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LOSSES FROM THE POOR QUALITY IN THE FOOD INDUSTRY

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ABSTRACT

The quality is an important part of the functioning company and also of the functioning society; it is the one of the essential attribute of the competitiveness. The quality management based on standards, certifications and own effort to continual quality improving become in today's world for the advanced food factories the commonplace. The aim of this paper is the application of essential theoretical knowledge from economics and quality management to the practical product analysis in the food industry. Here is used the analogical approach to the quality and the costs as in the automotive industry. The paper deals with the weight example of the selected foodstuff in the market and with the economic impacts of the weight deviations. The dairy industry in the Czech Republic is a stabilized branch, but with the decrease of the variability in the foodstuff production would be better not only the competitiveness of each dairy company, but also would be decrease in wasting of foodstuff and savings would be both on the consumer side and on the producer side.

KEYWORDS: Quality, loss from the poor quality, yoghurt, foodstuff, consumer.

INTRODUCTION

The quality belongs nowadays to the key competitive elements. Nevertheless, thanks to the general supply overhang to the demand practically in all commodities, it is no less an important aspect also the price, for which the product in the quality is offered. Both these aspects of the product (quality and price) are mostly taken into account in the automotive industry, where are sophisticated procedures for ensuring the high quality, but also the procedures for ensuring the continuous costs reduction and in that way also the prices reduction. In other branches is of course an effort to similar approaches, but the results are not always so evident, as in the automotive industry. One of the key branches for consumers, where should be applied the analogical approach to the quality and costs like in the automotive industry, is the food industry. Except of hygienic and culinary characteristics of the quality should be in the best way filled also the parameters concerning the marketed quantity of the foodstuff, which is declared on the packaging. The weight or the volume of the foodstuff cannot be lower, than presented on the packaging. Otherwise, it could come to the misleading of the consumer. But the quantity of the foodstuff should not be much higher, than presented on the packaging, because this increased quantity generally presents the loss that somebody has to pay. If this loss pays the producer or is the loss calculated into the price of the product and ultimately it pays the consumer, is this a negative phenomenon, which leads to the increasing of the product price. This text deals with the weight example of the selected foodstuff in the market and then are surveyed the economic impacts of the weight deviations.

THEORETICAL INPUT CONCERNING THE QUALITY AND ECONOMICS

We start with the brief theoretical input for the analysis in term of the quality and the losses from the poor quality. The real data we will analyze with the simple statistical indicators, concretely is concerned the mean value rating of the file by the arithmetic mean:

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$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} \quad (1)$$

where x is the measured value and n is the selection size.

Further is here the data diversion rating by the corrected sample standard deviation s:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} \quad (2)$$

where x is the measured value and n is the selection size.

Then we will use also more advanced procedures. We will estimate the percentage share of defective products with the normal diversification. For this purpose is t necessary to transfer the normal diversification to the standardized normal diversification (standardization), see Wonnacot (1993):

$$Z = (x-\mu)/\sigma \quad (3)$$

where

Z…appropriate multiple of the standard deviation
x…value, which we want to examine
μ…mean value of the diversification (using the arithmetic mean)
σ…standard deviation (using the corrected sample standard deviation s)

Consequently we will find in the statistical tables (Wonnacot, 1993) the probability value (Pr) for the Z, so mathematically Pr(Z > X), where X will be the examined limited value. This data processing is commonly known, so the reader can without major problems obtain the fast idea of attributes the data file. Nevertheless, in term of the variability analysis is this procedure not sufficient. It is necessary to take in account the total variability, i. e. the deviation from the target value not only in term of data diversion, but also in term of the mean value deviation from the target value (Japanese approach from Dr. Taguchi, see Taguchi (1990)), The target value can be given by the producer. For example for the yoghurt will be defined a target value with weight 150 grams, the total deviation from the total deviation will be calculated by the MSDvalue (Mean Squared Deviation):

$$MSD = [(y_1 - m)^2 + (y_2 - m)^2 + \cdots + (y_n - m)^2]/n \quad (4)$$

In this formula is different the marking of the measured value – we use y instead of x. The n symbol labels the sample size. With the m symbol we understand the target value, which is given by the producer or the prescript. The calculated MSD value can further answer for the estimate of the losses on the basis of the loss function and also for the estimate of the quality by the signal to noise ratio ((Japanese approach from Dr. Taguchi). The loss is calculated according to the formula (Roy, 1990):

$$L = k \,.\, (MSD) \quad (5)$$

L is the loss from the variability expressed in the monetary units. The k symbol is the cost coefficient. The cost coefficient is determined as the share between the loss A and the tolerance Δ power of two:

$$k = \frac{A}{\Delta^2} \quad (6)$$

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The loss A includes the total costs connected with the unsatisfactory quality of the product (reparation, scrapping etc.) and the tolerance Δ is the half of the tolerance field. Practically is the expression of the cost coefficient a trivial thing.

