Quality Control by Quality Management Tools

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Abstract*: This work describes the system of quality management and the method of its evaluation. The main part of this work is dedicated to monitoring quality of chosen product. "Carrier rear ARD91", which is made in organization Reydel Automotive Slovakia, in Nitra as a component for door panel, which is built in the motor car PSA Peugeot 208. The quality is now the most important factor of every organization for holding economic development and competition abilities. The final part of this study points out advantages of applying statistical methods of quality management in organization to ensure high quality of its products, reduce costs, economic growth and competitiveness in the market.*

Keywords: *quality, quality management system, regulation diagrams*

INTRODUCTION

The issue of production quality has now become a worldwide business phenomenon. The continual increasing demands of customers meant that besides the price of a product, quality is the most important factor in business. Not only is the quality basis for commercial success in the market, but it also carries overall business prosperity, because only the quality guarantees economically effective sale [3,9]. The current dynamic growth and rapid change of economic environment set a problem of ensuring long-term competitiveness for each organization. The decisive factor in a healthy market environment in relation with the customer is a marketing strategy based on advertising, product quality, prices, delivery terms, warranty terms, etc.. The decisive factor within the organization (internal environment) is a system and quality of organization management. This requires new methods of management and change in approaches to be put into practice. The basic objective is to increase efficiency, performance and product quality. Therefore, organizations introduce quality management systems [18]. When building a quality management system, the proposal and its adoption in management is important, but its implementation must be done from the root of the organization [15]. On the other hand, an organization that has a quality management system implemented is certified to the quality management system according to ISO 9001:2015, which demonstrates that it meets the requirements of not only the product quality but also for the manufacturing process [22].The aim will be to introduce statistical process control in the production process of a particular product by statistical methods in the organization Reydel Automotive Slovakia in Nitra. In the event of deteriorating quality or disagreement will be necessary to design effective measures to eliminate disagreements [4,13].

MATERIAL AND METHODS

Reydel Automotive Slovakia in Nitra has several manufacturing processes and distributes its products to several automotive organizations. Each type of product has its manufacturing process, which varies according to the requirements of a particular customer. In this paper we have chosen the manufacturing process of the right back carrier ARD 91 [14].

Gloss and colour check of a product is done by BYK – Gardner measuring device. AR91 carrier is a product used in the interior of a car, it is very important to maintain colour uniformity and therefore to perform control measurements gloss based on customer requirements.

Dimension check is among the most demanding inspection of a product. It is performed with a measuring agent onto which the product is fixed according to the procedure of the manufacturer and then measurement by micrometer is made. The measured values are entered into the control sheets, which are then analysed and evaluated [17].

Production of interior products for the automotive industry is extremely demanding on quality, production processes and compliance with all requirements of the customer. Statistical control methods enable tracing the process and based on the results assume its development [10].

Regulation diagram is used to set the process that will produce a product with a fixed measurable properties. The aim will be to apply regulation diagrams of an average ($\overline{x}$) and range *(R)* in the production process of AR91 carrier. We will monitor the dimensional control of carrier molding. Since the dimensions of the molding are determined by the customer, it is important to preserve them and keep within the tolerance limits [2,8].

We choose a number of subgroups. Based on the total number of measurements, we choose a range of a subgroup n=10.

We calculate an average value for every subgroup.

An average value of a figure in a subgroup:

$$\overline{X_i} = \frac{1}{n}\sum_{j=1}^{n} X_{ij} \qquad [1]$$

for i = 1,2,... k, and for j = 1,2,...

where :

i – subgroup serial number

j – serial number of value measured in a subgroup

k – number of subgroups

n – a range of a subgroup

X_{ij} – a value measured in a subgroup

A range in a subgroup:

$$R_i = MAX\ (X_{ij}) - MIN\ (X_{ij}) \qquad [2]$$

for i = 1,2, ... k, and for j = 1,2, ... n

where: $MAX\ (X_{ij}) - MIN\ (X_{ij})$ – maximum and minimum value measured in i-th subgroup.

