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IMPROVING THE QUALITY OF COVERS FOR SOFT FURNITURE MANUFACTURING PROCESS

BULGARU Valentina[1], COLIBABA Ala[2], MALCOCI Marina[3]

[1, 2, 3] Tehnical University of Moldova, Faculty of Textiles and Polygraphy, Bd. Ștefan cel Mare 168, Chișinău, R. of. Moldova, E-mail: valentina.bulgaru@fiu.utm.md

Corresponding author: Bulgaru, Valentina, E-mail: valentina.bulgaru@fiu.utm.md

Abstract: *The paper presents a case study regarding the analysis of the quality of the manufacturing process of soft furniture covers within the company "Z" Ltd, which operates on the territory of the Republic of Moldova. Starting from the fact that the products are destined for export to the EU, USA, Canada, China and the Russian Federation, it is obvious that their quality must be ensured at the highest level. The research methodology included the application of Shewhart p-type statistical control charts for the quality indicator - the percentage of the defective products, identified at the final control of manufactured products for a period of two consecutive years. It was found that the manufacturing process is organized at a high level, being equipped with high-performance equipment. The company has implemented a Quality Management System according to ISO 9001, but its efficient capitalization is diminished by staff turnover. The research results indicate that overall the manufacturing process is not kept under statistical control, because the variation of the analyzed quality indicator exceeds the calculated control limits of the process. It is recommended to develop measures to improve the quality of processes and products through actions aimed at directly productive staff and methods of work organization.*

Key words: *quality, enterprise, furniture covers, statistical control, defective.*

1. INTRODUCTION

In developed countries, the quality and reliability of products and services have become important factors in the competition of attracting and retaining customers. The activity of the companies in the light industry field from Republic of Moldova is mainly carried out through partnerships with foreign companies or they are founded with foreign capital, making products for famous brands and making products for export, which are marketed all over the world [1]. That is why the quality of the manufactured products must be at the highest level, being ensured by an adequate quality of the manufacturing process. Process improvement is a priority for enterprise management that requires a coordinated effort and communications between all groups in the enterprise from department managers to software developers [2, 3].

The paper presents a case study in an enterprise "Z" Ltd that makes textile products for the furniture industry. Production comprises about 230 types of soft furniture covers, which are exported and marketed in the EU, USA, Canada, China and the Russian Federation. Company "Z", founded in 2010, has grown from 90 employees at the beginning to about 540 today, of which about 330 are directly involved in the production sector. The volume of items exported annually reaches about 750,000 units. It should be mentioned that a Quality Management System is implemented in the company according to ISO 9001, the management has assumed responsibility for quality but there are still reservations for improvement.

The purpose of the paper is to identify / develop / establish measures to improve the quality of the products based on the analysis of the current situation regarding the level of internal quality.

Quality improvement represents a set of measures aimed at reducing the variability of a process, to minimize the products or services that do not comply with the specifications [4].

2. RESEARCH METHODOLOGY

Starting from the purpose of the work, the percentage of defective products was considered as an indicator of non-quality, calculated based on the data recorded at the final control of the manufactured products. In order to verify the stability of the production process and the fact that it is kept under statistical control, the method of statistical control sheets type p was applied with the construction of the Shewhart diagram, according to the methodology presented in GOST R 50779.42-99 (ISO 8258-91) [5].

The statistical control sheets allow the determination of whether or not the processes are kept under statistical control based on the analysis of quality indicators regarding the quality, the assessment of the stability of the manufacturing process, the determination of when the process should be adjusted. In this paper, the data collected for the period included in the study were analyzed and the Shewhart statistical control charts were constructed. This diagram, also referred to as the "behavioral diagram of a process" is a statistical tool meant to evaluate the nature of variation (change) in a process and to facilitate its forecast and management [6, 7].

The calculations for determining the statistical parameters are presented in table 1.

