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COSTS DUE TO THE VARIATION IN WEIGHT OF „CHOCOLATE-FILLED WAFFLE" AND „CHOCOLATE FOR COOKING"

ТРОШОЦИ ПОРАДИ ВАРИЈАЦИЈА НА МАСАТА НА „РОЛОВАН ВАФЕЛ ПОЛНЕТ СО КРЕМ" И „ЧОКОЛАДО ЗА ГОТВЕЊЕ"

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Abstract

Modern approach to the cost of quality requires constant analysis in order to achieve optimal quality, t.e. good quality at the lowest cost or better quality, but not spending too much. Profited is defined as the difference between the open market price of the product and the planned costs. Quality costs are divided in: costs for internal flaws, external vulnerabilities, assessment costs and prevention costs. According Taguchi method for calculating costs, any deviation of product properties defined level causes expense although these deviations are sometimes prescribed tolerances. This method is applied in the confectionary industry in production of „chocolate-filled waffle"and „chocolate for cooking"
Key words: *control, quality, costs*

Апстракт

Современиот пристап кон трошоците за квалитетот бара постојана анализа со цел да се постигне оптимален квалитет, т.е. добар квалитет при најмали трошоци или подобар квалитет, но не со преголеми трошоци. Профитот се одредува како разлика помеѓу цената на производ на отворен пазар и на планираните трошоци. Трошоците за квалитет се делат на: трошоци за внатрешни пропусти, трошоци за надворешни пропусти,трошоци за оценување и трошоци за превентива. Според Тагучиевата метода за пресметување на трошоците, секое отстапување на својствата на производот од дефинираното ниво предизвикува трошок иако тие отстапување понекогаш се во пропишаните граници на толеранција. Оваа метода е применета во кондиторска индустрија при производство на „ролован вафел полнет со крем"и „чоколадо за готвење".
Клучни зборови: *контрола, квалитет, трошоци*

Introduction

Quality costs are defined as a price that the manufacturer pays in order to ensure quality that's up to the buyer's expectations. Therefore, it would logically follow that better quality costs more. However, this is not always the case. Frequently, bad quality comes at a much higher cost [1]. According to Juran, "quality costs are a gold mine and represent a significant reserve that deserves attention and it's beneficial to conduct research on them" [2]. When defining the quality level, it's important to determine the optimal level that can be reached with the optimal level of costs, taking in consideration all the types of costs and where they are generated [3].

The overall manufacturing costs are mainly attributed to the basic manufacturing costs (raw materials, energy etc), quality control costs and the costs for correction of defective products [4]. So that one can determine, analyze and compare a company's costs to those of the competition, the same definitions for the types of costs need to be used. The management of quality costs needs to increase the understanding about the correlation between quality and economical management, and the quality costs need to be viewed as especially important information about quality [5]. An optimization of the manufacturing process, quality, price and costs needs to be conducted, so that a high level of quality of a given product is achieved. This can be accomplished with an analysis of the market needs, raising employee awareness about the importance of quality in the manufacturing process, regular control and implementation of corrective and preventive measurements, minimizing of the number of defective and low quality products, achieving a standard quality of the product etc [6, 7].

Experimental part

The research was conducted at the confectionery factory in Stip, the Republic of Macedonia. The object of observation was the deviation in weight outside of the specified range. For that purpose, Taguchi's formula for calculating of costs due to variation in weight of the confectionary products "rolled waffles with hazelnut" and "cooking chocolate" was applied.

