7. Низкая степень риска снижения доходности по сравнению с вложением средств в акции. Доход, получаемый инвестором по облигациям, не зависит от результатов хозяйственной деятельности инвестора или от волатильности рынка. То есть вложения в облигации являются менее рискованными.

8. Сравнительно невысокие транзакционные издержки. Для инвестора расходы на приобретение облигаций фактически зависят от размера комиссионных брокеру.

9. Льготный режим налогообложения. По еврооблигациям проценты выплачиваются без вычета налогов на проценты и дивиденды (withholding tax). Налог (уже как чисто подоходный налог) платится инвесторами по законодательству своей страны. Если же местное законодательство предусматривает удержание налога на проценты, который платит заемщик, последний обязан довести величину процентных платежей до уровня, обеспечивающего инвестору процентный доход, равный номинальному купону. Принимая во внимание, что еврооблигации в основном выпускаются на предъявителя, это позволяет инвесторам применять различные схемы минимизации налогообложения, в том числе посредством торговли через оффшорные счета [5, с. 26].

Таким образом, инвесторы на рынке еврооблигаций, в его широком понимании, хорошо защищены и имеют массу возможностей для реализации своих целей. В целом можно отметить, что дефолтов по еврооблигациям меньше, чем на локальных рынках. Это связано с особой ценностью международной репутации, защитой прав и интересов инвесторов. Значительные преимущества, которыми обладают еврооблигации как с точки зрения заемщика, так и сточки зрения кредитора (инвестора) позволили еврооблигациям всего за несколько десятилетий занять значительное место среди инструментов привлечения внешнего финансирования, а также ключевую позицию на мировом рынке ценных бумаг.

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УДК 330.101

IDENTIFICATION OF MODEL OF THE PRODUCTION PROCESS FOR THE PURPOSES OF QUALITY MANAGEMENT

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The article is the result of research on identification of models of production processes in terms of non-classical assumptions for quality management purposes. It discusses the classical model and indicators for assessing the ability that assume as its starting point the assumption of normal distribution features of the process. It proposes a general process model that allows precisely describe statistical characteristics of the process in any real case. In comparison to the classical approach it gives a more exact, determination of its capabilities. This model contains the type of process, statistical distribution and the method for determining the capacity and efficiency (long-term capacity) of the process.

The proposal contains own classification and the resulting set of types of processes. The classification follows the recommendations of ISO 21747: 2006 introducing models for non-stationary processes. However, the set of types of processes allows, beyond a more precise description of the process features, to use it to monitor the process.

We present a method that allows the identification of the process model in each case to choose the most appropriate model for the purposes of assessment, control and monitoring. Description of the method is illustrated by a block diagram of the main steps of proceedings.

Methods of identification are not currently known in the literature and it is an important theoretical and practical issue that deserves a solution.

Practical applications require computer-aided methods and specific algorithms of execution shown on the diagram of statistical tests.

Such a detailed presentation is beyond the scope of this paper.

In accordance with modern concepts of quality management in the sphere of production it comes down to solve the following problems:

− effective monitoring of the variability of production processes and their ability to manufacture products with a given level of quality,

− response to changes in the process, in particular the location of place and reason of the formation of various types of non-compliance with the specifications of products,

− improving processes by reducing the volatility of their parameters and hence the variation of quality of products.

Since the variability of processes and product characteristics can be described in terms of statistics, statistical methods mainly and area of expertise referred to as "statistical process control" are important in its reduction. Most of these methods for the effective application also require computer support.

To monitor the status of the process Shewhart control cards are traditionally used. The control limits are determined on the assumption that the process is stabilized, which means stability in time of the expected value and standard deviation of the variable, and is subject to the normal distribution.

Under these assumptions, the statistical parameters and process control limits of cards are determined from the parameters of samples taken from the process in the phase of preliminary tests.

If the process satisfies the assumptions of stability - we say often that it is "under control" - the quality in time characteristics is represented by a model often referred to "Shewhart process model" in the form:

$$x_t = \mu + \varepsilon_t \qquad \mathrm{t} = 1,2,..... \tag{1}$$

x_t - the value of the variable (product characteristics) at time t,

μ - process constant,

ε_t - variable with normal distribution N (0, σ) representing the random influences.

A change to one of the assumptions in real conditions (e.g. the expected value or standard deviation) drives the card to generate the signal of the deregulation process, which is

the main purpose of the card.