Table 1: *Calculations for determining the parameters of the statistical control chart [4]*

Statistical parameter	**Calculation relation**
Center line CL	CL= $\bar{p}$ = (p1 + p2 + …p12) / 12
Upper control line UCL	UCL = $\bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$
Lower control line LCL	LCL = $\bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$
$\bar{p}$ – the average weight of defective products in the 12 months analyzed, expressed in absolute values	
n - number of products checked each month (average value) = 1470 units	

3. RESULTS AND DISCUSSIONS

At the analyzed company, the production process is organized being subjected to the financial reports in periods of 12 months starting from September and ending in August. The situation regarding the quality of processes and products was analyzed during two consecutive years (tab.2, fig.1).

Table 2: *The percentage of non-compliant products during the analyzed period, %*

No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Ave rage**
Month	09	10	11	12	01	02	03	04	05	06	07	08	
Year I	10,5	8,17	4,71	6,54	8,84	5,26	2,66	4,40	5,03	8,85	4,85	5,09	6,25
YearII	6,76	3,38	6,36	7,02	8,59	4,36	6,85	7,21	6,00	5,57	2,73	4,32	5,76

The data presented in table 2 and fig.1 attest a variation of the weight of non-conformities from one month to another without indicating a certain trend, the percentage being between 2.66% (minimum share) and 10.56% (maximum share) in year I. The percentage of non-compliant products decreased from 6.25% to 5.76% on average in year II as compared to year I. This is a small decrease, but overall in year II the dynamics of non-conformities shows a smaller variation. Figure 2-3 shows the Shewhart diagrams for each separate year. The statistical parameters calculated for year I have values as follows:

CL= $\bar{p}$= (p1 + p2 + …p12) / 12 =

(10,5+8,17+4,71+6,54+8,84+5,26+2,66+4,40+5,03+8,85+4,85+5,09) /12 = 6,24 **(1)**

$$UCL = p + 3*\sqrt{\frac{p(1-p)}{n}} = 0{,}0624 + 3*\sqrt{\frac{0{,}0624(1-0{,}0624)}{1470}} = 0{,}0624+3*\sqrt{\frac{0{,}05851}{1470}} = 0.0624 +$$

$3* 0{,}00631 = 0{,}0624+ 0{,}01893 = 0{,}08133 = 8{,}13\%$ **(2)**

$$LCL = p - 3*\sqrt{\frac{p(1-p)}{n}} = 0{,}0624 - 3*\sqrt{\frac{0{,}0624(1-0{,}0624)}{1470}} = 0{,}0624 - 3*\sqrt{\frac{0{,}05851}{1470}} = 0.0624 -$$

$3* 0{,}00631 = 0{,}0624 - 0{,}01893 = 0{,}04347 = 4{,}35\%$ **(3)**

From fig. 2 it is observed that in September, January and June the share of defective products exceeds UCL, which indicates that the process is not stable, is not kept under statistical control and requires correction.

