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Quality estimation of process with usage control charts type X-R and quality capability of process C_p , C_{pk}

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Abstract: In this paper the selected problems related of modern quality monitoring and quality control in Polish companies have been presented. It has been found that monitoring of production processes is a necessary element of company proquality policy. Such approach is connected with continuous improvement of company. Possibility of usage of statistical techniques of quality estimation process has been discussed. For this purpose creation of control charts type X-R and also calculation of index quality capability of process C_p ; C_{pk} . Upon analyse suitable example has been shown, that their application permits to avoidance of many production defects already on the stage of production.

Keywords: Quality steering, Quality control, Production process, Quality improvement, control charts type X-R, Quality capability of process C_p ; C_p

1. INTRODUCTION

In the last year requirements of market put polish firms ahead of necessity of fulfilment of constantly growing larger customer's requirements. Pursuit to achieve a high standard quality became one of the basic strategic and operative intentions of modern polish enterprises [1-2]. It concerns: quality of organization the whole information system, design periods and technological aspects, as well asof individual quality creating final products stages, and time of order realization keeping [1-2].

The long-range practice of quality improvement has created and developed many methods using mathematical application for achievement of success. Mathematical applications are part and base of majority of proquality operation. They are associated with "team" of quality tools [3-4].

Norms standard EN ISO 9000:2000 and EN ISO 9001:2000 devote separate points to the most advanced group of quality tools which are statistical method. Thes norms underline their supporting role in relation to undertaken proquality operations. EN ISO 9001:2000 attach particular importance to their usage in control and monitoring of productive process [5]:

"...The organization shall apply suitable methods for monitoring and, where applicable, measurement of the quality management system processes. These methods shall demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, correction action shall be taken, as appropriate, to ensure conformity of the product..."

There is high possibility to define if the process behaves normally through collecting samples from this production process. If we decide, that correction of process is necessary, we will prevent production of defects [1-3].

In this paper selected problems, connected with creation of control charts type X-R and estimation of quality capability of process have been presented. And also suitable examples of quality estimation of production processes in Polish companies have been given.

2. CONTROL CHARTS TYPE X-R

The supervisory cards of different types in dependence from kind of analysed data be applied.

The control charts check existing of uncontrolled variation parameters and process. They are an effective tool for the presentation of data, as well as, an operational definition of when a process is in trouble. The control chart seeks to determine if a sequence of data may be used for predictions of what will occur in the future [2,6]. The form of control charts can be adapted for researching of quality process with the aid of one statistic measurements, for example, average values. And also this can be adapted for simultaneous researching of quality process with the aid two or more statistic measurements, for example, average values and range values[6-10].

Table 1.

Characteristic of chart type X-R [2]

Control charts type X_R	Characteristic
	Control chart can be applicable , when controlling feature is measurable and has normal schedule. Advantages: facility of application, small samples (= 2-10) n. Defects for each controlling feature should be create own chart, it is not possible to use check tests, range value reacts strongly on atypical value.

Greatest meaning among control charts with features based on numerical estimation have control charts type X-R, and this thanks to simplicity and speeds of qualifying of necessary statistical parameters. Order of action creating of control charts type X-R [2, 7,11]:

- 1) Analysis of production process in aim of statement:
- 2) Choice of estimation features of product.
- 3) Settlement of size sample and as well as frequency her taking sample size at least four
- 4) Project of form to assembling dates.
- 5) Designing of control charts.
- 6) Execution the analysis of control chart.

3. ESTIMATION OF QUALITY CAPABILITY OF PROCESS C_p , C_{pk} - SPC METHOD

The most popular method to use in quality assurance systems for productive process is Statistical Process Control (SPC).

SPC involves using statistical techniques to measure and analyse the variation of process [12-13].

Most often used for manufacturing processes, the intent of SPC is monitoring of quality product and maintain processes to fixed target. Statistical quality control allow to using statistical techniques for measuring and improving the quality of processes. Includes SPC in

addition to other techniques, such as sampling plans, experimental design, variation reduction, process capability analysis and process improvement plans. SPC is used to monitor the consistency of processes used to manufacture a product designed. It aims to get and keep process under control [6,7,13].

The characteristic feature of SPC is acceptance on main thing estimation of process course not single values of measurements, but values being with result of averaging in sample several elements received in proper distances of time [2,7]. Due to usage SPC we can say, that process is stable controllability, when variability in process is exclusively result of chance causes because in process step out systematic causes of variability [7].

Taking under attention above for objective estimations have been introduced two notions [12,13]:

- Ability of devices productive or ability of process - *qualified as width of field of tolerance of feature given products to dispersion of random*
- Possibility of placing of devices or of processes on advisable values – *fined on basis the deviation the controlled profile from purposeful value*

Stability of process parameter is defined by executable measurements in longest period of time. It on basis of got results defines the size of dispersion of given feature being the result of productive process.

If during of productive process we will qualify averages values from samples about little size, this we can in this way to mark deviation of average for course all process.

So, statistic index (indicator) applies for objective estimate [7,13].

