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Development of Internal Control Methodology by Using Statistical Methods of Variability Assessment of Material Flow Business Processes

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Abstract:

Variability or instability is one of the key features of any process, including business processes of material flow internal control. Variability is a characteristic of all natural systems and technical processes. The objects which properties can be characterized via certain parameters arise at the output of any process.

The article discloses the feasibility of using the statistical methods in the internal control system of business entities; in this case the focus is on the method of identifying the causes of variability using control charts of various types (Shewhart control charts) as a prime tool.

The view points regarding variability of famous academic economists who researched the business process management issues are also considered. Authors' classification of business process variation on types of material flow internal control with the allocation of controlled and uncontrolled variation is taken as the basis of the proposed application.

The method of using control charts in estimating the efficiency of material flow internal control business processes is described in detail.

Keywords: *Internal control, business process, cycle, variability, control charts, classification of variations, product quality, monitoring*

JEL Classification Codes: *M10, M40.*

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1. Introduction

As far as is known, there is nothing permanent in economics just as in nature; everything flows, everything changes. In practice, while developing some management systems, forming new control methods, improving the accounting methodology, we, as a rule, do not think about it at all, considering the object of interest in its unchanged form as a fact of life and then we wonder why the models, schemes and recommendations proposed in the scientific and practical studies do not work (Zobov *et al.,* 2017).

It would seem that logically relevant modern methods of measuring the parameters of business processes, which include, for example, the methods of measuring the quality of business processes, mathematical methods of estimating the parameters of business processes, methods of measuring balanced indicators and key performance indicators (balanced scorecard BSC and system of key performance indicators KPI), methods of measuring the duration, prime cost, profitability of business processes and others have been developed based on the results of multi-year scientific research and observations, fall short of expectations of their implementation. To resolve this issue, the methods for identifying problems aimed at investigating the causes of the business process poor status, which include Ishikawa method, Goldratt's method, as well as statistical methods, have emerged and worked out in the economic theory. The following methods may be referred to statistical methods:

- method for registering deviations where the checklists are the prime instrument;
- method for identifying the reasons of deviations (basic tool - Pareto diagram);
- method for identifying the causes of variability, using the control charts of various types as a main tool.

It is the latter method, its benefits and advantages, possibilities of use in the internal control business processes management system with regard to flow of tangible assets that we would like to settle upon in this article.

2. Theoretical, Empirical and Methodological Grounds of the Research

The values of variability indicators may slightly deviate from some mean value every cycle of a continuously operating business process. Such deviations may be considered as variations. The variations represent the true properties of each process. According to Adler (2012) *"The systems can be distinguished with help of variability as people are distinguished via fingerprints"*. Considering the fact that variability is an inherent property of the process, the changes in process performance indicators (measures) must contain information about events occurring in the system under study. Mistakes, deviations, errors that occur during the work of economic entities are the sources of variations. Deviations from the expected results of business

processes functioning are due to peculiarities of financial and economic activity and the impact of external factors.

Scientists, who have studied the management issues under the conditions of business process variability, consider Walter Shewhart (1939) as the founder of the concept of variation "control." Shewhart worked for Western Electric, when he set himself the task of explaining the cause of the futility of the attempts of Western Electric specialists to achieve uniformity, reliability and quality of output product (Adler, 2012). The company's specialists have found out an unusual effect of attempts to improve the quality of products: *"...the more they tried to achieve reproducibility and uniformity of product properties, the worst the result turned out to be, that is, the greater the differences and properties dispersion became."*

During studying the problems encountered in Western Electric Shewhart (1939) identified two main types of errors that were made by the company's specialists while classifying the deviations in the quality of products:

1) assignment of deviations to specific, exceptional ones while they were caused by the peculiarities of the company's technological process;
2) interpretation of deviations as a result of the influence of common causes, while they were due to special reasons (Adler, 2012).

Based on research findings, Shewhart decided to find a solution for improvement of product quality via identifying criteria of deviation classification and reduction of variations.

Correct diagnosis of deviation sources and variability of processes makes it possible to improve the quality of business processes. Shewhart distinguished controlled, natural (expressing the system stability) and uncontrollable, unnatural process variability (characterizing the system instability). Controlled variation is due to accidental causes arising from technological characteristics of the process under study. The controlled variation is characterized by structure stability and invariability in a certain time period.

Special reasons, which significantly affect the variability of measures of business operation items, may occur periodically during functioning of any business process. Uncontrolled variation arises, which characteristics should include the structure variability through time. *"Shewhart control chart is designed for detection of uncontrolled variation"* (Wheeler, 2009). According to Ishikawa (1985), Shewhart control charts (SCC) belong to *"the group of seven of simple methods"* of quality management.

If business process output indicators are formed under the influence of special reasons causing uncontrolled variation then the possibility of prediction of business

process results is drastically reduced. It is important, while identifying the signs of business process instability, to take actions aimed at returning the system to a stable condition as soon as possible. If the business process is in a stable state, managers can conduct operations regarding improvement of the internal control of business operation items with materials.