Boundaries designed in such a way correspond to the scope $\mu \pm 3\sigma$ of normal distribution variable and determine the "natural variability of the process". They are also the basis for calculating the process capability with respect to the technical requirements defined by two indicators [7 s.351, 355]:

$$C_p = \frac{USL - LSL}{6\sigma} \tag{2}$$

$$C_{pk} = \min\left\{\frac{USL-\mu}{3\sigma};\frac{\mu-LSL}{3\sigma}\right\} \quad (3)$$

where C_p, C_{pk} − Respectively process capability index and a minimum capability of process, USL, LSL - Respectively the upper limit and lower limit of tolerance, σ - The standard deviation of the variable.

The assumptions made in classical SPC conform to a model (1), which is not always appropriate to the actual situation, what must be a fundamental feature of each model.

Practical situations in the industry led to a change of methodological approach, recognizing several classes of process models, among which " Shewhart's processes " (normal) represent only one class. Recognition of the need to introduce new models of processes in some countries took a form of official standardization guidelines and recommendations. One example is Germany, where in 2002 DIN 55319 - Qualitätsfähigkeitskenngrößen was developed.

Also, a number of company recommendations (e.g.. Ford) provides a basis for the control, the need for analysis and process identification [2, p. 81.86], and for the use of special methods, if the distribution is incompatible with the normal.

The new approach was formally introduced in 2007 by ISO 21747 [3].

The use of this approach makes it necessary to identify potential types of processes and how to identify them and to establish statistical models for proper determination of process capability as well as their monitoring and control. The aim of the study is to present solutions to these two problems.

1. TYPES OF REAL PROCESSES

The new approach introduced by ISO 21747, recognizing non-stationary processes, distinguished eight types of processes called distribution models shown in Table 1.

The term "distribution model" was interpreted as "a specific schedule or distribution class [3 p.1] (6, p .47).

Distribution of the properties in the standard means "information about the probabilistic behavior of the properties" and "distribution class", "a specific family of distributions, in which every member has the same common characteristics under which the family is fully specified". Classification was based on the criteria shown in the table 1.

Table 1 − Basic characteristics of the time-dependent distribution models

Feature	time-dependent distribution models							
	A1	A2	B	C1	C2	C3	C4	D
location	c	c	c	r	r	s	sr	sr
variability	c	c	sr	c	c	c	c	sr
Temporary distribution	nd	1m	nd	nd	nd	as	as	as
Resulting distribution	nd	1m	1m	nd	1m	as	as	as

Source: [5, p.14].

Among these measures were the location and characteristics of distribution dispersion, and the characteristics of the instantaneous distribution and the distribution of the output.

Features of the location and dispersion are affecting the nature of the variability of these parameters of the distribution. The designations shall specify:

– "c" - this parameter remains constant during the study period (longer period).
– "r" - this parameter varies randomly,
– "s" - this parameter is changed in a systematic way,
– "sr" - this parameter is changed in a systematic and random way.

The characteristics of the distribution are marked, in turn, by the following abbreviations:

– "nd" - normal distribution (normally distributed)
– "1m" - other than the normal distribution, unimodal (one mode only).

– "as" - distribution of any shape (other than normal).

Temporary Distribution is characterized by the behavior of properties when tested in the short term. These properties are based on measurements of small samples, making up random sample. Usually it is the interval during which the sample is taken from the process.

The resulting distribution, sometimes called output decomposition of a process, is obtained from observing the process over a longer period. Then changes in the position of temporary distribution in the dispersion of the measurement resulted, and even other parameters of the distribution revealed.

Models of distribution, as time-dependent, are divided into four main categories:

A - processes with fixed position and dispersion, in which the instantaneous distributions do not change and are in accordance with the output distribution;

B - processes of fixed position but a variable dispersion;

C - processes of the solid dispersion but changing position in time;

D - processes with both variable characteristics.

Despite the importance of formal recognition by the ISO-21747 of non-stationary processes in the SPC, their own classification was proposed. It is one of the results of the study. It used, besides the criteria adopted in the standard, an additional criterion - "The distribution of the instantaneous position." Also it adopted a clear division of location and momentary distraction of distribution.

Based on the analysis of the various practical examples and presented in the literature synthetic classification of process shown in Figure 1 was made. For A2-type processes there examples of types of distributions were given. They do not exhaust all possibilities that may appear in the actual processes. Closer characteristics of the different types of processes was presented in Table 2.

On the basis of five criteria (shown in the columns of Table 2) 13 types of processes into which each real process can be classified were distinguished. The last column gives the models are also possible for use in determining " natural capability of process". The model includes a method for determining the ability of (M1, M2) and a statistical distribution or group of distributions (Fig. 1).

