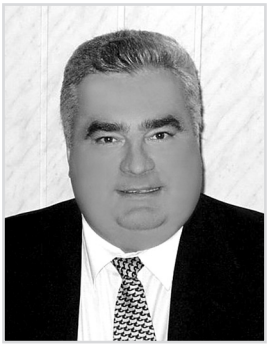
UDK 378,5



Rafik Starkov
D.Sc. (Economics), Professor,
Irkutsk State Technical University, Russia
83 Lermontov Str., Irkutsk, 664074, Russia
starckov.rafik@yandex.ru

Aleksey Sapozhnikov
D.Sc. (Economics), Professor,
Bratsk State University, Russia
40 Makarenko Str., Bratsk, 665709, Russia
alescha.sapozhnikov@yandex.ru

Pavel Lontsikh
D.Sc. (Engineering), Professor,
Irkutsk State Technical University, Russia
83 Lermontov Str., Irkutsk,
664074, Russia
palon@list.ru

Economic criteria of production quality management and loss minimization

Abstract. *Purpose* of the paper is to identify economic criteria of production quality management and determine the methods of loss minimization. *Methods:* comparative analysis, analogy, comparison and correlation. *Results:* economic advantages of standardization and metrology are determined. The list of quality cost components is defined; cost of quality analysis and assessment is provided. Assessing the relevance of the selection criteria for quality management in the management systems associated primarily with the objective of minimizing losses. Criteria for evaluating the quality of the quality management system and ways to minimize losses have been proposed. *Conclusion:* the authors' research measuring the cost of quality can be part of any quality management program. The described methods provide real opportunities for the identification and measurement of quality costs.
Keywords: Quality Tools; Loss Minimization; PQC concept; Standardization; Metrology; Quality Management; Cost of Quality
JEL Classification: M11

Старков Р. Ф.
доктор экономических наук, профессор кафедры управления промышленными предприятиями,
ФГБОУ ВПО «Иркутский государственный технический университет», Россия
Сапожников А. А.
доктор экономических наук, профессор, ФГБОУ ВПО «Братский государственный университет», Россия
Лонцих П. А.
доктор технических наук, профессор, заведующий кафедрой управления качеством и механики,
ФГБОУ ВПО «Иркутский государственный технический университет», Россия

Экономические критерии менеджмента качества производства и минимизация потерь

Аннотация. В статье выявлены экономические критерии менеджмента качества и методы минимизации потерь. Охарактеризованы экономические преимущества стандартизации и метрологии, которые авторы рассматривают как основные инструменты решения задач. Используя методы сравнительного анализа, аналогии и корреляции, определены компоненты стоимости качества производства, а также стоимости анализа и оценки качества. В результате проведенного исследования сформулированы рекомендации относительно выбора критериев обеспечения качества менеджмента и реализации путей для достижения минимизации потерь. В части 1). определения методов поддержания устойчивых темпов экономического роста; 2). обоснования внедрения принципов менеджмента качества, обеспечивающих высокую конкурентоспособность предприятия; 3). формирования эффективного воспроизводства и модернизации промышленности, повышения инвестиционной привлекательности при сокращении издержек и потерь, что позволит получить ощутимый эффект и ориентироваться на потребителя.
Ключевые слова: качество производства; управление качеством; минимизация потерь; концепция PQC (Production Quality Management); стандартизация; метрология; оптимизация затрат на качество.

Старков Р. Ф.
доктор економічних наук, професор кафедри управління промисловими підприємствами,
Іркутський державний технічний університет, Росія
Сапожніков О. А.
доктор економічних наук, професор, Братський державний університет, Росія
Лонцих П. А.
доктор технічних наук, професор, завідувач кафедри управління якістю і механіки,
Іркутський державний технічний університет, Росія

Економічні критерії менеджменту якості виробництва та мінімізації витрат

Анотація. У статті виявлено економічні критерії менеджменту якості та методи мінімізації втрат. Охарактеризовано економічні переваги стандартизації і метрології, що розглядаються авторами як основні інструменти вирішення завдань. Використовуючи методи порівняльного аналізу, аналогії та кореляції, визначено компоненти вартості якості виробництва, а також вартості аналізу й оцінки якості. В результаті проведеного дослідження сформульовано рекомендації щодо вибору критеріїв забезпечення якості менеджменту і реалізації шляхів для досягнення мінімізації втрат. У частині: 1). визначення методів підтримки стійких темпів економічного зростання; 2). обгрунтування впровадження принципів менеджменту якості, що забезпечують високу конкурентоспроможність підприємства; 3). формування ефективного відтворення та модернізації промисловості, підвищення інвестиційної привабливості при скороченні витрат і втрат.
Ключові слова: якість виробництва; управління якістю; мінімізація витрат; концепція PQC; стандартизація; метрологія; оптимізація витрат на якість.

