LIMITATION OF QUALITY COST MODELS IN AGRICULTURE

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Globalization of markets increases competitiveness in agricultural sector, so the companies and farms need to improve quality management and be able to estimate efficiency of this process. The efficiency depends on total quality costs, which have some particularities in agriculture comparable with other sectors of industry. There are two main results from this research. The first result is the identification of particularities of quality costs in agriculture. Some of failure costs are influenced by natural, climate and biological factors and are uncontrollable. For better quality costs management considering these factors the authors suggest to deploy internal and external failure costs into controllable and uncontrollable ones. The second result is proving that earlier developed quality cost models (QCM) have the limited value in agriculture. “Force major” makes more complicated the decisions making of quality costs management and linking towards minimum total quality costs. Moreover, these models are focused on the cost of optimal quality level and ignore changes of revenue. Efficiency of quality improvement process should be estimated by quality costs to sales revenue ratio.

Key words: quality, costs, non-conformance, models, improvement.

JEL Classification System: M21 – Business Economics, Q10 – General Agriculture.

Introduction

The main task for Baltic and other countries, which have joined the EU in 2004, is competitiveness in Europe and World market. Productivity is lower in agriculture than in other economic sectors. It is understandable that activity conditions in agriculture are generally different from those in other industries because of influence of natural and climatic factors. However, it has to be recognised that management level (especially quality management level) in agriculture is behind the quality management level in industry. There are a lot of examples proving that quality management helps not only to improve the quality of products, but also to increase an efficiency of company’s activity. Thus it is the main factor of competitiveness (Alekneviciute & Vanagas, 2004).

The economics of quality is closely related to quality costs. Managing quality costs begins with a general understanding and belief that improving quality performance, as related to product, and improving quality costs mean the same. Classification of total quality costs into failure costs and costs of quality investment is the key for solving the methodological problems of quality economics. As far as it concerns agricultural companies and farms, these costs have some particularities comparable with other sectors of industry.

Few quality cost models (QCM) are developed in order to determine an economically optimal quality level. These models have the limited value in agriculture because some of failure costs are influenced by natural, climatic and biological factors and some deviation of total quality costs does not depend on quality level in agricultural company or farm. Furthermore, QCM are focused on cost optimal quality level and ignore changes of revenue.

The object of the research – quality cost models and their application in the agricultural companies.

The aim of the research – to show the limitation of the use of QCM in agriculture. To reach the set aim the following tasks had to be accomplished: the particularities of quality costs in agriculture have been identified; models of cost of quality have been analysed.

The methods of logical thinking, comparison, analysis and synthesis, and graphic representation have been applied for proving the research results.

Particularities of quality costs in agriculture

Improvement of quality management contributes to customer satisfaction and to profits. The cost of quality techniques is a tool for management in its pursuit of quality improvement and profit contributions. Unfortunately, significant chunks of quality cost are simply unrecognized as most accounting systems are not designed to identify them. As this is generally the case, it is not too difficult to understand why in most companies top management are more sensitive to overall cost than to quality.
Quality costs are a measure of the costs specifically associated with achievement or non-achievement of product or service quality – including all product or service requirements established by the company and its contracts with customers and society. Requirements include marketing specifications, end-product and process specifications, purchase orders, engineering drawings, company procedures, operating instructions, professional or industry standards, government regulations, and any other document or customer needs that can affect the definition of product or service. More specifically, quality costs are the total of the cost incurred by investing in the prevention of non-conformances to requirements, appraising a product or service for conformance to requirements and failing to meet requirements (Campanella, 1999). The mentioned author groups all quality costs into four types: prevention, appraisal, internal failure and external failure. The same grouping is presented by Feigenbaum (2001).

The costs of all activities specifically designed to prevent poor quality in products or services are called prevention costs. Examples are the costs of new product review, quality planning, market research, supplier capability surveys, process capability evaluation, quality improvement projects, quality education and training. From the market research point of view agricultural companies or farmers in some cases know governmental quality requirements for raw material in advance, so they do not suffer these costs. But when the farmer sells, for example, berries directly to the user, he can suffer the above-mentioned costs. The other particularity is that a lot of farms in Lithuania and other new member-countries of the EU are small and due to that their efforts to invest in prevention of poor quality can be uneconomical.