Index capability of process takes under attention the value the averages of process inside the limits of field of tolerance. C_{pk} . It is required, in order to at least It was required the capability of process to carry out at least $C_{pk} = 1$, in practice for stabilized process accepts oneself value $C_p = 1,33$ [2,7,13].

4. PRACTICE USAGE ESTIMATION CAPABILITY INDEX AND CREATING CONTROL CHARTS FOR CHOSEN PRODUCTION PROCESS

Quality estimation of technological process of pipe without seam 65 x 3.1 x 1056.

Research based on one from firms of metallurgical industry. This researches referred creations of control charts type X-R for pipe without seam 65 x 3.1 x 1056 from steel of sort G335, according to PN-79/H-74244. Investigated propriety in this case is external diameter pipes $\varnothing 65$. It has been shown that steps for this features out greatest quantities frequency of defects, also what behind this goes large defects.

The next step of researches have been proofed capability of process. It was affirmed, that creation and utilization the method of control charts type X-R will considered case permits on it decrease the costs of production across deep analysis the productive process and the possibility it introducing the preventive workings and elimination of already exist problems. In this aim changes reaching of production have been observed, investigating in turn or in certain distances of time following pieces for ascertainment exist of changes reaching in production.

Observations have been repeated several times, and then counted average time, in which of change do not exceed admissible values. This period of time remained accepted for distance of time between samples and carries out 30 of minutes. Researches took places in monthly temporary distances, in sum passed it four onces, and this in turn series A, B, C, D.

Assembled given were of service to elaborations and creations executioner control charts type X-R .

And also to estimate index capability of process C_p (tab. 2) .The next steps as already have been said was creating a control charts type X-R . It has been shown two diagrams for average value (fig.1) and range value(gif.2) charts type X-R permits on obtainment of information on theme of process agreement with technical requirements. The next benefit is reach of information needs to modifying of process or changes this process.

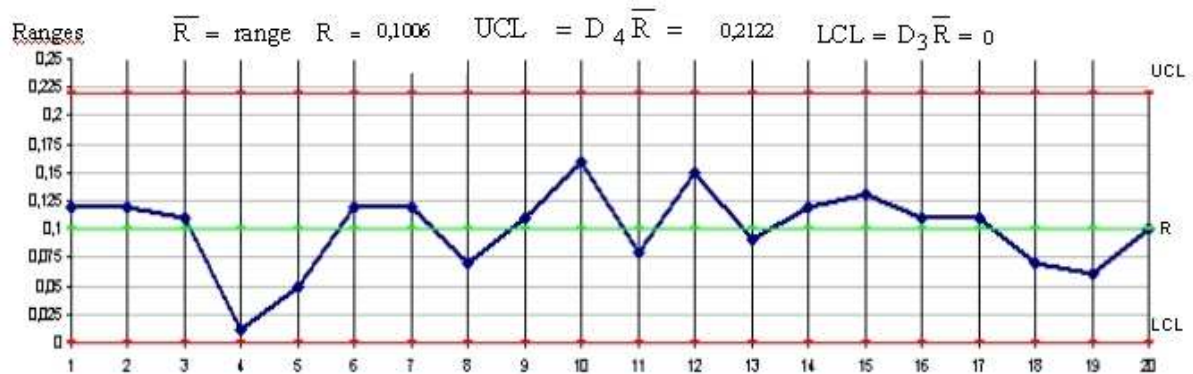


Figure 1. Diagrams of average values

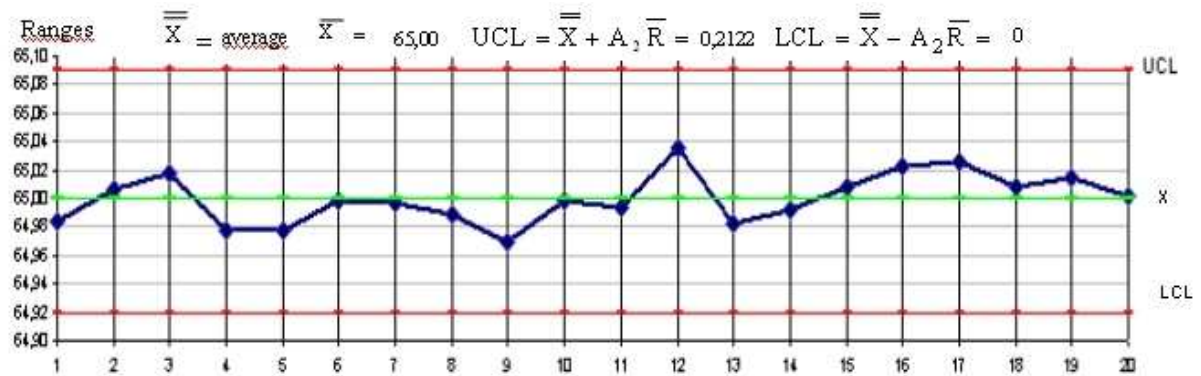


Figure 2. Diagrams of range values

Then permits on registrations of signals needed to undertaken of immediate decision in matter of research of reasons of process variability or nor of interfering in this process. It was found also, that numbers of samples are suitable.