Introduction. The relevance of the selection criteria for quality management in the management systems associated primarily with the objective of minimizing losses. The importance of this problem is confirmed by the possibility of achieving the following criteria (Lontsikh P. A., & Schadov M. I., 2011):

- the level of satisfaction of needs;
- iustainability and the priority of competitive advantage (progressive, rating);
- criteria for the formation of long-term vision and mission of providing a reliable forecast of development;
- availability of resources;
- risk assessment and minimization of losses.

The current state of economics requires conducting research of economic regularities related to quality assurance of goods, services and quality management. As the result, the theoretical base of the new, contemporary scientific direction has been formed – economics of quality.

Economics of quality is a part of the economic science, which studies the interrelation of quality indicators of objects or phenomena with economic indicators. It is an independent part of the total economic system of the organization, designated to resolve a series of individual economics tasks in the domain of quality assurance and improvement, and to provide competitive advantage of products, intended to address a number of important, popular and urgent economic problems. The immediate target of the economics of quality as a science is description, explanation and forecasting of regularities of the effect of quality onto processes and phenomena of social life.

Taking into consideration the entire system of economic relations, economics of quality facilitates the search of optimal solutions for social and economic problems at all levels of administrative hierarchy (municipality, city, region, country, international unions, and international organizations). The research area «Economics of quality» can be represented as an orderly system, which includes the tools of economics of quality, e.g. standardization, quality management, metrology, testing, training, forecasting and assessment. Both state and private structures of not only national, but also international level take part in their functioning.

The system of economics of quality enables to provide assessment of any object at any level of management (product, real property, enterprise, body of local government, region), acknowledgment of compliance of product and its unrestricted circulation in the internal and international markets, competitive advantage of economics – in this determining the relevance of the problem and motivate the tools used to achieve the goal.

Brief Literature Review. A lot of attention is presently dedicated to issues of quality management in the economic publications of the researcher community. Various aspects of quality management are considered in studies of Lontsikh P., Shchadov M. et al. (2011),Okrepilov V. (2011, 2012), Nechaev A. (2013), Savitskaya L. (2002), Feigenbaum A. (1986) etc.

The monograph Douglas C. Woods how s that low quality increases the cost of production and cause costs related to the low quality of products, is to create a complex system of checks and control products, as well as a was teofres our ces a tall stages of production. Hansen J. T. proves that the growth of direct production costs is only part of the total costs of insufficient quality. In studies conducted Rampersad H. K., are methods and principles of total quality management on the basis of which reached minimize losses and reduce costs.

Purpose of the research is to identify economic criteria of production quality management and determine the methods of loss minimization.

Results. Maintaining stable rate of economic growth, high competitive advantage are only possible on the path of innovative development of the country's economy, which calls for constant quality upgrade. By promoting the reduction of costs, upgrade of production facilities and training of staff, quality becomes the key to success, facilitates efficient reproduction and upgrade of industry cluster, improves investment attractiveness of both individual enterprises and regions in general.

In order to reach complete understanding of the economics of quality, it is necessary to discuss the economic advantages of the above-mentioned tools – standardization, metrology, quality management [1].

Standardization is one of the key factors affecting the upgrade, technological, social and economic development of Russia, as well as improvement of the country's defense capacity.

Standardization is expected to provide the following:

— development of fair competitive edge of the product (works, services);

— manufacture and circulation of innovative and high-tech products;

— improvement of product (works, services) safety level and quality;

— protection of life and health of citizens, private property and property of legal entities, state and municipal property;

— protection of environment, life and health of animals and plants;

— prevention of actions misleading the buyers, including consumers;

— energy efficiency and resources saving;

— positive economic effect on reduction of diversity level;

— information support.

Uniformity of measurements remains one of the core conditions of efficiency of research and development, management of production and other facilities, diagnostics and treatment of diseases, reliable accounting of material assets and energy resources, product quality control, labor safety conditions, environment protection, reliability of communication and transport, defense of the state.

It is important to note the importance of measurements in execution of commercial transactions through reduction of costs and elimination of disagreements through application of measurements.