The ideas of Shewhart apply not only to operations within production process, but also to a wide range of other problems. As Neave (2016) notes, referring to the statements of Deming, *"...the very first control charts which have to be plotted in any organization should refer not to the processes in the workshops, but to the data that is laid on the table of head of an organization - such as data on the budget, expectations, absenteeism, accidents and injuries."* Material flow internal control business processes are referred to the processes of which the decisions of the manufacturing organization management are directly dependent on (Henry and Hotelling, 1933).

3. Discussion

Based on the study of Shewhart's theory of production systems variations, we have developed a classification of types of variations of material flow internal control business process (Table 1). The classification is fulfilled according to the following classification criteria:

- causes of variation occurrence;
- belonging to the process under study;
- characteristics of variations with regard to their stability and invariability;
- need for management actions on the business process with the materials in response to identified variations;
- predictability of business processes results.

Table 1. *Classification of types of business process variations of material flow internal control.*

Classification creteria	Types of variations of business processes with materials	
	Controlled variations	Uncontrolled variations
1. Causes of variation occurrence	Natural reasons caused by process technological characteristics	Specific reasons caused by unusual actions
2. Belonging to the process under study	Belong to the process under study	Not a part of the process
3. Characteristics of variations with regard to their stability and invariability	Stable, constant through time	Instabile, inconstant through time
4. Predictability of business	High capability of exact	Low capability of

Classification creteria	Types of variations of business processes with materials	
	Controlled variations	Uncontrolled variations
processes results	prediction	prediction
5. Need for management actions on the business process in response to the identified variations	Administrative actions in response to detected variations are not desirable, they can lead to "disorder" of the system	Administrative actions in response to detected variations are needed, they aid to bring the system in an "ideal" state

It is necessary to define the boundaries within which the process is subject to controlled, natural variability only. Shewhart (1939) proposed to use control charts and three ranges of squared error calculated by means of statistical formula for this purpose. Deterministic constants that define the boundaries of natural variability interval above and below the mean value of the process functioning index (measure) are allocated when calculating. Setting the constants of natural variability interval boundaries makes it possible to perform diagnosis of process stability. Stable process makes it possible to predict its state only. The predictability of business processes with the materials is one of the essential prerequisites for management decision making in manufacturing organizations.

The ideas of Shewhart provided the basis for studies of such foreign scientists as Wheeler, Herny and Hotelling, Feigenbaum, Ishikawa, Goldratt and others (Wheeler, 2009).

Wheeler (2009) developed Shewhart's theory of variations and proposed to consider four possible states of the processes arising under the influence of variations: "ideal", "threshold", "on the edge of chaos", "in a state of chaos".

Henry and Hotelling (1933) paid special attention to the problems of predicting the effects of changing the non-convex functions – violations of convex prerequisites of elementary economics making it possible to predict the market collapse.

Feigenbaum (1986) author of the total quality management concept, which became a new philosophy in the field of enterprise management in 1960s. The main provision of this concept is the idea of quality management inclusiveness, which should involve all stages of product development and the entire levels of enterprise management hierarchy while implementing technical, economical, organizational, as well as social and psychological activities.

Ishikawa (1985) developed a management method aimed at identifying the true cause of a problem among a great number of other interrelated reasons based on application of the *"Ishikawa causes and results diagram"* instrument.

Goldratt (2009) developed a method of identifying problems (Goldratt's method) within the framework of the theory of constraints TOC aimed at identifying the root cause of a problem caused by a chain of related problems (some problems are considered as causes of other problems). Development of a complete set of reasons for each problem which makes it possible to eliminate the problem by eliminating just one cause of a set of reasons (furthermore, remedying one reason leads to elimination of the entire chain of related problems) is a feature of this method.

Four criteria of testing statistical hypotheses have been developed under conditions of economic instability and crisis with a high degree of uncertainty of anticipated development strategies:

- A. Wald decision criterion (maximin);
- R. Hurwitz decision alpha-criterion;
- L. Savage criterion of decisions (refusal of the minimax criterion);
- P.S. Laplace criterion of decisions (T. Bayes decision criterion).

Thus, the vitality and enduring value of the ideas expressed in the papers of Shewhart, the essence of which lies in the fact that the reduction of variability is one of the main objectives of business processes improvement, the results of which are of statistical nature, must be admitted.

According to the results of the above-mentioned academics we fulfilled a comparative analysis of variations influence on the state of material flow internal control processes based on the method of Shuhart. Comparison was made in the following areas:

- causes of variation occurence;
- nature of variations;
- stability of process;
- controllability of process;
- compliance of process outcome with the specified quality criteria;
- prediction of process results;
- trends of control charts use.

To illustrate this study, we chose a "product quality" criterion developed by Feigenbaum as a primary criterion of estimation. In his book, published in the US in 1983,Feigenbaum wrote as follows: *"As a matter of fact, the quality is a method of managing an organization. Just as finances and marketing, the quality has become an essential element of modern management"* (Feigenbaum, 1986). It would be nice to clarify that, in practice, it is advisable to use not only the criterion of product quality but also the criteria of duration, prime cost, and the profitability of business processes.