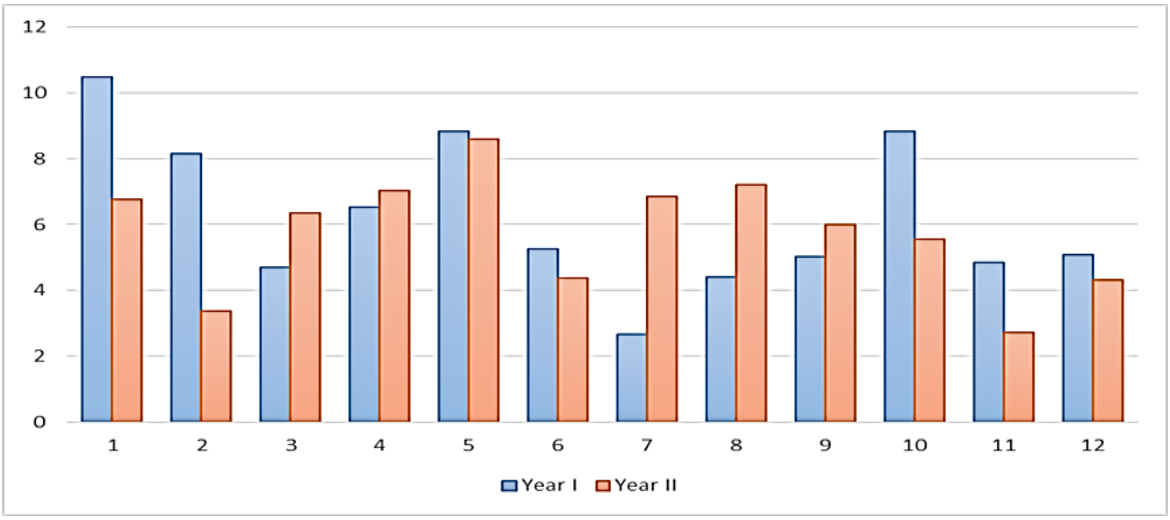

***Fig. 1**: Evolution of the percentage of defective products during the analyzed period*

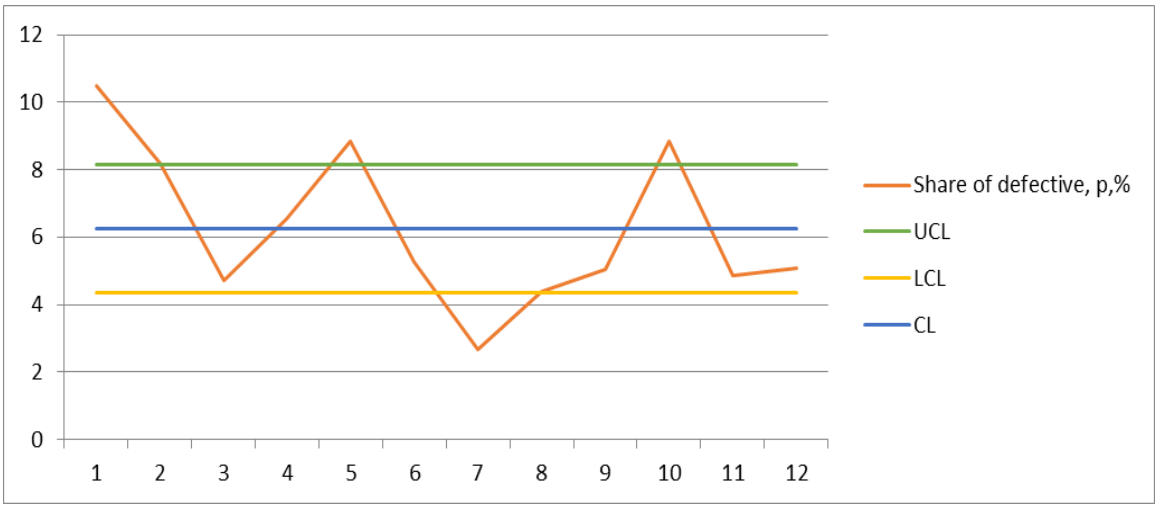

***Fig. 2**: Shewhart diagram for the share of defective products in year I.*

The causes of a higher percentage of non-conformities could be the volume of manufacture and the complexity of the product. Also in September the large number of defective products could be conditioned also by the fact that this month is the first one after the summer holidays and the employees need a period of adaptation. For the following year, year II the calculated statistical parameters are:

CL= $\overline{p}$= (p1 + p2 + …p12) / 12 =

(6,76+3,38+6,36+7,02+8,59+4,36+6,85+7,21+6,00+5,57+2,73+4,32) /12 = 5,76 % **(4)**

$$UCL = p + 3*\sqrt{\frac{p(1-p)}{n}} = 0{,}0576 + 3*\sqrt{\frac{0{,}0576(1-0{,}0576)}{1470}} = 0{,}0576+3*\sqrt{\frac{0{,}05428}{1470}} = 0{,}0576 +$$