A simple transformation of MSD we can get so-called signal to noise ratio (Roy,1990):

$$\frac{S}{N} = -10\log(MSD)$$

The signal to noise ratio is independent on the specifications and is an ideal instrument for the variability measuring. Without reference to thy type of the quality characteristics, it is always the highest value S/N as the most desirable. The unit for the S/N is the decibel (dB). The signal to noise ratio has a wide spectrum of usage. In this text we will use it only for the quality comparison of two data files, by the using the orientation rule "3dB". Clausing (1994) says that if the S/N value will improve of 3 decibel (dB), the quality will improveapproximately twice.

CASE STUDY – THE ANALYSIS OF THE YOGHURT WEIGHT

The food factories produce products, where some of them have prescribed the zero deviation under the given weight (legislative requirement). The producers generally try to ensure the zero deviation so that they set the fulfilling machinery to the higher weight value than the lower specification limit (LSL) is. In the following example we have available data, which come from the one notable producer of dairy produce. In this case is the yoghurt with the prescribed weight of the foodstuff 150 grams. Whereas the research is anonymous, we will title the yoghurt with the fictive name YOG. There were weighed together 54 samples, which were chosen by the random selection.

In the table 1 are the essential statistical indexes from the giver data file.

Index	Value
Samples	54 pieces
Mean value (arithmetic mean)	154,77 grams
Corrected sample standard deviation s	3,37 grams
Minimal value	146 grams
Maximal value	165 grams
Quantity of values smaller than 150	4 pieces

Table 1 Statistical index – the Czech yoghurt YOG

From this simple table is it evident that the weight of yoghurts extensively vary and even that here is a high quantity of defective products. When we will suppose the normal data diversification and we will approximate the calculations to all population, we will get the estimate of the quality in term of the product weight. We are interested especially in the information on a supposed percentage of the defective products from the factory, respectively on the percentage of the satisfactory products. Practically, it means to make the probability calculation that the yoghurt will have smaller weight than 150 grams.

The Z-value for 150 grams will be defined (see the formula (3))):

Z = (150 - 154,77)/3,37 = - 1,42

Then the probability (Pr) that the product will weigh less than 150 grams:

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Pr (X<150) = Pr (Z < -1,42) = Pr (Z > 1,42) = 0,078 = 7,8 %

Approximately 7,8 % of products will be out of lower specification limit (LSL = 150 grams), which is at the same time the target value m. These are the defective products that should not come to the market. Apparently the input control does not catch these defects. These products cause the direct loss for the consumer. Conversely, only 92,2 % of the products will weigh 150 grams or more (the process yield is 92,2 %); these products will from the point of view of consumer satisfy. In term of economy is here still another problem. The higher the positive deviation from LSL (or target value m = 150 grams) will be, the major loss will be due to an excess quantity of yoghurt, which is in the crucible. In other words, the variability causes the financial loss. The reduction of the financial loss is possible only with the reduction of the variability. How is it in confrontation with the yoghurt produced abroad? For the confrontation we will take the yoghurt produced in Germany. We will title the yoghurt with the fictive name GHURT. In the table 2 are the results of research in the form of essential statistical indexes.

Index	**Value**
Samples	54 pieces
Mean value (arithmetic mean)	152,32 grams
Corrected sample standard deviation s	1,65 grams
Minimal value	148 grams
Maximal value	155 grams
Quantity of values smaller than 150	3 pieces

Table 2 Statistical index – the German yoghurt GHURT

Similarly, as in the previous case we will estimate with the normal diversification the supposed percentage of the defective products.

The Z-value for 150 grams will be defined:

Z = (150 - 152,32)/1,65 = - 1,41

Then the probability (Pr) that the product will weigh less than 150 grams:

Pr (X<150) = Pr (Z < -1,41) = Pr (Z > 1,41) = 0,079 = 7,9 %

Now, we can compare some of the selected statistical indexes between the Czech and German yoghurt (see table 3).

