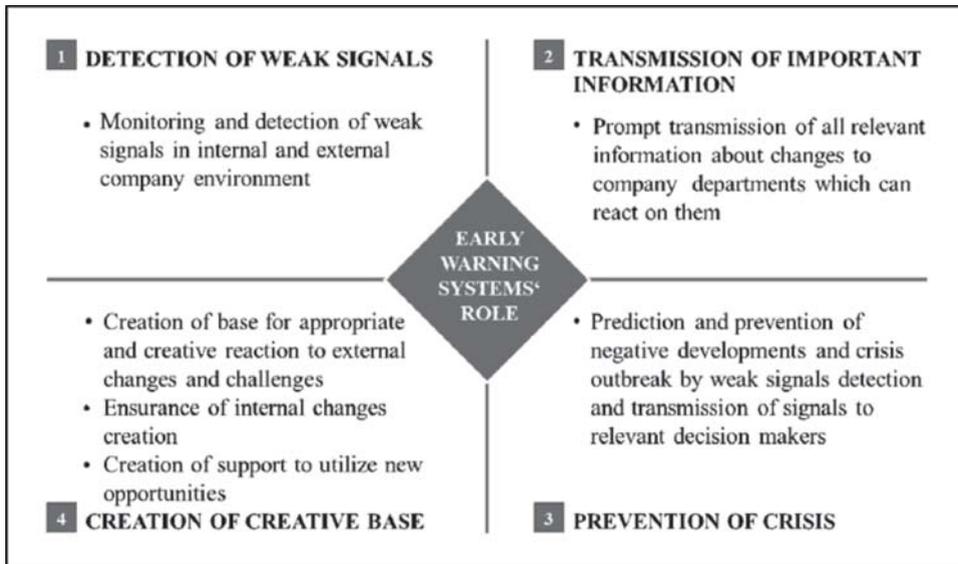


Figure 1. Functions of early warning system

Source: Bickhoff, N., Blatz, M., Eilenberger, G., Haghani, S., & Krause, K.-J. (2004). *Die Unternehmenskrise als Chance, Innovative Ansätze zur Sanierung und Restrukturierung*, Berlin, Springer.

Construction of the early warning system

The construction of the early warning system for the needs of the dynamic model of business processes improvement passes through three main stages.

In the first stage the way of reporting the changes in the environment is selected. Three main approaches exist in the practice: signal, discrete and structural.

With the signal approach, the values of the selected indicators are compared, at the initial position and immediately before the occurrence of the change in the environment (Kaminsky, Lizondo & Reinhart, 1997). It is necessary to choose period on which the signals must be reported. Its determination is within the competency of the organization's managers. Also, the control limits are identified, which are between two and three standard deviations of the indicators average values. In the classic model only one control limit is identified (Kaminsky et al., 1997), but later has also started determination of „warning limits” (Brugemann and Linne, 2002). The reporting of a weak signal, which is followed in future by a change in the environment is assumed as „a good” signal. Accordingly, the reporting of a signal, which is

not followed afterwards by a significant change in the environment, is called a bad signal or „noise” (Kaminsky et al., 1997). The main problem that should be solved is related to the selection of accurate early warning indicators, which should omit the bad signals and record the good ones (Kaminsky et al., 1997). To that end, the indicators are divided into the following four classes.

Table 1. Classification of the emitted signals

	Change in the environment (within the selected period)	No change in the environment (within the selected period)
Emit a signal	A	B
Don't emit a signal	C	D

Class A – indicators that have emitted signals during the relevant period and afterwards a change in the environment has occurred – good signal; **Class B** – indicators that have emitted signals, but a change in the environment has not occurred – bad signal; **Class C** – indicators that have not emitted signals, but a change in the environment has occurred – bad signal; **Class D** – indicators that have not emitted signals and there is no change in the environment – good signal.

Source: Kaminsky et al., 1997 (modified).

Every early warning system based on the signal approach should strive to minimize the correlation „good signal” to „bad signal” (A/B) (Kaminsky et al., 1997). There are also additional correlations between the classes, under which each indicator is evaluated: „the propensity of emitting a good signal” is equal to $(A/(A+C))$; „the propensity of emitting a bad signal” is determined in a similar way $(B/(B+))$; „noisiness of the indicator” $([B/(B+D)]/[A/(A+C)])$; „conditional probability of change in the environment” $[A/(A+B)]$; „unconditional probability of change in the environment” $([(A+C)/(A+B+C+D)])$ (Kaminsky et al., 1997). The signal approach of the early warning system is a useful tool of analysis, but it should not be absolutized (Edison, 2000). Combined with other techniques and methods of analysis and assessment, it gives a clear vision of the organization and its environment.