3* 0,006077 = 0,0576+0,01823 = 0,07583 =7,58% **(5)**

$$LCL = p - 3*\sqrt{\frac{p(1-p)}{n}} = 0{,}0576 - 3*\sqrt{\frac{0{,}0576(1-0{,}0576)}{1470}} = 0{,}0576 - 3*\sqrt{\frac{0{,}05428}{1470}} = 0{,}05762$$

– 3* 0,006077 = 0,0576 – 0,01823 = 0,03937 = 3,94% **(6)**

From fig. 3 it is observed that in January and April the share of defective products exceeds UCL, which indicates that the process was not kept under statistical control this year, being unstable. In such a situation, the quality level and the additional efforts to remedy the non-conformities cannot be predicted. The production process must be brought in a state of control and subsequently initiated to reduce the average percentage of non-quality.

The causes of a large percentage of non-conformities could be the same as the higher volume of manufacture in these months, more complex products and the fact that January is the first month after the winter holidays.

If we start from defining the production process as "all the conscious actions of the employees of an enterprise, directed with the help of different machines, machines or installations on the raw materials, materials or other components in order to transform them into products, works or services with certain value of market "[5], we understand that its stability is dependent on a number of factors related to both machines, materials and the human factor.

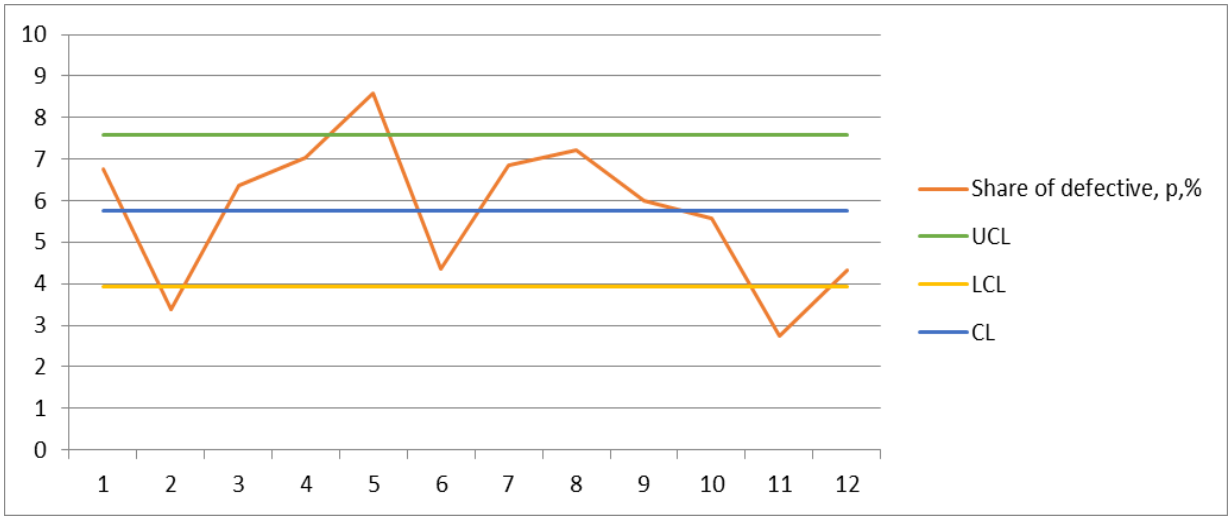

***Fig. 3**: Shewhart diagram for defective products identified at final control in the second year*

In order to establish the specific causes of the variation, the most frequently encountered defects were analyzed in the period included in the study and some possible causes were identified as well as the ways of solving-remedying the detected defects (table 3). As can be seen from the table, the defects detected are of 3 categories: material defects, sewing defects, labeling and packaging defects, the causes being mostly human errors and non-quality materials delivered by suppliers.

