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Comparison of the classical variation coefficient with calculated with the ring method for survey BOST results

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Abstract: This article presents two methods of the variation coefficient calculating: the classical method and the ring method. These methods were used to study the distribution of pairs of validity ratings on the map of stability for two factors: the stability of the process and the quality of the product. Coefficients of variation for each zone are dependent on the method of their calculation.

Key words – quality, stability, the topological metric, the BOST method

1. Introduction

The article concerns the analysis of the structure of the stability map, in which there are two variables: the stability and the quality.

„**Stability** – one of the fundamental concepts of cybernetics closely associated with the idea of the immutability (…). The system can exhibit complex action (behaviour), but some of its characteristics remain unchanged (…). Stability is the behaviourist term defined with the analysis of the system behaviour (proceeding)" (FIEDORENKO N. P. 1985).

„**Quality** - a set of the product or service characteristics, crucial for their ability to satisfy stated and potential needs" (GRIFFIN RICKY W. 2000).

The results were obtained by questionnaire. The survey was carried out in a company producing plastic products.

Relationships between the stability of the processes and the quality of products (services) are recognized on the map of stability of the processes shown in Fig. 1.

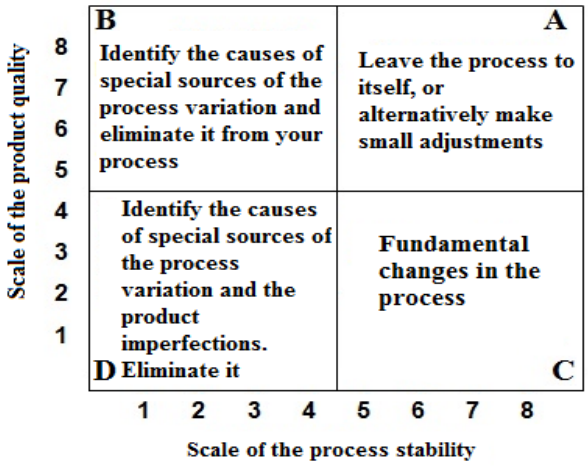

Fig. 1. General characteristics of the map of stability
Source: authors' personal elaboration

2. Presentation of the survey results on the map of stability

In Figure 2 the map of stability including the test results from the BOST survey (BORKOWSKI S. 2012a, BORKOWSKI S. 2012b, BORKOWSKI S. 2012c) for the analyzed company is presented.

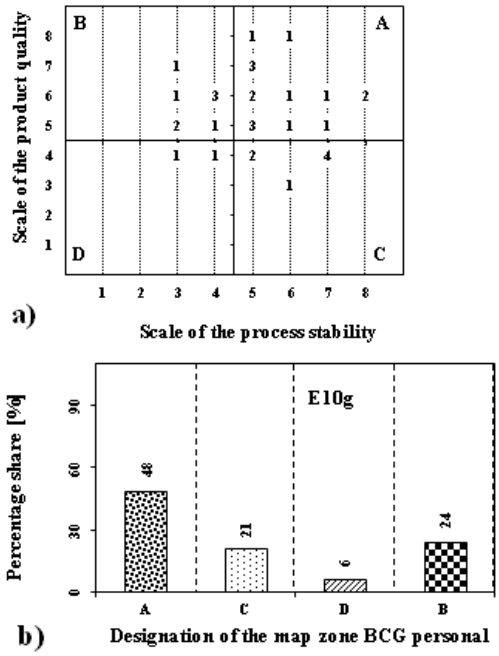

Fig. 2. Stability and quality. Characteristic: a) placement of ratings on the map of stability, b) division (%) of ratings into the map of stability zones
Source: authors' personal elaboration

Both scales take the values of 1 to 8 and provide 64 possibilities of point positions. The entire map is divided into 4 zones defined on the basis of the accepted range values of each scale.

3. The classical recognition of the statistical analysis of the BOST survey results

Figure 3 presents the summary of the distribution coefficients of variation ratings of the factors FX and FY (describing the map of stability) and their pars in zones of the map of stability (in Fig. 3a and 3b 1 - is a zone A, 2 – is a zone C, 3 - is a zone D and 4 - is a zone B).