The discrete approach is a variety of the signal one, but with the difference that where the value of an indicator deviates from the average one beyond the specified limits, the indicator adopts the value „one” (Hajivassiliou and Ruud, 1994). While varying within the admissible deviations, its value is „zero”. Subsequently, the value is regressed by using the „logit” or „probit” models¹, in order to determine the probability of occurrence of a change in the environment².

¹ In many cases the choice depends on the researcher’s decision.

² For more information see: Hajivassiliou, V. and Ruud, P. (1994). *Classical Estimation Methods for LDV Models Using Simulating*. In Handbook of Econometrics, Volume IV, Elsevier Science B.V.

With the structural approach, various econometric models are used and the regression analyses are applied directly on the selected indicators.

On the second place, the type of the early warning indicators and the relations between them are determined. The type and number of indicators could be determined from:

- analysis of the external environment;
- analysis of the internal environment;
- the strategy of the organization through a balanced scorecard.

Analysis of the external and the internal environment of the organization with the dynamic model of business processes improvement

Upon the analysis of the external and the internal environment of the organization, the potential sources of damages and benefits for the organization are described and examined, notwithstanding whether they are beyond or within the corporate borders. The analysis is focused as on the external, as well as on the internal environment of the company, since they generate the strong and the weak signals.

External environment factors

The external environment is an aggregation of factors and components, which are not part of the company, but affect it. Such are the factors of the social, political, economic and technological environment (Eversheim, 1990). The changes in the environment have significant effect on the organization, but its influence on them is limited. The company should react to each change in the environment in order to be competitive. An important specific of the dynamic model of business processes improvement is that upon the analysis of the external environment, great attention is paid to the comparison with the direct competitors, as well as to the market position of the organization. The direct competitors are subject to monitoring and analysis, since their organizational and operational structures are similar and the flaws in the examined company could be outlined more clearly. Further, the elaboration of strategy or the implementation of a new product on the basis of performed analysis compared with the direct competitors could lead to stabilization and enhancement of one's own market position.

- ⇒ social environment – it describes the culture and the norms in the social system. The influence of the cultural differences is weaker compared to the legislations of the various countries. It is expressed in regional changes and specifications of the products. The social environment factors are subject of research of the marketing departments (Hentze, 1993).
- ⇒ political environment – it reveals the influence of the legislative, executive and judicial power on the organization. Here are included also the regulatory documents, regulations and laws, ensuing from international agreements and allian-

es, which are obligatory to be performed by any economic entity in the country. The rules and norms fixed by the state serve to define the external borders of the organization. They are specific for each sector and branch of economy. The relationships inside the company are regulated through intra-company regulations and/or formation of groups by interests, etc.

- ⇒ economic environment – it includes the measurers of the national economy and the international markets trends of development. Also, the influence of changes in the value of the resources needed for the realization of deliveries and sales is taken into consideration. The selection of a concrete indicator to be reviewed ensues from the specifics of the organization (Gälweiler, 1986). The economic environment factors exert the strongest influence on the organizations, since they affect their main goal, namely the profit (Hentze, 1993). Because of that reason the analysis and forecasts of the economic environment are of big importance and find wide application in the practice.
- ⇒ technological environment – it concerns mainly companies applying strategy based on products innovation. The analysis of the technological environment is aimed at continuous supply of information and knowledge about the technology of the production processes. That knowledge is both familiar and applicable in the practice, or is in the development phase (Becker, 1988).

Internal environment factors

Characteristic for the analysis of the internal factors influencing the designing and the improvement of the business processes is that they are divided into three groups: the ones affecting the resources; the orders; and the products³. It should take into consideration the influence of: reasons for the occurrence of technological interruptions; what the technological norms for the branch are at present and their future changes; presence and significance of future economic forecasts (Hentze, 1993).

- ⇒ resources – these are all necessary factors and components for the transformation of inputs into ready production. The resources are material (machines, buildings, personnel, etc.) and intangible (company culture, know-how, information, etc.). The material resources are used at a given moment only on one place, while the intangible – on different places and simultaneously. One of the most important company resources is the staff. The labour and knowledge applied by them in the production predetermine the company success. At the same time the workers and the company are in a mutual contradiction. The employees' income, in the form of wages, represents a significant financial expense for the organization. On the other hand, those incomes generate consumption,

³The two familiar techniques of the internal environment analysis are not applied – through „the Porter's chain of values” or through „analysis of the resources according to their profile”.

which leads to increase of company's revenues and hence increasing the success (Kreikebaum, 1997). Through the interaction of the resources after placing the order, the final result is achieved – product/service. This product is designated to satisfy the needs of an internal or external customer. Selling is a process of moving product from the company to customers.