Designations in Table 2 specify the following models or group schedules:

IJMD − other than the normal unimodal distribution,

NR − normal distribution "extended",

NN − distribution is not normal and not unimodal,

MRN − a mixture of normal distributions (table 2).

Expanded distribution here means fitted statistical distribution in which "the natural variability of the process" has been calculated using the additional variability (method M2) defined by one of the following formulas:

$$\hat{\mu}_{add} = \max_{i\in(1,N)}(\bar{x}_i) - \min_{i\in(1,N)}(\bar{x}_i) \text{ - According to the span of average samples} \quad (4)$$

$$\hat{\mu}_{add} = wariancja(ANOVA) \text{ - According to the method of analysis of variance} \quad (5)$$

where $\bar{x}_i$ - The average value of a feature in the i-th sample, N - total number of samples in the sample.

However, the standard does not provide detailed method for inclusion of an additional variation determined by ANOVA or process models, for which a suitable variant shall be used (4), (5) of additional variance.

Closer characteristics of the methods listed in the "model of distribution” of Table 2 is presented in [1] and [3].

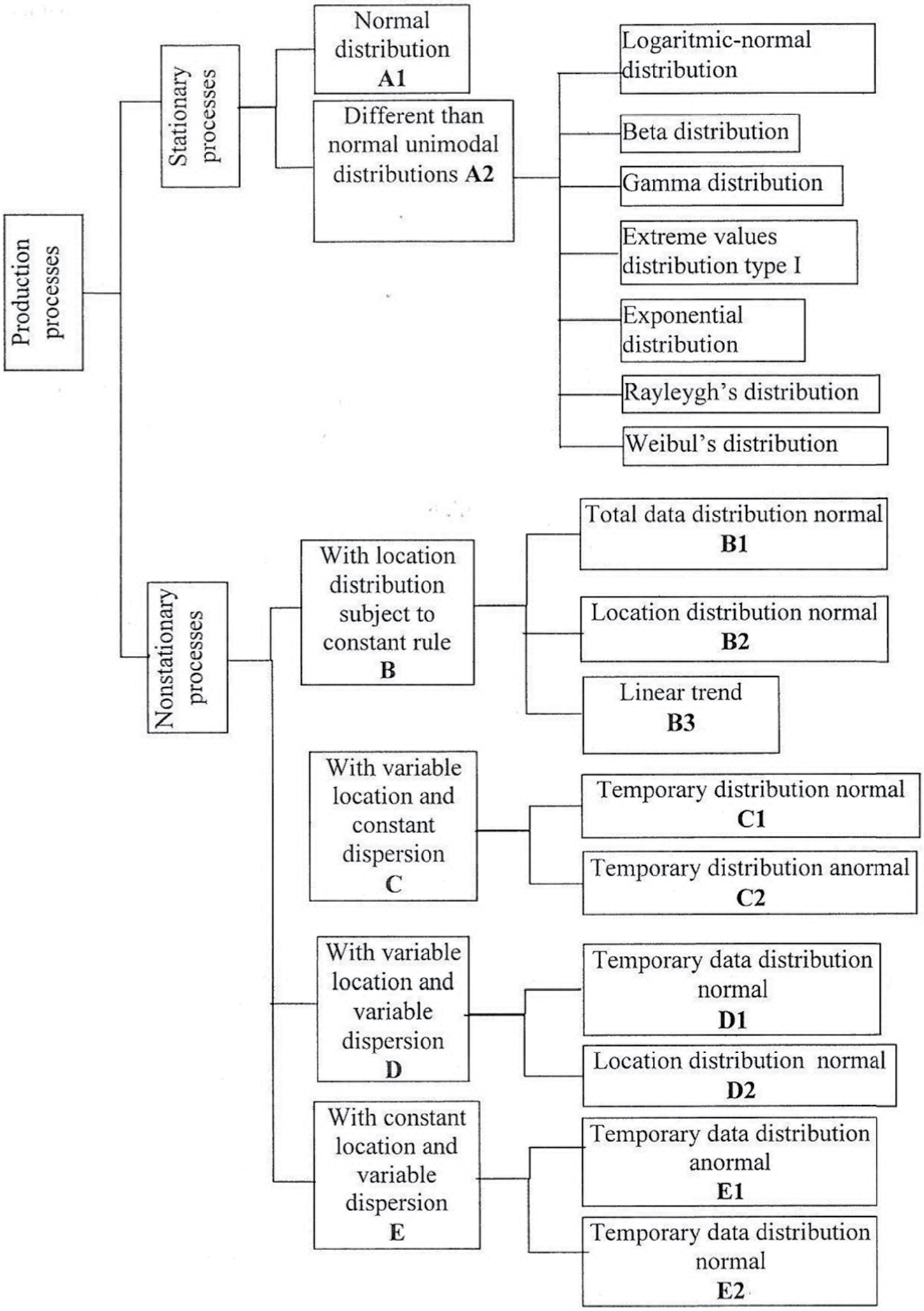

Fig. 1 – Classification of production processes from the point of view of statistical models of the distribution of characteristics

Source: *[own development]*.