Software used: Statistika StatSoft 9, Microsoft Office Excel 2007

Taguchi's approach to costs

Quality is determined by the losses that a product inflicts to society by degrading the environment, as well as the costs that caused by the functions of the product in the process of its application, as shown on figure 1:

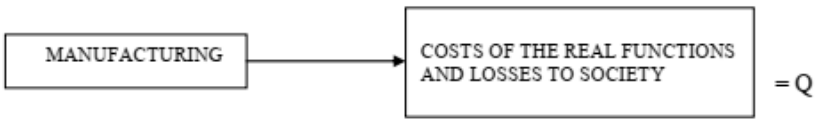

Figure 1. Taguchi's approach to costs

According to this approach, every deviation from the product's properties increases costs, even if the deviations are sometimes within the allowable tolerance. This method is used in large volume production, because there it can give excellent results and a new approach [8,1].
In order to calculate the costs, the following formula is used:

$$L_y = k\left[s_y^2 + (\bar{y} - m)^2\right] \quad (1)$$

$$s_y = \sqrt{\frac{\sum (y_i - \bar{y})^2}{n-1}} = \sqrt{D} \quad (2)$$

$$k = \frac{A}{(3s_y)^2} \quad (3)$$

Where:
L_y – the company's costs, due to the variation of the parameter;

s_y – standard deviation of the parameter;
y_i - i – value of the parameter;
$\overline{y}$ - arithmetic mean value of the parameter (y);
n - number of measurements taken;
D - dispersion;
m – target (defined value of the parameter);
A – cost of remanufacturing;
k - proportionality constant.

Results and discussion

Costs due to the variation in weight of "chocolate - filled waffles" - A deviation of the weight outside of the specified range of a confectionary product, chocolate - filled waffles, has been observed. The declared weight of the product is 180 g and the standard deviation of weight is ± 4.5%. That means that the products that weigh less than the lower specified limit (172 g) are recalled, and the products that weigh more than the upper specified limit (188 g) are approved for sale. The fewer products are under the lower specified weight limit, the lower the manufacturing costs, and the product is more standardized. Out of 600 packages of waffles that were weighed during 13 consecutive days, 93 packages were determined to weigh more than 188 g (exhibit 1). Taguchi's formula was applied in order to analyze the impact that the variation in weight has on the company's costs. By applying the formulas (1), (2) and (3), the following results were derived:

0.03 EUR – the loss for a single package of chocolate - filled waffles
0.14 EUR – the loss for a kilogram of chocolate - filled waffles

The derived results show that during the manufacturing of chocolate - filled waffles there are great losses and that there is a serious problem with the increase of costs. If all the packages are over the declared weight, the loss in a single day of manufacturing of 5000 packages would be 128 EUR, 1020 EUR in a month, and 12250 EUR in the course of a year.
Therefore, corrective measurements need to be applied so that the problem with precision is decreased. In this way, a reduction of the defects and costs at an acceptable level for the company can be achieved.

Costs due to variation in weight of "chocolate for cooking" - A deviation of weight outside of the specified range has been determined in the confectionary product "chocolate for cooking". The declared weight of the product is 100 grams, and the standard deviation of weight is ± 2%. That means that the products that weigh less than the lower specified limit are recalled as inadequate, and all the products that weigh more the upper specified limit (102 g) are approved for sale. Out of 600 chocolate bars weighed during 20 consecutive days, 91 were determined to weigh more than 102 g (exhibit 2). By applying Taguchi's method, using formulas (1), (2) and (3), it was determined that:

0.02 EUR – the loss for a single bar of chocolate for cooking
0.21 EUR – the loss for a kilogram of chocolate for cooking

From the derived results we can conclude that during the manufacturing of chocolate for cooking there are great losses and the increase of costs is a serious problem. If all the chocolate bars are over the declared weight, the loss in a single day of manufacturing of 2 000 bars would be 42 EUR, 447 EUR in a month and 3983 EUR in the course of a year. Therefore, corrective measures need to be applied so that the level of defects and costs is decreased to an acceptable

level for the company.

Conclusion

By decreasing of the costs due to low quality, prevention of defects instead of their correction and an optimization of the manufacturing process of the "chocolate - filled waffles" and "chocolate for cooking" products, the technological processes can be improved. The benefits of the applied method are as follows:

By applying Taguchi's method for calculating the manufacturing costs for the confectionary product "chocolate - filled waffles", it was determined that the loss for a single 180 g package is 0.03 EUR. If all the packages are over the declared weight of 180 g ± 4.5%, the loss in a single day of manufacturing of 5 000 packages would be 128 EUR.
By applying Taguchi's method for the confectionary product "chocolate for cooking" it was determined that the loss for a 100 g bar is 0.02 EUR. If all of the chocolate bars are over the declared weight of 100 g ± 2%, the loss in a day's manufacturing of 2 000 chocolate bars would amount to 42 EUR.