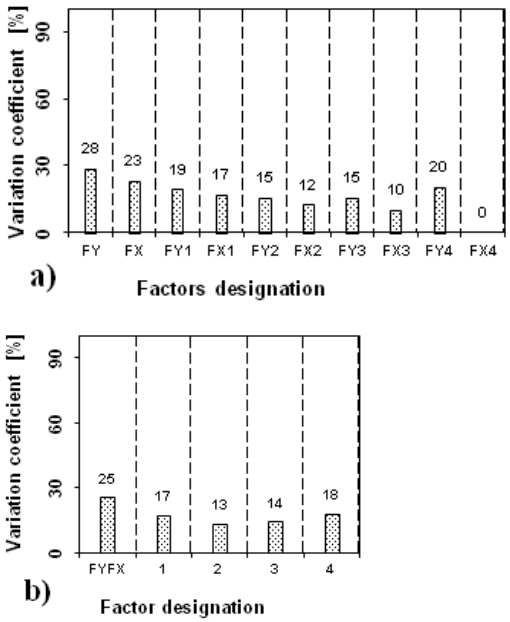

Fig. 3. Comparison of the variation coefficient validity ratings: a) factors - stability of the process (FY) and quality of products (FX), b) their pairs in the map of stability zones
Source: authors' personal elaboration

Variation coefficients presented in figure 3 indicate the moderate diversification of the distribution ratings validity factors FX and FY in the entire map of the process stability, because its values exceed slightly more than 20% and are poorly differentiated in particular zones of the map, where values balance between 0 – 20%.

Analyzing pairs of the factors FX and FY we also notice poor differentiation of the distribution ratings validity factors was noticed, because the values of the variation balance from 13-18 in each zone.

4. The metric (rings) in the map of stability analysis

Due to the differences in the frequency of individual survey results on the map of stability the dominant points appear, which represent numbers of the highest value. These points will be accepted in each zone as centers of certain neighborhoods in the form of wheels and rings with a certain radius using a particular type of the topological metric. The analysis was performed using the most intuitive metric called Cartesian (DUDA R. 1986). Analyzing the plastics processing company, for which the map of the process stability was created

we define coordinates of rings centers in zones (assuming, according to earlier findings the points of the highest value, or those lying nearest to the point with coordinates (8,8) considered to be the most beneficial in the evaluation process):

- in the zone A – the point with coordinates (5,7),
- in the zone B - the point with coordinates (4,6),
- in the zone C – the point with coordinates (7,4),
- in the zone D - the point with coordinates (4,4).

as shown in figure 4.

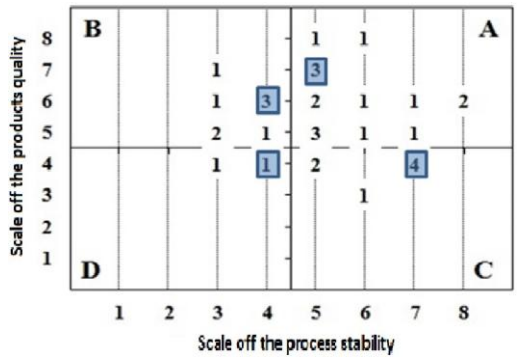

Fig. 4. The map of stability - means the rings

Source: authors' personal elaboration

The next step is to determine the radiuses of rings overlapping each zone of the map and determine the percentage of the results plotted on the map in the individual rings.

In the building of rings, already mentioned topological metric called Cartesian, has been used. Created rings are presented in figure 5.

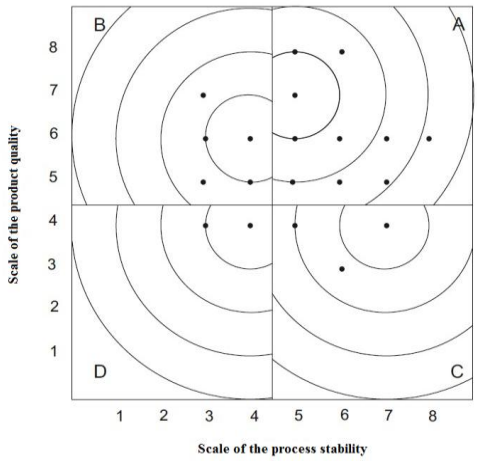

Fig. 5. Distribution of rings on the map of stability

Source: authors' personal elaboration

Percentage share of individual survey results previously plotted on the map in defined rings are presented in table 1.