It has been described that after receiving of first 20 samples and inscription this of suitable form, and then counting of limits control for average value and range value, that a process is stable. Confirmations this conclusion form control chart was estimation of quality index capability C_p . Investigation repeated four times in temporary distances of five weeks.

Table 2.
Estimation of index capability of process C_p

	Seria A:	Seria B:	Seria C:	Seria D:
Dla X :				
\bar{X}	23,89	23,9	23,9	23,9
UCL	23,93	23,94	23,94	23,94
LCL	23,85	23,86	23,85	23,85
Dla R:				
\bar{R}	0,0645	0,057	0,07	0,07
UCL	0,136	0,12	0,15	0,014
LCL	0,00	0,00	0,00	0,00
$\sigma = \sqrt{\frac{\sum_{i=1}^m (X_i - X_{sr})^2}{m-1}}$	0,015	0,078	0,014	0,009
$C_p = \frac{B-A}{6\sigma}$	0,889	1,026	1,071	1,744
$C_{pk} = \frac{X_{sr} - A}{3\sigma}$	0,889	1,026	1,19	1,938
$C_{pk} = \frac{B - X_{sr}}{3\sigma}$	0,889	1,026	0,952	1,55

5. SUMMARY

Usage of quality research and estimation methods in Polish industry permits to avoid occurrences of productive defects already in production stage, which helps in elimination of their source formation.

Employment of suitable methods of estimation and forecasting enables us to foresee whether, and when quality feature is not situated in founded admissible area. Such activities permit to properly react in early stages of production, setting of devices.

Most often used for manufacturing processes, the intent of SPC is to monitor product quality and maintain processes to a fixed target. Statistical quality control refers to usage of statistical techniques for measurement and improvement the quality of processes and include SPC in addition to other techniques, such as sampling plans, experimental design, variation reduction, process capability analysis and process improvement plans. The present idea of quality concentrates first of all on change of quality approach strategy. At present special pressure attention is paid to "prevention strategy" which replaces "detecting strategy". SPC is used to monitor the consistency of processes used to manufacture a designed product. Its aim is to get and keep process under control.

Summing up, it was found that the aim of usage of control charts type X-R in above process is measurement and minimization of variations occurring in process, and essential aspects is delimitation of coefficients of process correctness what in effect leads to improvement. Control charts and quality index of capability, in showed example, determine

quality tools, enabling to decide about usage of suitable activities in case when we have some problems with our process. It means that alarming signals originating from process. Such statistical activities allow to prevention of defects instead their of defecting.

Statistical methods are as a optimising factor of production process, and what behind this goes - are chances on improvement of economic situation of companies, so important on free-market economy sphere.

REFERENCES

1. S. Tkaczyk, M. Dudek: Mat. Konf. „Zintegrowane systemy zarządzania – jakość, środowisko, technologia, bezpieczeństwo, Szczyrk 2000, 413
2. O. Hryniewicz: Nowoczesne metody statystycznego sterowania jakością, PAN, Warszawa 1996
3. S. Tkaczyk, M. Dudek : Process implementation of quality assurance systems, Mat. VI Międzynarodowej Konferencji Komitetu Nauki o Materiałach PAN, Gliwice- Wisła 1997, 197.
4. E.W. Deming: Quality, Productivity and Competitive Position, University of Cambridge 1982
5. EN ISO 9001:2000: “Quality Management Systems - Requirements”, 2000
6. E. M. Saniga, D.J Davis., T.P. Williams : Economic, Statistical and Economic – Statistical Design of Attribute Charts, „Journal of Quality Technology”,vol. 27-1/1995, 56-73
7. A. Hamrol: „Zarządzanie jakością. Teoria i praktyka”, PWN, Warszawa –Poznań, 1998
8. J..M. Myszewski: „Zarządzanie Zmiennością. Systemowe spojrzenie na metody statystyczne w zarządzaniu jakością”, „ORGMASZ”, W-wa, 1998
9. S Tkaczyk, M. Dudek.: Mat. Konf. PF ISO 9000 „Metody i narzędzia doskonalenia jakości”. Cetniewo 1999
10. L. Wasilewski : Statystyczne metody doskonalenia jakości produkowanych wyrobów, OBJW ZETOM, Warszawa, 1994
11. S. Tkaczyk : „Inżynieria jakości a inżynieria materiałowa”, „ORGMASZ”, W-wa, 2000
12. S. Tkaczyk, M. Dudek: Methodology research of quality in industry, Mat. VII Międz. Konf. Komitetu Nauki o Materiałach PAN, Gliwice – Zakopane 1998, 513.
13. S. Tkaczyk, M. Dudek: Oceny jakościowe zdolności procesów i maszyn, Mat. II Ogólnopolskiej Konf. Naukowej Problemy Jakości stymulatorem rozwoju technologii bezodpadowych, II, Kraków 1999, 197-206