Appraisal costs are associated with measuring, evaluating or auditing products or services to assure conformance to quality standards and performance requirements. These include the costs of incoming and source inspection/test of purchased material; in-process and final inspection/test; product, process, or service audits; calibration of measuring and test equipment; and the costs of associated supplies and materials. For example, agricultural companies should control the germinating power of seeds, if the plants are in (out off) condition during the vegetation period, if the final products (grains, vegetables) meet the requirements of government or customers.

The costs resulting from products or services, not conforming to the requirements or customer/user needs, are called failure costs. Failure costs are divided into the categories of internal and external failure costs. Internal failure costs occur prior to delivering or shipment of the product, or the furnishing of the service to the customer: costs of scrap, rework, re-inspection, re-testing, material review, and down grading. The main particularity of these costs in agriculture is that companies or farmers produce biological products and in most cases they have not possibility “to re-work or repair” and loose sales or get price lower than the expected one. The other feature is that agricultural production is more or less influenced by natural, climatic and biological factors, which can debase the quality very much and are impossible to manage. In some cases it is better not to deliver poor quality products than to lose the market share.

External failure costs occur after delivery or shipment of the product, and during or after furnishing of the service to the customer: costs of processing the customer complaints, customer returns, warranty claims, product recalls, penalties, customer/user goodwill, lost sales. Lost of sales, as the external failure costs, agricultural companies of farmers need to differentiate: a value of contribution margin lost due to the sales reduction because of quality problems from a value of contribution margin lost due to the sales reduction because of quality problems from a value of contribution margin lost due to the sales reduction because of influence of natural and climatic factors. The reason is that the latter lost is not the result of poor quality management.

As mentioned earlier, the amount of internal and external failure costs the companies suffer depends on the specific uncontrollable factors. Total internal and external failure costs depend on the branch of agricultural production: more in plant-growing, less – in stock-breeding; more in growing vegetables in field; less – in hothouses. For better quality costs management with respect to these factors the authors suggest to deploy internal and external failure costs into controllable and uncontrollable (Figure 1).

![Fig. 1. Modified classification of quality costs with respect to specific character of agricultural business](image-url)
Campanella (1999) pointed out that the goal of any quality cost system is to facilitate quality improvement efforts that will lead to the opportunities of operating cost reduction. The strategy for using quality costs is quite simple one: (1) take direct attack on failure costs in the attempt to drive them to zero; (2) invest in the “right” prevention activities to bring about improvement; (3) reduce appraisal costs according to the achieved results; and (4) continuously evaluate and redirect prevention efforts to gain further improvement. This strategy is based on the premise that:

• for each failure there is a root cause;
• causes are preventable;
• prevention is always cheaper.

Two last statements of Campanella are questionable ones if the agricultural sector is discussed. Firstly, some causes (natural, climatic factors) are not preventable ones. Secondly, agricultural company or farmer can not reduce part of internal and external failure costs by investing in quality, because the above-mentioned factors are uncontrollable. These conclusions are proved by Freiesleben (2004), stating that the notion of optimal prevention refers to the fact that prevention has diminishing returns, such that an excessive prevention spending might not always be economically reasonable.

How to determine an economically optimal quality level? Quality cost models can help to answer this question.

**Value of quality cost models in agriculture**

One of the problems in quality management is to avoid causes of deviations from the plan to produce only good products. Solving of this problem is closely related with finding deviating parameters and eliminating the root causes for the deviations. The purpose of QCM is to determine the changes of total quality costs for changing quality levels.

First QCM was developed by Juran together with Lundwal and published in Juran (1951). According to Juran the costs of poor quality (internal and external failure costs) decrease with higher quality levels, while the costs of achieving good quality (appraisal and prevention costs) increase. The total quality costs minimize somewhere below perfection and has a parabolic shape as depicted by Freiesleben (2004b).

This model is in conflict with current trend in industry related with Six Sigma. Six Sigma is the technique, which asserts that minimization of quality costs is very close to perfection, and that the objective of company should be the level of defect smaller than 3.4 parts per million. Six Sigma programs have been shown to be the key success factor in leading companies such as Motorola and General Electric (Hahn et al., 2000). According to Neuscheler-Fritsch & Norris (2001), it is a disciplined approach that helps organizations consistently meet customer requirements and drive continuous improvement through the process focused management. Six Sigma organizations follow a rigorous process improvement methodology – the define-measure-analyze-improve-control (DMAIC) method – managing by fact with data and measurement tools, techniques and systems.