The analysis of the current situation at the analyzed company suggests that the necessary actions should be planned and carried out must be oriented first and foremost to the staff. About the role of the staff in achieving the objectives in the field of quality is specified in all the textbooks of the field, but also in the publications that present the experience of some actual companies. "The quality of the

company on the market means more than the quality of its products. It includes: the quality of the work of each employee, the quality of collaboration between company departments and between the company and external partners. The activity of achieving absolute quality begins with a considerable effort to motivate staff by applying management techniques and methods from the field of human resources "argue the authors of the article [9].

Table 3: *The most common defects, causes and solutions*

Order number	Type of defect	Cauze	Solution
1	Wrong / Missing Label	Label / Box	Personal training
2	Deformed label	Label operator error	Label change (reprocessing)
		Error in control at receipt of materials	Process control
3	Wrong stamp of the week on the label / Missing	Sample Control Before Production is Missed	Reprocessing Infoliere
4	Defective box	Wrong label / Product	Personal awareness
5	Wrong box size	Wrongly set car	Personal warning
6	The sewn pieces are not identical	Operator error	Rebuild parts
7	Improper Velcro	Mistake mistake	To change the part
8	Improper hem	Operator error	Car repair
9	Defective fabric: Difference in shade	Operator error	Material reception control
10	Defective fabric: Unpleasant odor	Improper treatment	Material reception control
11	Stains on the fabric	Inattention of the operator, dirty work	Personal training Material reception control
12	Wrong piece in the set	Operator error	Part change
13	Color difference of the parts in the set	Set sewn from marks with different shades of color	Restore set of parts
		Fabric defect	Restore landmark Material reception control
		Pairing of items with different shades of color in a set	Redo set
14	Wrong folding	Operator error	Fold over
15	Wrong packaging	Operator error	Repackaging

For company "Z" Ltd it is recommended:

• *Improvement / development / diversification of methods and methods of recruiting directly productive personnel.*

In this sense it is recommended to strengthen the relations with the College of Light Industry and with the professional School of profile and to maintain partnership relationships not only during the internship period, but also throughout the year, in order to attract new specialists. train at the next activity in the company.

• *Motivating staff through training.*

Ongoing training and staff dedication to quality is a key factor in achieving the goal. It is proposed to create the training area for employees within the company to train and motivate staff, in the future having a contingent keen to work for a longer period of time and which will contribute to improving the quality of the products. (study program, teaching materials, practical training with persons designated by the administration, etc.). As a consequence, the strengthening of the responsibility and satisfaction of the employees related to the work performed will be ensured.

• *Proposing a motivating pay system for quality assurance.*

Although the application of the principle of pay according to the level of professional qualification satisfies in most cases and the requirements of co-interest for the provision of a higher quality work, it is nevertheless necessary to place a special emphasis on stimulating the work of higher quality, since there are situations in which two workers, having the same qualification give different results in terms of quality. It is proposed to introduce percentage quotas as an increase in salary depending on the level of quality achieved by each individual or team.

4. CONCLUSIONS

In the furniture textile products industry, customer demands and quality standards increasingly require suppliers to follow and stabilize processes, to meet the requirements of physical-mechanical parameters and to obtain high quality products. A simple technique to ensure the quality of products and processes is the application of statistical control of the process. Thus, we can understand the importance of interpreting changes in process behavior and the corrective actions needed to improve processes, using a number of statistical methods including the statistical control chart. The real situation at the company "Z" Ltd attests a variation of the percentage of nonconforming products, which exceeds the calculated control limits of the process, which indicates that the production process is not kept under statistic control in terms of quality level. It is recommended to develop measures to stabilize the production process, which is quite complex and influenced by a number of factors. The human factor is one of the most important, given the sufficient technical-material endowment, therefore the planned actions must be oriented towards the personnel directly involved in the production and at the methods of organizing the work.

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