	Czech yoghurt YOG	**German yoghurt GHURT**
Mean value (arithmetic mean)	154,77 g	152,32 g
Corrected sample standard deviation s	3,37 g	1,65 g
Minimal value	146 g	148 g
Maximal value	165 g	155 g
Estimated percentage of defects	7,8 %	7,9 %

Table 3 Confrontation of statistical indexes – the Czech and German yoghurt

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From the table is evident that the percentage of defective products is basically the same at the both yoghurts. In term of financial loss caused by the quantity of the defective yoghurts (weight under 150 grams) will be both products in the same condition. Basic difference is in the data diversion, when the standard deviation of the German yoghurts is roughly half, but also the mean value is closer to the target value of 150 grams. How is it in term of the total financial loss caused by the variability? And how will be it in term of confrontation of the total quality of yoghurts with the usage of S/N? Within this research, there is not known the concrete loss A, not even the concrete producer, because the samples were chosen in the market randomly, without connecting cooperation with the producers. Let us try to do a rough estimate. The price of both products in the market is the same (15 CZK) and therefore we can suppose that the loss A will be the same for both producers. According to the fact that the defective yoghurt is recyclable, will the loss present especially these items: opening the crucible of the defective yoghurt, the crucible is thrown to the rubbish, addition of the yoghurt to the mixture and new filling into the crucible. This can be circa the third of the selling price (i.e. at 25 % of profit margin in the multiple store amounts the selling price of the producer 12 CZK), so the loss A will be 4 CZK. The tolerance will be estimated by the mean value of the process. It is at the Czech seller 154,77; and when we subtract 150, is the tolerance circa 4,77. Similarly, at the German seller is the mean value152,32, after the subtraction 150 is the tolerance equal to 2,32.
Now, we will calculate the expense ratio according to the formula 6. For the Czech producer k = 0,18. For the German producer k = 0,19. We can calculate the MSD and if we already know the expense ratio, we are able to express the loss L an also the ratio S/N. The calculation results, which were done in the Excel software, show the table 4.

Index	Czech yoghurt YOG	German yoghurt GHURT
MSD	34,02 grams	8,04 grams
L (per production unit)	6,12 CZK	1,53 CZK
S/N	-15,32 dB	-9,05 dB

Table 4 Losses from the variability and the quality in S/N

The loss L at the Czech producer is circa 4 times higher. This shows also the quality value S/N, when the German yoghurt has the S/N value by 6 decibel, i. e. 4 times higher quality in term of the weight. The loss L is related to the production unit and is expresses the all-society loss, especially the loss of producer and consumer in confrontation with an ideal product. If we would multiply the unit loss for example by the quantity of the produced yoghurt pieces a year, we would get a really high number, when we consider the fact that the yoghurt is produced in million pieces.

OTHER ECONOMIC CONSEQUENCES OF POOR QUALITY

A consumption basket we can imagine as a big shopping basket, where is everything, what an average Czech household consumes; it consists of approximately thousands items divided into 12 basic categories. In the economic theory presents the consumption basket a model consumption of an average household. The items are aggregated into 12 groups (e.g. clothing, foodstuff, transport, holiday etc.), to each item is given the stress according to its representation in the average household spending, the total stress of the consumption basket is 1 000 ‰. The consumption basket represents so the typical group of goods, on their basis is calculated the price level, respectively the inflation rate. In the following graph are the percentage shares of essential 12 items of the consumption basket.