Natural causes of variations resulting from process technological characteristics cause an "ideal" and a "threshold" state of the business process. The business process is stable and completely controlled in an ideal state. Exact prediction of possible process outcomes is possible. A product which characteristics fully comply with the specified quality criteria is designed at the output of an ideal process. Continuous use of control charts will ensure constant monitoring of possible variability and will serve as a means for identifying specific variations.

There are also specific reasons in a small quantity in addition to natural causes of variations when the system is in a "threshold" state. This leads to a small quantity of inconsistencies at the output of a business process. The system being in a "threshold" state shows not a full but a reasonable degree of control and a number of defective products can be made in this regard. In this case, control charts are used for identifying the reasons of possible specific variations that should be eliminated. Further, it is possible to start configuring the system, correcting the process purposes and changing the tolerances. The use of control charts will make it possible to estimate the process modification results, maintain the process in a controlled state and implement changing over of a system from a threshold state into an ideal one.

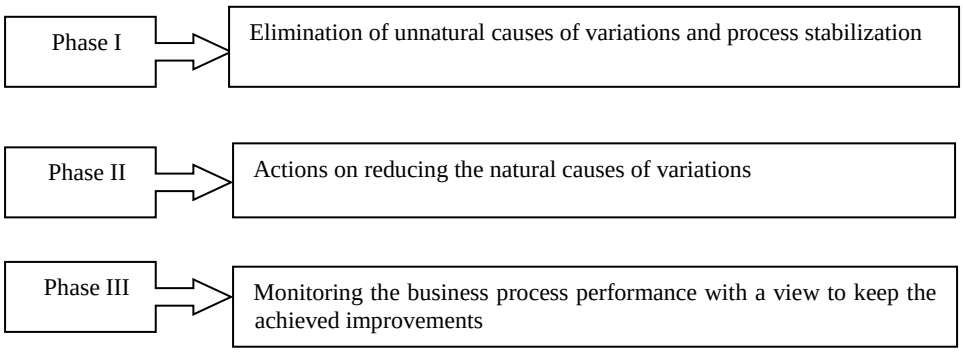
The state of the system under the influence of variation special reasons is characterized as "on the edge of chaos" or "in a state of chaos." In this state, the process shall be considered as an uncontrolled one despite the fact that the products being in full compliance with the specified quality criteria are being made in the certain periods of system operation. But nonconforming products are being produced at some unexpected moments at the output of the process. It is impossible to fulfill prediction of process results in a state "on the edge of chaos." The process stability is maintained in certain periods of time only. When the system is in the state "on the edge of chaos," control charts are used to identify the special causes of variations.

The products not meeting the quality criteria are constantly produced in a "chaos" state. The prediction of process results becomes impossible. The process is in an unstable and uncontrollable condition. Random changes being generated by specific variations raise obstacles to application of measures regarding process improvement. The application of control charts is the only way of removing the system from a state of chaos with a view to eliminate specific reasons of variations. In this case, the control charts serve as a confirmation instrument of removing the special reasons of variations from the process due to its modification.

Real business process is never perfectly stable. There are always reasons that lead to uncontrolled variations. The early detection and elimination of unnatural variations as well as implementation of further work on improvement of business processes is the objective of the material flow internal control system. The improvement of business processes may occur in three phases (Figure 1):

1) elimination of unnatural causes of variations and process stabilization;
2) actions of reducing the natural causes of variations;
3) monitoring the business process performance with a view to keep the achieved improvements.

Figure 1. *Phases of business process improvement*



It should be mentioned that control charts can play a major role in the improvement of processes in each of the three phases. In the first phase, the control charts serve as a diagnostic tool of unnatural, uncontrolled causes of variations. After special reasons of variations have been excluded, specialists performing control functions can proceed to improvement of business processes. When performing actions of reducing natural causes of variations, recalculation of control limits is fulfilled. In the third phase of business process improvement control charts are used for diagnosing the causes, which may adversely affect the state of the process stability achieved in the second phase.

4. Conclusions and recommendations

Thus, summarizing the above-mentioned theories, it should be mentioned that variability is one of the main features of material flow internal control business processes as it was found out during the study. It is practically impossible to ensure the effective functioning of an economic entity internal control system in the current economic environment without regard to this factor. There are a number of methods in theory and practice, which make it possible to ensure generation of the forecasts of expected changes in the relevant business processes, one of which is the method of control charts application (Shewhart method). This method provides an opportunity to identify and promptly remove unnatural causes of variations, take actions to reduce natural causes of variations and fulfill permanent monitoring of business process functioning with a view to preserve the achieved improvements.

The application of this method using the chosen "product quality" criterion enabled to develop four models of the material flow internal control business process state presented in this article. The use of these models will make it possible to ensure improvement of an economic entity internal control system functioning in practice as well as to provide implementation of three phases of this business process improvement.

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