References

[1] Чепујноска, В., *Менаџмент на квалитет - теорија, наука и практика*, Технолошко – металуршки факултет: Скопје, 2009, стр. 89-91, 231
[2] Godfrey. B., Juran, J., *Juran's Quality Handbook*, 3-th Edition, McGraw-Hill: New York, 1998, pp 29-30
[3] Kelly, John M., *Total quality management*, Alexander Hamilton Institute INC: New York, 1997, pp 37-39
[4] Vasconcellos, A., *Quality Assurance for the Food Industry*, CRC Press LLC: Florida, 2005, pp 79-81
[5] Oakland, J., *Quality Management*, Butterworth-Heinemann, Linacre House: Oxford, 2004, pp 135-147
[6] Roy, R., A., *Modern Approach to Operations Management*, New Age International, New Delhi, 2005, pp 17-24
[7] Чепујноска, В., Чепујноски, Ѓ., *Управувањето со квалитетот*, Економски факултет, Скопје, 1993, стр. 130
[8] Zio, E., *An Introduction to the Basics of Reliability and Risk Analysis,* World Scientific Publishing: Italy, 2007, pp 247

exhibit 1. Values of the weight of „chocolate - filled waffles"

number of measurements	weight y_i (g)	$y_i - \bar{y}$	$(y_i - \bar{y})^2$	number of measurements	weight y_i (g)	$y_i - \bar{y}$	$(y_i - \bar{y})^2$
1	202	-0,5	0,25	48	205	2,5	6,25
2	200	-2,5	6,25	49	205	2,5	6,25
3	203	0,5	0,25	50	205	2,5	6,25
4	203	0,5	0,25	51	206	3,5	12,25
5	201	-1,5	2,25	52	205	2,5	6,25
6	203	0,5	0,25	53	205	2,5	6,25
7	201	-1,5	2,25	54	207	4,5	20,25
8	201	-1,5	2,25	55	208	5,5	30,25
9	199	-3,5	12,25	56	208	5,5	30,25
10	199	-3,5	12,25	57	205	2,5	6,25
11	206	3,5	12,25	58	205	2,5	6,25
12	206	3,5	12,25	59	205	2,5	6,25
13	206	3,5	12,25	60	206	3,5	12,25
14	207	4,5	20,25	61	205	2,5	6,25
15	207	4,5	20,25	62	200	-2,5	6,25
16	208	5,5	30,25	63	200	-2,5	6,25
17	198	-4,5	20,25	64	197	-5,5	30,25
18	199	-3,5	12,25	65	195	-7,5	56,25
19	198	-4,5	20,25	66	95	-7,5	56,25
20	208	5,5	30,25	67	210	7,5	56,25
21	209	6,5	42,25	68	210	7,5	56,25
22	209	6,5	42,25	69	203	0,5	0,25
23	208	5,5	30,25	70	203	0,5	0,25
24	210	7,5	56,25	71	202	-0,5	0,25
25	210	7,5	56,25	72	200	-2,5	6,25
26	207	4,5	20,25	73	200	-2,5	6,25
27	200	-2,5	6,25	74	199	-3,5	12,25
28	200	-2,5	6,25	75	198	-4,5	20,25
29	202	-0,5	0,25	76	199	-3,5	12,25
30	203	0,5	0,25	77	199	-3,5	12,25
31	203	0,5	0,25	78	200	-2,5	6,25
32	198	-4,5	20,25	79	198	-4,5	20,25
33	197	-5,5	30,25	80	205	2,5	6,25
34	205	2,5	6,25	81	203	0,5	0,25
35	205	2,5	6,25	82	202	-0,5	0,25
36	205	2,5	6,25	83	197	-5,5	30,25
37	205	2,5	6,25	84	200	-2,5	6,25
38	200	-2,5	6,25	85	193	-9,5	90,25
39	195	-7,5	56,25	86	205	2,5	6,25
40	200	-2,5	6,25	87	201	-1,5	2,25
41	200	-2,5	6,25	88	207	4,5	20,25
42	207	4,5	20,25	89	201	-1,5	2,25
43	203	0,5	0,25	90	195	-7,5	56,25
44	195	-7,5	56,25	91	202	-0,5	0,25
45	201	-1,5	2,25	92	198	-4,5	20,25
46	202	-0,5	0,25	93	198	-4,5	20,25
47	205	2,5	6,25				