Table 2 − Characteristics of the types of processes with the potential models of statistical distributions

Process type	Temporary location	Momentary dispersion (variance)	Distribution of temporary position (means)	Distribution of temporary data (samples)	Distribution of total data (populations)	Distribution model
A1	Constant	Constant	-	Normal	Normal	M1 (Normal)
A2	Constant	Constant	-	Inny JMD	IJMD	M1- IJMD
B1	Variable	Constant	IJMD	Normal	Normal	M2-a2-1 M1-NR1
B2	Variable	Constant	Normal	Normal	NN	M1-MRN, M1-NR2 ≡ M2-a2-2
B3	Variable	Constant	Linear Trend	Normal	NN	M1- MRN M2-a1
B4	Variable	Constant	Normal	Normal	Normal	M2-a2-1 M1-NR1
C1	Variable	Constant	IJMD	Normal	NN	M1-MRN
C2	Variable	Constant	IJMD	IJMD	NN	M1-MRN
D1	Variable	Variable	IJMD	Normal	NN	M1-MRN
D2	Variable	Variable	Normal	IJMD	NN	M1-MRN
D3	Variable	Variable	NN	NN	NN	M1-MRN
E1	Constant	Variable	-	Normal	NN	M1- MRN M1-NR3 ≡ M2-a3
E2	Constant	Variable	-	IJMD	NN	M1-MRN

Source: *[own elaboration].*

M1-IJMD - method of percentages (MUP), matched unimodal distribution other than the normal,
M1-MRN - method of percentages (MUP), matched mixture of normal distributions,
M1-NR1 - MUP, the normal distribution of the total variance by ANOVA (normal expanded)
M1-NR2 - MUP, a normal distribution with variance by a combination of the total variance and the variance of the instantaneous position,
M1-NR 3 - MUP, a normal distribution with variance total by a mixture of normal distributions,
M2-a1 - method of explicit inclusion of an additional variation of "a1"
M2-a2-1 - method of explicit inclusion of an additional variation of "a2-1"
M2-a2-2 - method of explicit inclusion of an additional variation of "a2-2"
M2-A3 - the method explicit inclusion of diverse temporary variance.

2. MODEL OF THE PRODUCTION PROCESS IN THE TERMS OF NONCLASSICAL ASSUMPTIONS

The concept of the model is defined differently in the literature, depending on the field of knowledge and needs in solving specific problems.

According to M. Tyranska model is a "simplified representation or representation of reality (from the Latin. Modus means to measure, model, the way in which you do things). It presents the structure, features, operation of existing or proposed facility, providing information that will enable knowledge about it "[5 p.343].

Model focuses on the elements characterizing the object from a particular point of view or which have significant impact on the specific process.

The object of interest in this work is a model that aims to precisely determine the capacity and efficiency of the process with more general than classical assumptions. The model of the process, including the method of identification is shown in Fig. 2.

The model presented on it is a graphical schematic description of manufacturing process in terms of non-classical assumptions for its evaluation and control. Like mathematical models it consists of two basic parts:

− describing in a certain way, a set of variables and relationships between them (in the mathematical models in the form of an equation or set of equations)

− presenting the method of determining parameters (equation or set of equations) called estimation parameters of the model.

Both parts can be specified by model in the broad sense. The first part is a model in the strict sense. This first part is mostly a mathematical model in the usual sense, but without the second part "model" is only a vague description of reality without practical application.

This division also clearly visible in Figure 2. A section called process model is a model in the strict sense. With the "method of identifying a process model", it is a model in the broad sense. The model consists of:

− the type of process and its characteristics,
− statistical distribution characterizing the process,
− evaluation of process performance.

The identification method based on a random sample identifies parameters of the model (that well describes the process) for the specific process. From the set of types of processes the type of process and its characteristics are selected. It is the phase of process type identification (fig. 2).