Value of selective average is calculated according to the following formula:

$$\overline{\overline{X}} = \frac{1}{k}\sum_{i=1}^{k} \overline{X_i} \qquad [3]$$

Value of an average range is determined:

$$\overline{R} = \frac{1}{k}\sum_{i=1}^{k} R_i \qquad [4]$$

$\overline{X}_i$ a R_i are averages and range in i – th subgroups (i = 1,2, ... k)

$\overline{X}_i$ a R_i form central lines (CL) in regulation diagrams.

The width of a regulatory field is determined through upper and lower regulation limits for the average and range.

$$UCL_R = D_4 \,.\, \overline{R} \qquad [5]$$

$$LCL_R = D_3 \,.\, \overline{R} \qquad [6]$$

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2 .\ \overline{R} \qquad [7]$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - A_2 .\ \overline{R} \qquad [8]$$

D_4, D_3 and A_2 – constants varying depending on the extent of sub-groups. Upper and lower regulatory limits are indexed as dashed horizontal lines in the table.

If we calculated the central lines and regulatory limits, we draw regulation diagrams. Their analysis shows that the process is under statistical control. We need to monitor that all points lie between the upper and lower regulatory limit [16].

As in any of the following situations, the process is not under statistical control. The manufacturing process must be stopped, investigated and preventive or corrective action has to be done. If none of the above situations occurs, we can conclude that the process is under statistical control [19].

RESULTS AND DISCUSSION

Visteon is the fourth largest supplier of automotive parts in the world. Its operations are focused on the manufacture of interiors, climate and electronics for major automotive organization. The organization has two zones for plastic moldings injection, four mounting areas manufacturing finished parts for the customer and two paint shops. We focused on the quality assessment of "The rear right carrier ARD 91", which is produced at the injection press for plastic products of Krauss Maffei. ARD rear carrier 91 is produced as a component of ARD door panel 91 which is supplied to the customer of PSA Peugeot Citroen in Trnava [23].

AR 91 rear carrier is an interior part and should be monitored for colour uniformity of the product and also its gloss. Gloss is controlled according to customer requirements based on standard (Fig. 1) according to which we set the BYK – Gardner apparatus.

Fig. 1 Standard for gloss check

The tolerated value is 1.7±0.5 mm (Fig. 2). Gloss check is carried out by quality inspector. There are precisely targeted spots on the product where measurements are necessary. The measurement procedure is developed according to customer requirements.

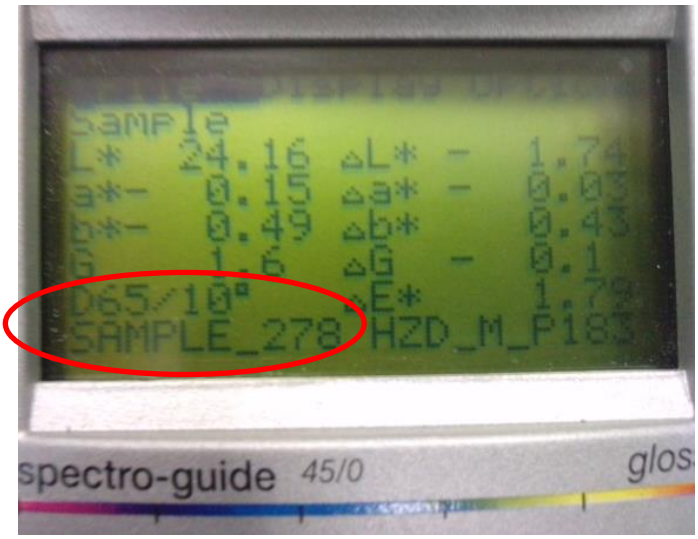

Fig. 2 Correctly measured value of gloss

Dimension check is performed on the measurement agent that is undertaken by the worker of quality at each production run or when halting the machine because of a fault (Fig. 3).

Fig. 3 ARD 91 rear carrier clamped in a measurement preparation

Records of calibration of the instrument are in a possession of a laboratory technician and the scale is labelled with a validity of the calibration. Samples of injected "ARD 91 rear carriers" were taken at 10 minute intervals. After two hours of cooling in the natural environment (production plant), the measurements were done. Since the carriers are prescribed with three measuring points, we have chosen dimensional control of the measuring point. This point has, according to the customer's requirements tolerance of 1.0 ± 0.7 mm. The spot refers to the carrier height in the *z* axis. According to the results of measurements, it is clear that all the measured values are within tolerance, but it is not possible to estimate the process regulation and highlight variations in the manufacturing process. Using statistical methods in organizations improve the effectiveness and efficiency of production processes. Subsequently, we calculated the average value of the whole process ($\bar{X}$) and the value of the range ($\bar{R}$) that form a central line in regulation diagrams (Tab.1).