The new QCM first appeared in Kondo (1989) and a number of later researchers also suggested that the old model was inadequate one. Deming (1986) pointed out that the costs of selling defective products were so high that quality costs would only be minimized in the case of 100 percent conformance. Consequently, he saw no reason to measure quality costs since the only sensible strategy was being sure that no defective products were produced at all. Juran & Gryna (1993) stated that “while perfection is a goal for the long run, it does not follow that perfection is the most economical goal for the short run or for every situation”. This means that prevention has diminishing returns and that returns to prevention depends on the already achieved quality level, on technological options, and on learning over time.

Freiesleben (2004b) presents four points concerning discrepancy between the old and the new quality cost models. First, the old model is more suitable for the company with a poor quality level. The argument is that better experience in quality improvement reduces prevention and appraisal costs, because finding and curing all root causes in the next improvement effort would be less costly for this company. Second, the old model is a spotlight on the technological proficiency of the time it was constructed. The prevention of defects has since become more feasible due to technological advances, which benefits both the finding of feasible remedies and the methods of process monitoring. Third, the old model makes no reference to the duration for which a company has been engaged in quality improvement. Fourth, the unit cost consideration makes a strong point that the exponential shape of the “costs of achieving good quality” curve is unrealistic. At higher quality levels, more good products are available to bear the costs of both prevention and appraisal.

Freiesleben (2004b) presents the connection between the two quality cost models as it is shown in Figure 2. If a company starts out with the quality level $q_1$, it gathers information about its quality problem and detects some major root causes for the problem. “As a result of the learning that took place as part of the investigation, the “costs of achieving good quality” curve $C_1$ has been changed to $C_2$. The optimal improvement effort is to increase the quality level from $q_1$ to $q_2$. The detected root causes are eliminated, and $q_2$ is reached”.

Before the next improvement procedures the process of learning takes place and other root causes were detected. This changes the “costs of achieving good quality” curve to $C_3$. This improvement effort results in the now-optimal quality level $q_3$. According to Freiesleben (2004b), “the change in the “costs of achieving good quality” curve reflects the changed return on prevention, which in this new
situation is better than in the first improvement effort. This is a direct reflection of technological progress and learning, both contributing to an easier root cause detection and elimination. The same logic applies for the successive quality improvements, until the company achieves quality perfection and the curve of the new quality cost model applies. The failure cost curve is not affected by this continuous improvement progress and is therefore not shown in the figure”.

Fig. 2. Development of the costs per unit of good product over time according to Freiesleben (2004b).

What is the limited value of both the old and the new QCM in agricultural companies and farms? As it was mentioned by Freiesleben (2004b), old QCM presupposes for company with a poor quality level, the conclusion can be made that agricultural companies and farmers can minimize the total quality costs somewhere rather below the perfection. Quality costs management will have the positive effect during the fixed period if increasing costs of quality investment influence the decreasing failure costs at a higher level. Consideration of the assumptions of the old and the new QCM makes it clear that continuous improvements not only increase the quality level, but also decrease the effort necessary to achieve the next improvement. Even in the case if failure costs are not affected by continuous improvement progress, total costs decrease increasing the conformance to quality. This means that quality improvement process is directly related with the increase of efficiency of quality prevention and appraisal process.

This is true if quality of products depends only on improvement process in a company. As agricultural business is more or less surrounded by natural, climatic and biological factors, internal and external failure costs can increase, when company or farmer invests in quality, thinking about the achievement of higher quality level. Due to this fact total quality costs will increase and real amount will be higher than the expected one.

The authors have modified Figure 2 into Figure 3 in order to show the influence of the above-mentioned factors on internal and external failure costs and to prove the limited value of both the old and the new QCM from the agricultural business specific point of view. The difference between these figures is in failure cost curve. Freiesleben (2004b) makes an assumption that failure cost curve is not affected by the continuous improvement process. The authors make an assumption that failure cost curve is affected by the continuous improvement process as well as by uncontrollable factors, which influence internal and external failure costs and some deviation of total quality costs does not depend on quality level in agricultural company or farm. Then total quality costs, as it is shown in Figure 3, can be higher at a lower conformance to quality: higher at quality level $q_1$ compared with level $q_1-x$; level $q_2$ compared with level $q_2-x$; level $q_3$ compared with level $q_3-x$. “Force major” makes more complicated quality costs management decisions making and linking towards minimum total quality costs.