Graph 1 Percentage shares of essential 12 items of the consumption basket

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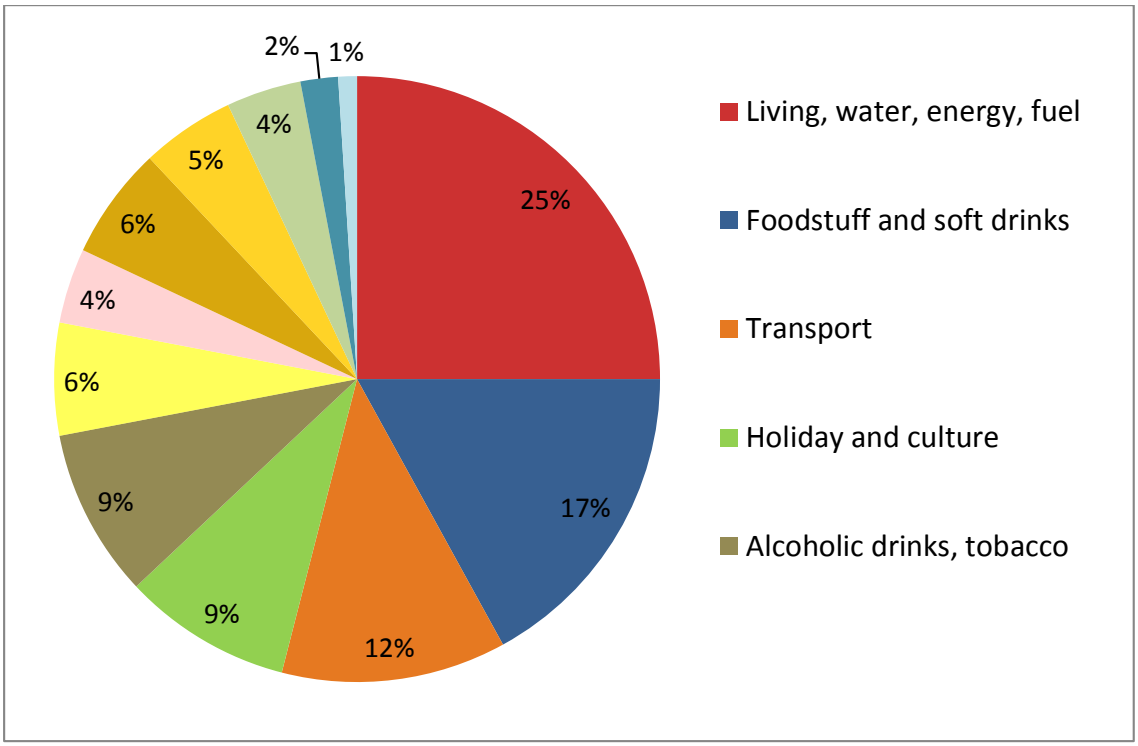

GRAPH 1

The consumption basket has a naturally different content in different countries in the world. The biggest difference is it possible to see in the advanced and the developing countries. The poorer the country is, the bigger parts of consumption present the fundamental foodstuff and living. We can do the image according to the part of the consumption basket, which contents the foodstuff, alcohol and tobacco. These goods occupy the biggest part of the consumption basket. In Czech Republic occupy within the consumption basket the foodstuff and soft drinks 170,824417 ‰. The yoghurts are the part of this group and they have the stress 5,055369 ‰ of all items. In term of an analysis in the case study were chosen the creamy fruit yoghurts, having the stress 3,018475 ‰. An average Czech household, according to the CSO (Czech Statistical Office) consumes 2 457 CZK per capita and month within the group of the consumption basket "Foodstuff and soft drinks", which have the stress by 170,824417 ‰. At the recalculation of the stress and the redistribution comes to the fact that at average 1 person spends for the creamy fruit yoghurts 45 CZK per month. It means that in the Czech Republic, where is according to the CSO at 31. 3. 2015 in total 10 537818 inhabitants, is spent 474 201 818 CZK for yoghurts a year. It appears from this that the loss from the variability per production unit is 6,12 CZK, the consumption is according to the consumption basket 3 yoghurts per capita and month, then the total extent of loss from the variability is 193 474 338,48 CZK. If we would recalculate the CZK in the present exchange rate into the EUR[3], the loss from the variability, which pays the consumer in the price of yoghurt, would be equal to 7 123 694,51 EUR (!). If the Czech producers would achieve the German quality, when the loss from the variability is only 1,53 CZK, the extent of loss from the variability would be only 48 368 584, 62 CZK, which is 1 783 173,63 EUR.