An efficient system of commercial measurements yields considerable economic benefits, including:

— consumer protection;

— creation of equal conditions for all participants of commercial transactions;

— efficient control of resources;

— identification of fraud;

— reduction of disagreements and cost in commercial transactions;

— acquisition maximum profit for the state on export of raw materials.

Establishing economically optimal areas of development for metrological support is one of the key economic problems of metrology.

Quality improvement is accomplished through use of inventions, creation of new products, new technologies, offer of new services etc. This contains the essence and rationale of innovations. It is well known that innovations may be created and implemented in virtually all aspects of human life, including in economics, ecology, social development. Special attention should be dedicated to innovations in management. One specific type of such innovations is implementation of modern quality management methods, in particular, creation of quality management systems.

Over 30 years of positive experience of implementing these systems at the enterprise level show their high efficiency. Results of numerous surveys indicate that systems promote higher satisfaction among consumers, standardization (and, therefore, harmonization) of business processes, creation of favorable conditions for implementation of other management systems – environment protection, occupational health and safety etc.

Many modern companies are oriented at consumers and they strive to improve quality of their products to maximize fulfillment of consumer demands. Any serious attempt to improve quality requires consideration of the amount of costs associated with this activity, since the objective of continuous improvement of quality is not only fulfillment of consumer's expectations, but also doing so at the lowest price. This is possible only through reduction of cost required to accomplish quality, however, reduction of these costs, in turn, is only possible if they are clearly defined and measured. This is why measurement and

accounting of the Cost of Quality (CoQ) must be on the agenda of modern managers. Before proceeding with the description of the existing methods for assessment of the cost of quality, it is necessary to provide a definition for the term «costs» and provide a more detailed classification of the cost of quality [2].

In contemporary practice, cost of quality is understood as the combination of costs, which are determined by the need to accomplish or maintain a particular level of quality at enterprises, i.e. determined by fault prevention actions, planned quality control, elimination of errors inside and beyond the firm, as well as implementation of external managerial functions in this domain [3].

The sum of all costs of quality constitutes the total cost of quality. This cost is composed of cost of preventive actions, cost of control and cost of loss (internal and external). Change in the achieved level of quality is reflected in the change of components, and, accordingly, of their sum – total cost of quality [4].

Analysis of the cost of quality consists of determination of the research method for cost of quality and activity within the quality management system, while assessment of the cost of quality consists of the activity related to determination of interrelation and impact of the cost of quality onto economic indicators of the organization activity model. Main targets of analysis:

– Identification and assessment of the amount of required investments into provision (safeguarding) and improvement of quality;

– Provision of the required quality of manufactured products while minimizing total costs of production and operation;

– Identification of interrelations between cost of quality and results of the company's economic activity;

– Determination of critical areas of production activity, which call for measures to improve production organization.

As noted above, economics of quality is immediately related to the concept of «cost of quality». This concept appeared in the 1950s. Several main approaches to accounting and assessment of the cost of quality can be distinguished.

In 1951, Joseph Juran published his «Reference Book on Quality Control», which proposed the classification of quality costs. This work received the name of «PAF-model» (Prevention, Appraisal, Failure). In accordance with that model, cost of quality is divided into:

- preventive costs (cost of works for development and planning of quality loss reduction),
- assessment costs (cost of control and testing),
- costs incurred due to failures, related to loss due to inadequate processes of design and production, which, in turn, may be related to external or internal defects [3].

The first and the second categories yield to control by means of management, while the third category describes the loss.

This approach to assessment, accounting and analysis of the cost of quality became the basis of the British standard BS 6143:1992, which was later ratified in the system GOST R as standard GOST R 52380.3-4005. Quality management guide. Part 2. «Model of prevention, appraisal and failure» [5; 6].

Relation between types of costs and total cost of quality is indicated at Figure 1.

The key disadvantage of this theory and that by solving the task through search of extremum, an optimal ratio of the cost of quality can be found. However, this will result in a certain «economically justifiable» level of defects. It does appear appropriate to consider this level acceptable [7].

However, lately companies began to assign high priority to preventive measures. Thanks to use of new technologies, the industry was able to reduce the number of failures, while human error reduced through production and control automation. Figure 2 illustrates the contemporary model of optimal cost of quality.