Table 1. Percentage structure of the family of rings created on the basis of the topological metric for each zone of the numbers map

Designation of the map zone	Rings characteristics							
	$0 \le r < 1$	$1 \le r < 2$	$2 \le r < 3$	$3 \le r < 4$	$4 \le r < 5$	$5 \le r < 6$	$6 \le r < 7$	$7 \le r < 8$
A	19	31	37.5	12.5	0	0	0	0
B	37.5	62.5	0	0	0	0	0	0
C	57.1	14.3	28.6	0	0	0	0	0
D	50	50	0	0	0	0	0	0

Source: authors' personal elaboration

5. Statistical analysis - presentation of variation coefficient using the metric

The starting point for the analysis is the map of the process stability showing the evaluation of factors validity (FX-quality of the product and FY-stability of the process on the scale 1-8) as points of the specified coordinates.

The considered feature is the share of individual survey results previously plotted on the map in the defined rings. The element of the statistical analysis is the variation coefficient of the characterized feature percentage share. The values of the variation coefficients and the number of non-empty rings in particular zones of the map of the process stability are placed in table 2.

Table 2. Juxtaposition of variation coefficients of the percentage share of points in rings

Zone marking	Value of the variation coefficient	Number of non-zero rings
A	39.0	4
B	25.0	2
C	53.4	3
D	0.0	2

Source: authors' personal elaboration

In the examined map of stability based on the analyzed company, the variation coefficient of the percentage share of points in rings in particular zones takes values from 0 to 53,4. This indicates the variety of diversity of the examined feature in zones. From the

strong in the zone C through moderate in zones A and B to the total lack of differentiation in the zone D.

6. Comparative analysis

Analyzing figure 3 and table 2 we can write rows, where the zones of the map of the process stability are arranged according to the size of variation coefficients of factors FX (product quality) and FY (stability of the process) calculated in two ways.
Traditionally - based on data from the BOST survey

$$B > A > D > C \quad (1)$$

Using topological metric - creation of the rings

$$C > A > B > D \quad (2)$$

The use of Cartesian metric with respect to the maps and the division of zones into the rings will not only change the variation coefficient, but also changes the order of zones in the subjective series. In the first series, taking into account the results of the traditional tool in the first place stands B, which means that in this zone the variation of the analyzed feature is the highest. In the second series, to construction of which was used metric in the first place stands zone C, which was previously at the end of the series. Only zone A was on the same (second) position in both series.

7. Summary

The creation of the map of stability will help to choose the best method for a quick solution of the problem, to stabilize the process and improve the quality of the product. Points on the map are indicators of the ability for the process stability (predictability), which expresses the knowledge of our manufacturing processes and manufactured products.

Managerial decisions should be made based on the particular methodology for analysis of the results (PIECH H., PTAK A., ZHOU N. 2015), because, as indicated by the quoted example, depending on the results other factors validity series are formed.

The analysis presented in the chapter showed that the management decisions with regard to the two-dimensional areas of the company activity can be done using topological metric, which usage enables finding the best solution in the studied production process.

Literature

1. BORKOWSKI S. 2012a. *Dokumenty zawierające wymyślony termin (TOYOTARYZM) oraz zawierające nazwę i strukturę opracowanej metody (BOST). Potwierdzenie daty.* „AAK" KANCELARIA PATENTOWA s.c. Częstochowa.
2. BORKOWSKI S. 2012b. Toyotaryzm. *Wyniki badań BOST*. Wydawnictwo Menedżerskie PTM, Warszawa.
3. BORKOWSKI S. 2012c. *Zasady zarządzania Toyoty w pytaniach. Wyniki badań BOST.* Wydawnictwo Menedżerskie PTM, Warszawa.
4. DUDA R. 1986. *Wprowadzenie do topologii*. PWN, Warszawa.
5. FIEDORENKO N. P. 1985. *Słownik matematyki i cybernetyki ekonomicznej*. PWE, Warszawa.
6. GRIFFIN RICKY W. 2000. *Podstawy zarządzania organizacjami*. PWN, Warszawa.
7. PIECH H., PTAK A., ZHOU N., *The Setup Method of the Order with the Help of the Rough Sets Convention*, Lecture Notes in Artificial Intelligence nr 9120, Proceedings of the 14th International Conference on Artificial Intelligence and Soft Computing. Part II (ICAISC 2015), Zakopane, Polska, June 14-18, 2015, (2015), pp. 495-503.