- ⇒ orders – the order expresses the needs of an internal or external customer of the relevant product/service and triggers the performance of the process. External customers are outside corporate boundaries and are users of complete product/service. Internal customers can be departments that ordering unfinished product which will be processed into next phase of production cycle. Upon receipt of the result of the process, the customer is paying certain price. He evaluates the process for compliance with the agreed specification through factors, such as: time needed for delivery; abundance that time; quickness of service; price and quality of the product. Upon noncompliance with some of the listed factors, it is assumed that the customer shall turn to a competitive enterprise. The demand of company products leads to increase of the revenues and enhancement of the organization's success. From this point of view, the preferences and the desires of the customer are of great importance for the companies. They must take central place in the process of taking strategic and operative decisions.
- ⇒ products – the products represents the result of the running of a process. The material and intangible resources of the organization are implemented in the product. The products themselves may also be determined as material (goods) and intangible (services) (Spur, 1994). The formation of a new product through running a process is characterized by the transformation of materials or of partially ready components and adding value (Günther, 2005). The processing and the transformation of those components into an end product can be expressed in change of the physical condition or addition of complementary benefits for the customer.

Selection of early warning indicators based on balanced scorecard

Besides based on the analysis of the external and the internal environment, the early warning indicators may be derived also from the organization's strategy. To that end, key indicators⁴ are used in the balanced scorecard, through which the strategy is performed. The change in the environment leads to a change in the rate of strategic goals achievement. The key indicators from the balanced scorecard record any deviation from the set forth goals. The presence of a stable deviation from the goals generates a necessity of reorganization and optimization of the business processes.

⁴Those are indicators of qualitative and quantitative measuring of the rate of achievement of the set forth corporate objectives (Kaplan and Norton, 1996).

On the grounds of this dependency, the early warning indicators could be derived from the key indicators used in the balanced scorecard. Another reason of deriving the early warning indicators from the balanced scorecard is that similar to them, the key indexes are also selected on the basis of defined criteria. They should be „measurable”, „accessible”, „clearness”, „balanced”, „quantitatively measurable”, etc. (Kaplan and Norton, 1996). However, the practical researches show that the selection of indicators is complied with the specific of each company (Table 2).

Table 2. Example indicators

Finance	Customers
Total assets	Market share
Total income/assets	Customer volume
Income of a shareholder	Time needed for a client
Income from new products (customers)	Customer Loyalty Index
Total profit / assets	Index of customer satisfaction
Profit of a shareholder	Index of satisfaction of distributors
ROI	Rate of customers growth
Profitability of invested capital	Annual sales per customer
Profitability of income from new products	Profitability of a customer
Cost of capital	Return volume
Cash flow	
Internal business processes	Learning and Development
Administration costs	Index of staff turnover
Stocks turnover	Costs of staff training
Preparation time of production process	Satisfaction index
Production costs	Relative share of trained staff
Share of the rejected production	Relative share of training costs
Cost of purchasing and delivery of inputs	

Source: Schneier, Cr., Shaw, D., Beatty R. *Performance, Measurement, Management and Appraisal Sourcebook*, Numan Resource Development, 1995 (modified).

A list of possible early warning indicators is drafted from the obtained information from the analysis of the environmental factors affecting the organization, as well as from the balanced scorecard. The initial list may include also indicators from other sources of information, such as: consultancy companies, unit leaders, specialized literature, existing regulatory basis, market researches, etc. (Sexton, 2011). This information should be of high quality and accessible. Many of the initially chosen indicators are similar in their essence. Due to that reason, a selection of the indicators is done, most often through discussions between the executive officers and the heads of departments. Several individual indicators may be aggregated in one or to

be completely dropped off the system⁵. Besides, the various indicators are evaluated also in accordance with the emitted good signals to the system. In general, the definition of the indicators is a specific task for each business unit. Summarizing universal indicators is at least incorrect and even impossible.

Determining the causal relations between the indicators

The causalities between the indicators can be divided into: directly or inversely proportional; functional or stochastic. It is characteristic for the directly proportional relations that upon increasing/decreasing of the value of one of the indicators, the other is changing in the same direction. With the inversely proportional relations – the increasing of one of the indicators leads to decreasing the other one and vice versa. Functional dependency is present where a direct relation exists between the indicators⁶. Stochastic are the indirect, probability relations between the indicators. For the normal functioning of the early warning system it is necessary to ascertain whether causalities exist between the selected early warning indicators and what they are. This way, in case of deviation in one of the indicators, the managers shall be aware how the others would change.