Table 1 Measured values of ARD 91 Rear carrier

Serial number	Measured values, mm										$\overline{X}$	R_i
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}		
1.	0.93	1.02	1.17	1.28	1.10	1.19	1.12	1.15	0.90	1.23	1.11	0.38
2.	0.92	1.04	1.27	1.04	1.09	1.18	1.25	1.30	1.00	0.85	1.09	0.45
3.	0.90	1.23	1.17	1.09	0.94	0.93	1.43	0.99	1.05	1.14	1.08	0.53
4.	0.87	0.94	1.17	1.31	1.08	1.06	1.29	1.26	1.29	1.03	1.13	0.44
5.	1.06	1.19	1.27	1.20	1.29	1.19	1.23	0.92	1.20	1.06	1.16	0.35
6.	1.09	1.24	1.29	1.27	1.03	1.22	0.92	0.87	1.26	1.30	1.15	0.43
7.	1.39	1.32	1.26	1.31	1.36	1.23	1.13	1.23	1.18	1.00	1.24	0.39
8.	1.07	1.13	1.25	1.33	1.23	1.36	1.11	0.96	1.07	0.98	1.15	0.40
9.	0.94	1.06	1.43	1.36	1.24	1.14	1.07	1.32	1.36	1.34	1.23	0.49
10.	1.04	1.08	1.25	0.99	0.96	1.24	0.94	1.29	1.17	1.22	1.12	0.35
11.	1.04	1.49	1.28	1.42	1.24	1.24	1.19	1.17	0.94	1.17	1.22	0.55
12.	1.18	1.05	1.27	1.01	0.94	0.82	0.99	1.08	1.09	1.24	1.07	0.42
13.	1.24	1.00	1.23	1.30	1.27	1.40	1.24	1.36	1.16	1.23	1.24	0.40
14.	0.94	1.11	1.00	1.12	0.85	0.97	0.92	1.34	1.03	1.09	1.04	0.49
15.	1.26	1.14	0.96	1.17	1.28	0.96	0.93	1.12	1.26	1.00	1.11	0.33
16.	1.08	1.37	1.33	1.07	1.16	1.16	0.95	1.40	1.14	1.25	1.19	0.45
17.	1.17	1.09	1.30	0.96	1.13	1.23	0.95	1.17	1.19	0.95	1.11	0.35
18.	1.09	1.28	1.19	1.00	1.12	1.19	1.23	1.21	0.89	1.07	1.13	0.39
19.	0.93	0.98	0.94	1.17	1.30	1.09	1.19	1.17	1.21	1.24	1.12	0.37
20.	0.96	1.23	1.18	1.29	1.25	1.14	1.07	1.23	1.00	0.91	1.13	0.38
21.	0.97	0.96	1.23	1.32	1.20	1.07	1.34	0.99	0.98	1.24	1.13	0.38
22.	1.35	1.30	1.26	1.07	1.12	1.08	1.02	1.14	1.26	1.33	1.19	0.33
23.	1.24	1.23	1.36	1.26	1.24	1.32	1.25	1.17	1.03	1.24	1.23	0.33
24.	1.24	1.30	1.24	1.09	0.94	0.90	1.07	0.96	0.98	1.27	1.10	0.40
25.	1.23	1.06	1.14	0.96	0.88	1.05	1.14	1.23	1.05	1.26	1.10	0.38
											$\overline{\overline{X}}$ =1.14	$\overline{R}$ =0.42

We indexed all of the values calculated in a graph and created diagrams for $\overline{X}$ - diagram for average and created diagrams for R-diagram for range (Fig. 4).