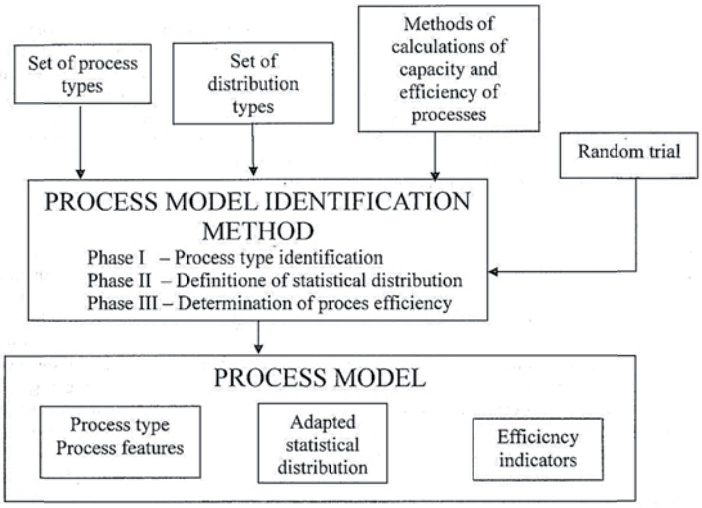

Fig. 2 – Graphical representation of the model of the production process in terms of nonclassical assumptions

Source: *[own development]*.

Then a statistical distribution that best characterizes the process is fitted - from the set of types of distributions. It is the phase to determine statistical distribution. In the third phase process performance indicators are calculated. For a given type of process an appropriate method of calculation of productivity shall be adopted (and possibly abilities). The data provided to it are from the characteristics of the distribution. The steps of method of identification are shown in Chapter 3.

3. METHOD OF IDENTIFICATION OF PROCESS MODEL

Proper identification of various types of processes and corresponding models of statistical distributions is a crucial issue in determining their further qualitative ability, monitoring and control. In this regard at the same time there is no appropriate method. Therefore, an attempt was made to develop it.

Identification of process model in the form of so-called. preliminary tests is carried out where:

− SPC control card is introduced for the first time,
− production of a new or changed product is started
− production conditions have changed, ie. change of materials, technologies, personnel, equipment, etc.,
− periodic check the constancy of adopted parameters and the adequacy of the model.

The procedure for identifying the model is a logical sequence of statistical tests as a result of which we should get answers to basic questions, such as:

− If the process is stationary, i.e. Has it a constant expectation and constant variance?
− Does lack of stationarity of process is only caused by volatility during the expected value with the existence of constant variances?
− Is lack of stationarity of the process due to variation in the time variation of the process with the stability of the expected value?

− If there is a non-stationary process both in terms of its location and the dispersion (the expected value and the variance)?

− Whether temporary distribution of data is a normal distribution?

− Whether the total distribution of data is a normal distribution?

Based on the answers to these questions we identify the type of process.

After identifying the type of process the next problem is to calculate the so-called natural boundaries for individual cases of processes. They are used to assess the capacity and performance, as well as being used in the control cards.

It is connected with somemore questions:

− what statistical distribution, from the set of classic distributions, most accurately describes the distribution of measured values of the process in the case of stationary processes?

− which non-classical distribution describes the distribution of measured values for non-stationary process?

− what method should be applied to determine the natural capacity of the process?

After obtaining answers to these questions it follows the calculation of the natural boundaries of the process and its quality ability.

This carried out step is based on the general guidelines described in ISO standards. However, they do not involve the choice of particular methods. This problem is resolved, but it is not presented here.

Graphical representation of the identification procedure is shown in Fig. 3 (a-e). It consists of the three phases:

− identification of the type of process (Fig. 3a, 3b, 3c),

− identification of statistical distribution model (Figure 3d, 3e),

− designation of process capability (Figure 3d, 3e).

The second and third phase are shown together in conjunction with particular types of processes.

The block diagram contains a standard references between pages, using a dual convention to go to certain parts of the scheme. Numerals refer to parts of the procedure describing the type of process identification phase. Gray letter marks (e.g. A1, B3) indicate the places of the second and third phases identified for a specific type of process.

CONCLUSIONS

Synthetically presented statistical models of processes allow precise, real their characteristics. This gives a true picture of the capacity and efficiency of the processes, and using this term ability we meet requirements. The model also indicates the real causes of instability and directions the operation of process improvement.

This is an important theoretical and practical topic. The method of identification of the process model allows in each case to choose the most appropriate model for the assessment, control and monitoring. Methods of identification are not currently known in the literature and

this is an important issue that deserves a solution.

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