In the third stage of building the early warning system for the needs of the dynamic model, control limits of the already selected indicators are set forth. A concrete value is specified for each indicator. Through it slight deviations in the indicators can be detected. The monitoring periods are determined, which are specific for each company.

In order to select the control limits, it is necessary to identify firstly the average level of each indicator. This is done by setting their quantitative values. The control limits are selected similar to those in the control cards. They can be: narrow – „warning limits” and broad – „intervention limits” (Kamiske, 2007). In practice, most often the „warning” limit is assigned a value of two sigma, and a „control” – three sigma from the mean. The more narrow control limits are chosen, the more signals will be counted, but at the same time will increase the reporting of bad signals (Bussiere and Fratzscher, 2002). Moreover, for some specific indicators (e.g. unemployment) is not necessary placement of the lower control limit. Therefore, the selection of specific values of the control limits is also the responsibility of management and is specific for each organization. If the values of a given indicator fall outside the „warning limit”, a signal is sent for the appearance of a deviation. This deviation may have random character and to not have any further influence. But if increasing, the values of the indicator shall cross the „intervention limit”, whereof immediate taking measures for the improvement of the relevant process should follow.

⁵ See: Kaminsky et al., 1997.

⁶ The functional relations could be: full – where their relation is quantitative; and incomplete – where the relation is of qualitative nature.

After the control limits of the indicators have been set, the monitoring periods should be selected. They also are specific for each company. The practice shows that most often quarterly periods are selected. A follow up reporting is done each quarter. Another possibility is the selected monitoring period to be in compliance with the product life cycle. Upon presence of an indicator value outside the „control limit”, adjustment of the monitoring period is allowed.

Functioning of the early warning system

The functioning of the early warning system is performed by monitoring of the internal and the external environment of the organization. In the basis of this periodical research lies the cybernetic approach. Through recording the weak signals sent by it, the arising threats or possibilities are identified (Krystek and Müller-Stewens, 1993). The indication of such changes in the environment arising is realized within the already specified monitoring zones (Hahn and Klausmann, 1986). The monitoring is performing several main tasks. The first one is to accumulate information from the environment, through which innovative production technologies can be discovered, which could have positive effect on the organization. Another task of the monitoring is to regulate the responsibilities and competencies of the employees upon crossing the control limits of the relevant indicators. This is allowing for, in case of any deviation beyond those limits, the use of all resources for its elimination. In this regard, the application of elaborated in advance crisis strategies is necessary. All employees must be familiar with them and should undertake the relevant actions related to their application. An additional task of the monitoring is the provision of data about the position of the company in the branch and its status compared to the direct competitors at certain periods. The performance of the monitoring in the dynamic model of business processes improvement may be described as a sequence of several steps.

- ⇒ **Step 1:** Scanning of the environment for the presence of weak signals. In case of available such signals, the change of the indicators values is reported.
- ⇒ **Step 2:** In case of available deviations beyond the warning limits, an analysis is done of the reasons of their occurrence. All deviations are presented in a web diagram. This way, it becomes clear whether the deviations in the indicators are positive or negative.
- ⇒ **Step 3:** It is ascertained whether there exists any functional relation between the deviations of the individual indicators.
- ⇒ **Step 4:** In the fifth step a prognosis of the deviations development is made. The purpose is to identify the future change of each deviation, as well as its stability. Should the prognosis model show a trend towards increase and possibility of crossing the control limits, the next step should be undertaken. Otherwise, we assume that the deviation is of random nature and shall not cross the control limits.

⇒ **Step 5:** Sending information to the second module of the dynamic model of business processes improvement about the presence of deviations generating the necessity of processes optimization. The goal is to achieve sustainable improvement in the organizations process structure.

Whether the process optimization is effective and sustainable is determined at the next scan.

Conclusion

The early warning system presents the first phase of the dynamic model of business processes improvement. In this module monitoring of the company and the environment is performed. Early warning indicators are defined, which allow earliest possible reporting of changes in the environment. The indicators are derived through analysis of the external and the internal environment of the company or from the key indicators of the balanced scorecard. It is necessary to set forth control limits for each indicator as well as a period of time for the monitoring. The practice shows that the optimal monitoring period is quarterly. In case of deviations beyond the control limits of any indicator, analysis is performed of the reasons of its arising and prognosis of its future change. The actual bettering of the relevant process, in which a deviation has occurred, is done in the next module of the dynamic model. The application of the early warning system in combination with the „Business processes improvement” module, where the actual improvement is done, of the dynamic model of business processes improvement allows for the achievement of sustainable and efficient optimization of all processes in the organization.

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