In 1979, one of the world-renowned American specialists of quality management Philipp Crosby published his book «Quality for Free». In his studies of the cost expression of quality, he put forward the concept of Zero Defects. This means that the producer has to pay not for quality, but rather for absence of

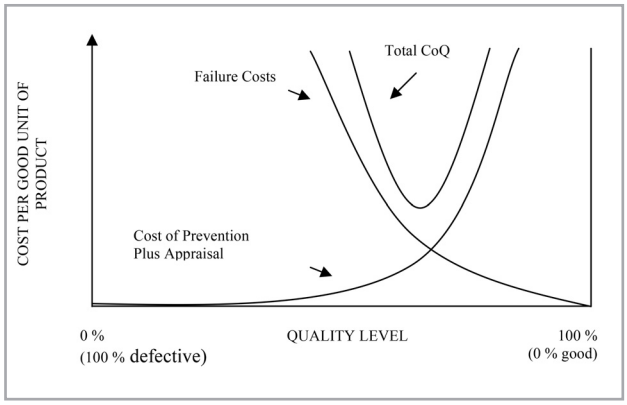


Fig. 1: **Model of the optimal cost of quality**
Source: Own research

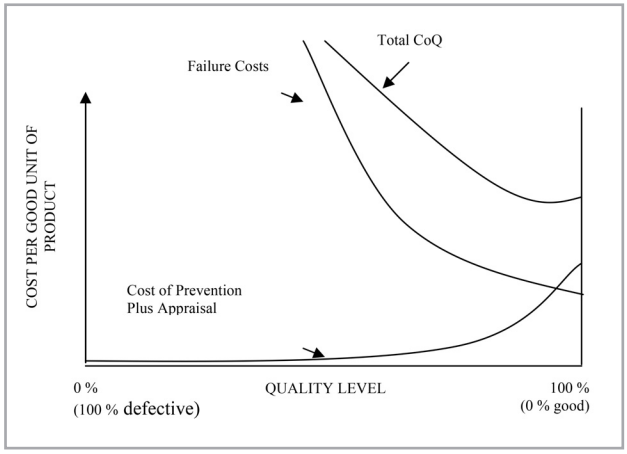


Fig. 2: **Contemporary model of the optimal cost of quality**
Source: Own research

quality. Each worker must perform his/her work right the first time.

The proposal put forward by Ph. Crosby is related to splitting the costs into two categories. This approach differentiates the following:

- costs related to production of the «right products the first time» *(cost of compliance).*
- costs incurred due to the need to mitigate the omitted non-compliances or defects in products *(cost of non-compliance).*

Total cost of compliance and cost due to non-compliance combined produce the total cost of process. The model of costs can be generated for any process of the enterprise [1]. The approach of Philipp Crosby was implemented in another British standard BS 6143:1992, which was ratified in the Russian system GOST R in the form of standard GOST R 52380-2005 Quality Management Guide. Part 1. «Model of the cost of process» [5; 6].

In 1960–1970s, the term «cost of quality» was mainly used to measure production and warranty costs. However, at a later stage, managers developed the understanding that all services and departments of an enterprise make mistakes one way or another. This is not only true for «blue collar», but also «white collar» jobs. It was estimated that mistakes made by the latter account for 20% to 35% of the total cost of quality [8].

In order to engage the administrative staff into activity for improvement of quality and reduction of costs caused by defects, the term «defect», which predominantly belongs to production, was replaced by «error» [9].

Specialists did not exhibit uniform understanding of the term «cost of quality». It was originally interpreted as the «Cost of poor quality» The concept of PQC (Poor Quality Cost) is different from preceding concepts in several provisions, as it divides the costs into the following categories:

1. Direct PQC:

a. Controllable PQC:

– cost of error prevention (related to rendering assistance to staff in correct performance of their work);

– cost of assessment (related to determination of product quality compliance);

b. PQC for elimination of the consequences of errors omitted:

– external error;

– internal error;

c. *equipment-related PQC* (investments into testing equipment plus the cost of area occupied by this equipment);

2. Indirect PQC:

a. Costs incurred by consumer due unsatisfactory quality;

b. Costs related to absence of consumer's satisfaction;

c. Cost of lost reputation [2].

Model of the cost of process PQC presents the systems of economic properties, which are concentrated at the process, rather than products or services. The cost of process is defined as the total cost of the 2 groups of costs:

1) Conformal (required) costs – actual cost of the process performed in compliance with requirements of standards/specifications;

2) Nonconformal (additional) costs – excessive costs related to increase of the cost of process due to unsuccessful implementation.

Unfortunately, contemporary systems of accounting do not provide the opportunity to identify all components of the cost of quality and analyze the collected data. The Activity-Based Costing (ABC) method can be proposed as a solution to this problem. This method constitutes a procedure for distribution of overheads and indirect costs in individual types of works/operations on a pro rata basis to real costs when using a particular type of resources.