Both QCM are focused on cost optimal quality level. Considering the objective of a company – maximization of owners’ value – it can not be forgotten that this value also determines revenue. Total costs can maximize profit if revenue is constant. But in a competitive market the revenue of a company will increase with increasing quality levels either through higher prices or higher sales volumes. So the other methodological aspect of quality of economics is the necessity to evaluate effect of quality management in terms of profit, not costs. Freiesleben (2004a) pointed out that “if a company has a poor quality level, an initial investment in quality improvement lowers its production costs and increases its revenue. In most cases, these benefits are greater than the costs for the improvement. A cycle of quality investments can start, which ultimately transforms the poor quality producer into a high quality producer and simultaneously increases profitability. And profits count, not costs”.

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Profit is an absolute economical indicator and shows only the effect of quality management decisions in a company. Increase of profit over time does not mean that increase efficiency of quality improvement process. This argument is proved by Feigenbaum (2001), who states that “for many companies, the costs of quality failures can amount to more than 20% of sales, compared with 10% of sales in pacesetter organizations”. Brust & Gryna (2002) assert that “for manufacturing companies, the cost of poor quality, such as scrap and rework, runs in the range of 5 to 35% of sales revenue, for service organizations - 25 to 40% of operating expenses”. Mukhopadhyay (2004) states that estimation of quality costs helps to reduce costs of non-conformance. For example, in the Indian textile industry, while average companies earn a profit of about 4-5% of turnover, good companies earn a profit of about 10% of turnover. Therefore, in a horizontal analysis of efficiency of quality improvement process it is better to calculate total quality costs to sales revenue ratio, costs of quality investment to sales revenue ratio, failure costs to sales revenue ratio. Some problems can arise during the inflation, when input price index increases more than output price index. In such situation, which is formed in agricultural sector more frequently than in other sectors of industry, the horizontal analysis of the above-mentioned ratios will present the perturbed results of quality management efficiency.

**Conclusions**

Increasing prevention and appraisal quality costs decrease failure costs and maximize value of a company. Major part of agricultural companies and a lot of farms in the new members-countries of the EU are small and due to that their efforts to invest in prevention of poor quality can be uneconomical ones. The main particularity of internal failure costs in agriculture is that companies or farmers produce biological products and in most cases they have no possibility “to rework or repair” and lose sales or get price lower than the expected one. The other feature is that agricultural production is more or less influenced by natural, climatic and biological factors, which can debase the quality very much and is impossible to manage. From the external failure costs, especially lost of sales point of view agricultural company of farmer need to differentiate the value of contribution margin lost due to sales reduction because of quality problems from the value of contribution margin lost due to sales reduction because of influence of natural, climatic and biological factors. The reason is that the latter lost is not the result of poor quality management. For better quality costs management considering these factors the authors suggest to deploy internal and external failure costs into controllable and uncontrollable ones.

Consideration of the assumptions of the old and the new quality cost models makes it clear that continuous improvements not only increase the quality level, but also decrease the effort necessary to achieve the next improvement. Even in the case if failure costs are not affected by continuous improvement progress, total costs decrease when the conformance to quality increase. This means that quality improvement process is directly related with increasing of efficiency of quality prevention and appraisal process. But this is true if quality of products depends only on improvement process in a company. As agricultural business is more or less surrounded by natural, climatic and biological factors, internal and external failure costs can increase, when company or farmer invests in quality, thinking about the achievement of higher quality level. Due to this fact total quality costs will increase and real amount will be higher than the expected one. “Force major” makes more complicated the decisions making of quality costs management and linking towards minimum total quality costs.

QCM are focused on cost optimal quality level. Considering the objective of a company – maximization of
owners’ value – it cannot be forgotten that this value also determines the revenue. Profit is an absolute economical indicator and shows only an effect of decisions of quality management in a company. Efficiency of quality improvement process it is better to estimate by calculating quality costs to sales revenue ratio. Some problems can arise during the inflation, when input price index increases more than output price index. In such situation, which is formed in agricultural sector more frequently than in other sectors of industry, the horizontal analysis of above-mentioned ratios will present the perverted results of quality management efficiency.

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