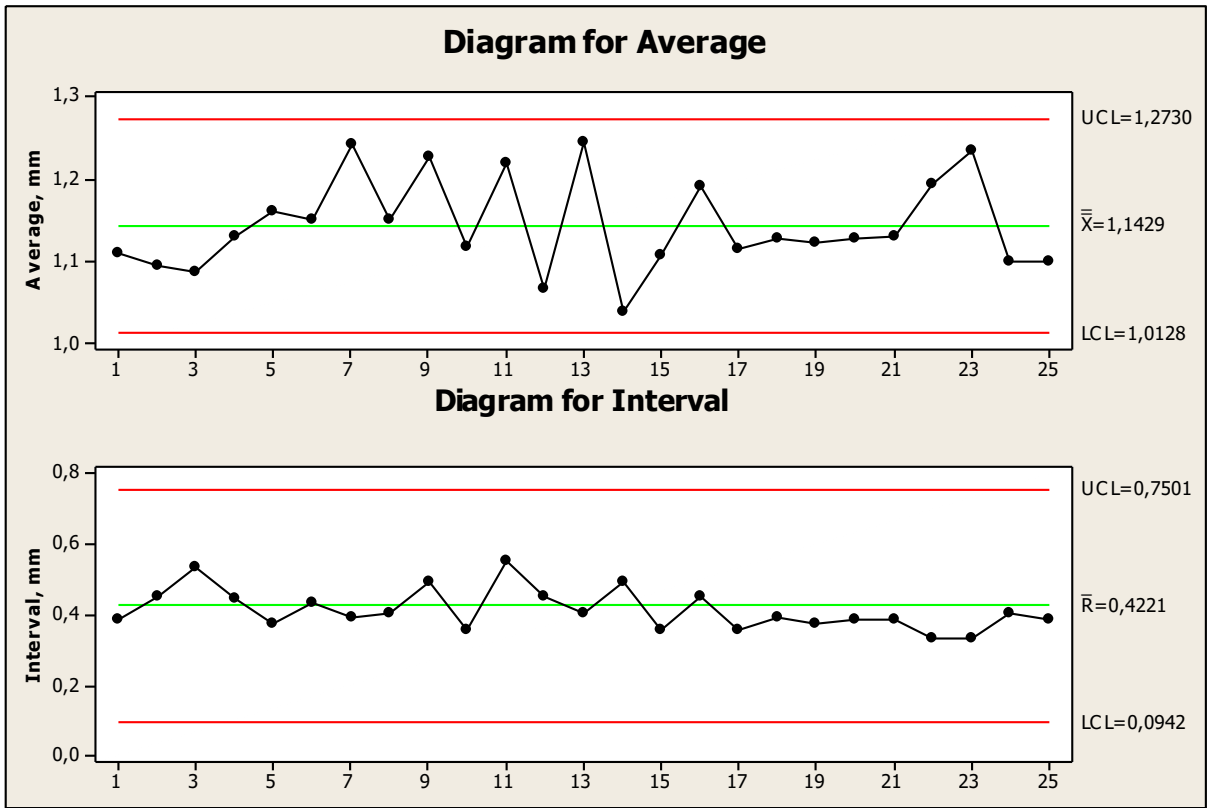

Fig. 4 Regulation diagram for average and range

CONCLUSION

Implementation and monitoring of quality in all processes must be perfectly designed, understood and monitored. Introducing statistical regulation of process should help to reinforced monitoring of production process. Therefore, organizations are turning to quality management systems, which are aimed at defining processes and production methods. All employees in all positions try to carry out their work in accordance with quality requirements in order to satisfy customer's requirements and thus meet the aim of the organization. Gloss check of a product carried by the BYK – Gardner measuring apparatus is a very accurate method of ascertaining the eligibility of production in terms of customer's requirements for colour and gloss uniformity of the product. By introduction of statistical methods in the production process, we can monitor the quality of the production process and the product itself. Therefore, using regulation diagrams for the average ($\overline{X}$) and range (R), we monitored the production process of the ARD 91 Rear carrier. Based on the analysis of these regulation diagrams, we found that while the process is under statistical control, the values they have indicate that the manufacturing process of ARD 91 Rear carrier has a fluctuating nature. Regulation diagrams should be implemented in the production process so that a production progress would be easily viewed and predictable. Their introduction would made the organization even more effective and would still possibilities for improvement.

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