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In simply words, if it would produce with the lower variability, it would be saved:

$$7\ 132\ 694{,}51 - 1\ 783\ 173{,}63 = 5\ 349\ 520{,}88 \text{ EUR}$$

The consumer in the Czech Republic would save monthly in recalculation circa 5 349 521 EUR, which is 145 105 757 CZK. The variability decrease of the production could lead to the price decrease of yoghurts and so to the demand increasing for them; eventually the consumer would invest their money in other products, what could stimulate the economics of the country. In the development of the consumer prices shows the Czech Republic for the first time from its entry into the European Union (EU) the fastest increasing of consumer prices in a group of foodstuff, including soft drinks, of all EU member countries. The growth of an average annual rate was noticed at all other monitored dairy products, namely ranging from 1,3 % (half-fat UHT milk) to 9,6 % (yoghurts). (MZe, 2015) The dairy industry was always very important field of social-economic structure of the European agriculture, which exemplifies also the continuous effort to create a system for an income protection of dairy producers. Since 2010 was renewed the growth of yoghurt import, which increased in 2012 annually by 2,8 thousand tons, i. e. by 13,9 %. There were imported both flavored and not flavored yoghurts. The import share in the domestic production was 17,2 % and the import share in the consumption in 2012 presented 20,6 %. Yoghurts were imported into the domestic market from 16 countries, especially from Germany and Poland. From the total yoghurt production, which annually decreased by 131,4 million liters, the production of flavored yoghurts presented 87,8 million liters. The domestic consumption of yoghurts annually increased by 9,0 thousand tons, i. e. by + 9,0 %. (CSO, 2015) The growth of the world dairy production after the period of economic crisis accelerated again. Selected dairy processors with an international activity in TOP 20 are described in the following table. (Food revue, 2011)

Company	Country	Market share	Volume of milk (million tons)	Turnover milliards USD
Fonterra	New Zealand	3	20,5	
Nestlé	Switzerland	2,2	14,9	19,6
Danone	France	1,2	8	12,9
Kraft foods	USA	1,1	7,5	7

Table 5 World dairy processors

The Czech dairy industry is more than 10 years an integral part of European dairy industry. In term of a volume the Czech Republic processes circa 1,7 % of European milk and still is this a significant sector of national economy. In the Czech dairy industry operates only 35 industrial companies and 5 leading companies from worldwide TOP 20. The volume of processed milk in Czech Republic at foreign investors represents more than 45 %. Nevertheless, the leading Czech dairy companies in Czech Republic are the companies with all-Czech stock, like Madeta processing 13,6 % of volume of milk in Czech Republic, Agrofert – Olma with 8,5 %, tatra with 8,3 % or Kunin with 4 %.

CONCLUSION

The above-mentioned case study showed that the quality of German yoghurt in term of the inside weight is 4 times better than the Czech yoghurt. Similar is the total unit financial loss from the variability of the weight, when the German yoghurt has 4 times lower financial loss. It is possible to appeal to this Czech producer, but also to all producers generally, to minimize the variability of the production. The decrease of the variability presents overall the million savings. Well, if the Czech producer of yoghurt could get with the variability to the German level, he could save 6,12 – 1,53 = 4,59 CZK per unit. In term

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of the application of the consumption basket and the monthly household consumption is the loss from the variability, which pays the consumer in the price of yoghurt 7 132 694,51 EUR. And in term of technical and financial costingness this decrease of the variability does not present an invincible problem. There is more or less only exchange of the production line of the more modern and more accurate machinery for filling. The prices of this machinery are in order of ones million CZK and the economic return is so very fast. In case the Czech yoghurt producers could get near to the qualityof German producers, concerning the variability, the Czech consumers could save in a recalculation 5 349 521 EUR, which is 145 105 757 CZK. In the economic term the consumer would have cheaper foodstuff. The redistribution of the costs to each item within the household consumption would lead to an increase of shopping possibilities, because the consumer would not cover the producers' excess in the price of purchased goods. Although, the purchasing power of inhabitants would not change, the customers would be able to buy a higher volume of these goods at the same income (yoghurt, fermented milk product or other foodstuff with lower weight variability). With the decrease of the variability of foodstuff production would except of benefit for customers and savings of producers decrease also the high wasting of foodstuff, when on the one hand, millions of people worldwide suffer from hunger, on the other hand, people waste the foodstuff. The food industry should take an example by the automotive industry, where the variability is reducing until the current limit of human and technical possibilities. The dairy economics and the dairy industry of the Czech Republic is as a whole relatively stabilized and advancing industry able to European competition. But with the decrease of the production variability of foodstuff would improve the competitiveness of each dairy company and also it could decrease the wasting of foodstuff; and savings would be on the consumer's and producer's side. The perspectives of the next development are more positive and it will depend only on the entrepreneurs, how they their current situation evaluate and take advantage of the opportunity from the market.

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