The method of Activity-Based Management (ABM) takes into consideration all processes in the company with breakdown by type:

– processes generating added value for customer;

– processes generating added value for company;

– processes, which do not generate added value (e.g. mitigation of errors in issued invoices);

– processes to maintain activity of the company (e.g. annual mandatory audit).

This method deploys process-oriented economic tools, such as ABC and Activity-Based Budgeting (ABB). In combination, they create the methodology for processing of economic information and activity-based management – «ABC – ABB – ABM» [10].

There are specific features in each direction of implementation of innovative achievements into production as part of scientific and technical process. These features are taken into consideration in calculation of the annual economic effect.

Alongside with other indicators, the annual economic effect is one of the main elements for calculation of capital investments' economic efficiency and new equipment.

Conclusion. Thus, the authors of this publication have made a significant contribution to the development of problem analysis to ensure the competitiveness of enterprises and the definition of performance indicators. These criteria apply the system of indicators of profitability, calculated as the ratio in the general form of profit to the cost.

Moreover, depending on the objectives of the study, the numerator and denominator of this fraction may be specified that, in turn, allows for factor analysis of cost-effectiveness, based on which the detailing was carried out.

In conclusion, we point out that the practical value of the authors' research measuring the cost of quality can be part of any quality management program. The described methods provide real opportunities for the identification and measurement of quality costs, thus, contribute to targeted efforts to improve quality and reduce costs.

References

1. Okrepilov, V. V. (2012). Economics of Quality as a Versatile Development Tool. *Ekonomika kachestva (Economics of Quality), 1*(1) (in Rus.).
2. Freiesleben, J. (2012). Often Neglected Costs. *Delovoe sovershenstvo (Business Perfection), 3* (in Rus.).
3. Feigenbaum, A. (1986). *Product Quality Control.* Moscow: Economics (in Rus.).
4. Shank, J., & Govindarajan, V. (1999). *Strategic Management of Costs.* St. Petersburg: Biznes-Mikro (in Rus.).
5. GOST R 52380.3-4005. *Quality management guide.* Part 1: Model of the cost of process (in Rus.).
6. GOST R 52380.3-4005. *Quality management guide.* Part 2: Model of prevention, appraisal and failure (in Rus.).
7. Adler, Yu. P., & Schepetova, S. E. (2005). *System of the Economics of Quality.* Moscow: Standarty i Kachestvo (in Rus.).
8. Savitskaya, L. N. (2002). Value of PQC System for Companies. *Upravlenie kompaniej (Company Management), 2* (in Rus.).
9. Harrington, H. (1987). *Poor-Quality Cost.* N.Y.: ASQC Quality Press.
10. Nechaev, A. S., & Basova, A. V. (2013). Taxation as an instrument of stimulation of innovation-active business entities. *World Applied Sciences Journal, 22* (11), 1544-1549.

Received 02.02.2015

References (in language original)

1. Окрепилов В. В. Экономика качества как универсальный инструмент развития / В. В. Окрепилов // Журнал Экономика качества № 1 (1), 2012.
2. Freiesleben J. (2012). Often Neglected Costs / J. Freiesleben // Business Perfection. № 3, 2012 (In Rus.).
3. Фейгенбаум А. Контроль качества продукции / А. Фейгенбаум. – М. : Экономика, 1986.
4. Шанк Дж., Говиндараджан В. Стратегическое управление затратами / Дж. Шанк, В. Говиндараджан. – СПб. : ЗАО «Бизнес-Микро», 1999.
5. ГОСТР 52380.3-4005. Руководствопоэкономикекачества. Часть 1. «Модельзатратнапроцесс».
6. ГОСТ Р 52380.3-4005. Руководство по экономике качества. Часть 2. «Модель предупреждения, оценки и отказов».
7. Адлер Ю. П., Щепетова С. Е. Система экономики качества / Ю. П. Адлер, С. Е. Щепетова. – М. : РИА «Стандарты и качество», 2005.
8. Савицкая Л. Н. В чем ценность системы PQC для компаний? / Л. Н. Савицкая // Управление компанией. – № 2, 2002.
9. Harrington H. Poor-Quality Cost / H. Harrington. – N.Y. : ASQC Quality Press, 1987.
10. Nechaev A. S., Basova A. V. Taxation as an instrument of stimulation of innovation-active business entities / A. S. Nechaev, A. V. Basova // World Applied Sciences Journal: IDOSI Publications. Pakistan. № 22 (11), 2013. – P. 1544–1549.

Статья поступила в редакцию 02.02.2015