Average weight is $\bar{y} = 202,5$g

exhibit 2. Values of the weight of „chocolate for cooking"

num. of meas.	weight y_i (g)	$y_i - \bar{y}$	$(y_i - \bar{y})^2$	num. of meas.	weight y_i (g)	$y_i - \bar{y}$	$(y_i - \bar{y})^2$
1	120	-6,76	45,6976	46	129	2,24	5,0176
2	120	-6,76	45,6976	47	129	2,24	5,0176
3	125	-1,76	3,0976	48	130	3,24	10,4976
4	120	-6,76	45,6976	49	130	3,24	10,4976
5	120	-6,76	45,6976	50	130	3,24	10,4976
6	130	3,24	10,4976	51	129	2,24	5,0176
7	120	-6,76	45,6976	52	129	2,24	5,0176
8	120	-6,76	45,6976	53	128	1,24	1,5376
9	130	3,24	10,4976	54	128	1,24	1,5376
10	125	-1,76	3,0976	55	128	1,24	1,5376
11	125	-1,76	3,0976	56	125	-1,76	3,0976
12	127	0,24	0,0576	57	125	-1,76	3,0976
13	127	0,24	0,0576	58	125	-1,76	3,0976
14	130	3,24	10,4976	59	123	-3,76	14,1376
15	130	3,24	10,4976	60	123	-3,76	14,1376
16	120	-6,76	45,6976	61	120	-6,76	45,6976
17	129	2,24	5,0176	62	120	-6,76	45,6976
18	129	2,24	5,0176	63	120	-6,76	45,6976
19	125	-1,76	3,0976	64	130	3,24	10,4976
20	125	-1,76	3,0976	65	125	-1,76	3,0976
21	120	-6,76	45,6976	66	125	-1,76	3,0976
22	120	-6,76	45,6976	67	129	2,24	5,0176
23	120	-6,76	45,6976	68	129	2,24	5,0176
24	129	2,24	5,0176	69	130	3,24	10,4976
25	129	2,24	5,0176	70	130	3,24	10,4976
26	129	2,24	5,0176	71	130	3,24	10,4976
27	125	-1,76	3,0976	72	122	-4,76	22,6576
28	125	-1,76	3,0976	73	125	-1,76	3,0976
29	129	2,24	5,0176	74	125	-1,76	3,0976
30	129	2,24	5,0176	75	130	3,24	10,4976
31	130	3,24	10,4976	76	130	3,24	10,4976
32	130	3,24	10,4976	77	130	3,24	10,4976
33	125	-1,76	3,0976	78	130	3,24	10,4976
34	125	-1,76	3,0976	79	129	2,24	5,0176
35	127	0,24	0,0576	80	129	2,24	5,0176
36	127	0,24	0,0576	81	130	3,24	10,4976
37	125	-1,76	3,0976	82	130	3,24	10,4976
38	130	3,24	10,4976	83	125	-1,76	3,0976
39	130	3,24	10,4976	84	125	-1,76	3,0976
40	130	3,24	10,4976	85	130	3,24	10,4976
41	125	-1,76	3,0976	86	129	2,24	5,0176
42	125	-1,76	3,0976	87	129	2,24	5,0176
43	129	2,24	5,0176	88	130	3,24	10,4976
44	130	3,24	10,4976	89	125	-1,76	3,0976
45	130	3,24	10,4976	90	130	3,24	10,4976
46	130	3,24	10,4976	91	130	3,24	10,4976

Average weight is $\bar{y} = 202,5$g