Małgorzata ROSZKOWSKA, MA
Faculty of Economics and Management, University of Bialystok
e-mail: malgorzata.roszkowska@gmail.com

DOI: 10.15290/oes.2018.02.92.18

ECONOMIC EFFECTIVENESS OF QUALITY ACTIVITIES – THE ESSENCE AND CONDITIONINGS OF MEASUREMENT

Summary

The aim of the paper is to discuss the concept of the efficiency of quality activities, its measurement conditionings and to verify the selected solutions in the context of a production company's business practice. The research presented in the paper required a review of the subject literature, and the proposed solutions are identified on the basis of empirical data from the analyzed enterprise. The obtained results prove that it is possible to use both the indicator analysis and the assumptions of the model of Activity Based Costing (ABC) for evaluation of the economic efficiency of quality activities. The solutions presented in the paper may be used in practice by production companies which attach relatively high importance to the quality of the goods they manufacture.

Key words: quality, costs of quality, quality activities, economic efficiency, activity based costing

JEL: D24, D61, L15

1. Introduction

Assuming that quality is a source of competitive advantage, an increasing number of companies functioning in Poland implement quality management systems compatible with the ISO 9001 standard[1]. However, what is important is not so much the possession of the certificate, but having an efficiently functioning quality management system, focused on ensuring both the efficiency and effectiveness of realized activities, which should consequently translate into production of goods which meet very high quality standards. While investing in quality, special attention must be paid to the ratio of achieved effects to the incurred inputs, aiming to strengthen particularly those quality activities that guarantee maximum economic efficiency.

Continuous technological advancement and the changeability of the business environment prompt managers to strive at improving both the quality of produced goods and the efficiency of realized activities. Efficient quality man-

[1] The latest amendment to the ISO 9001 standard took place in September 2015, which was reflected in the Polish standard PN-EN ISO 9001:2015-10.

agement is determined by numerical information, on the basis of which it is possible to make rational decisions. Numerical information, which takes into consideration the costs of identified quality activities, must be reliable, precise and up-to-date. Therefore, economic efficiency ought to be the main premise for decisions, both short-term and long-term ones. One must agree with the opinion of W. Świtalski, who writes that the implications of the relationship between quality and economic efficiency deserve attention not only due to their importance for business practice, but also because they enhance the ability of economic theory to explain the phenomena observed nowadays in the turbulent environment of the global economy [Świtalski, 2008, p. 143].

The aim of this paper is to discuss the idea of the efficiency of quality activities, the issues associated with its measurement, and to attempt a verification of selected solutions in business practice. The study conducted for the needs of the paper aimed at verifying the validity of the hypothesis that the evaluation of the economic efficiency of activities in the field of quality (using methods based on identified costs of quality) generates a comprehensive collection of information necessary for making rational decisions in a production company.

2. Economic aspects of quality activities in production companies

Quality is a concept which, both in theory and practice, can be variously defined [Stecyk, 2016, pp. 28–34; Wronka, 2016, pp. 13–22]. The discrepancies result from, among other things, the fact that the problem of quality is addressed by representatives of various scientific disciplines, frequently representing different points of view, and usually lacking a common conceptual apparatus.

According to R. Karaszewski and K. Skrzypczyńska, attempts to define quality clearly show that although this category seems uncomplicated, in reality it is extremely difficult to define precisely [Karaszewski, Skrzypczyńska, 2013, pp. 13–14]. This is because quality can be perceived in many dimensions. E. Skrzypek claims that it is not possible to define quality in an unequivocal and categorical way [Skrzypek, 2000, p. 15]. On the other hand, M. Bugdol states that the concept of quality has been changing along with the development of civilization [Bugdol, 2011, p. 10]. It used to be believed that quality means perfection, whereas now it is assumed that quality is the degree to which a certain product satisfies the needs of consumers. Contemporary approaches to the concept of quality result from the changes taking place on global markets and in the environment of companies.

Under the normative approach, in accordance with the ISO 9000 standard, quality is "the degree to which a set of inherent characteristics[2] of an object ful-

[2] Inherent characteristics are the distinguishing features of a good; they include its physical, ergonomic, functional, operating, and temporal traits. Non-inherent properties, on the other hand, include features ascribed to a good, e.g. its price.

fils requirements" [PN-EN ISO 9000, 2016, 3.6.2, p. 22]. Inherent characteristics are understood here as the set of attributes of a product, whereas requirements are the needs or expectations that are specified or adopted. As can be noticed, in the ISO 9000 definition, quality refers to an object. An object means anything that can be separately described, analyzed and evaluated, i.e. a product, service, process, activity, resource, system, and organization. Meanwhile, a property (distinguishing feature) can either be ascribed to an object or inherent, i.e. existing on its own.

It stems from the above that quality is a multidimensional concept that can be virtually combined with each aspect of a company's functioning. Owing to this, in an economic entity this category is usually defined through the prism of tasks realized by particular elements of its organizational structure, but in each case, quality[3] [Crosby, 1979, p. 9]:

- has to be defined as conformance to requirements,
- is achieved through prevention, not appraisal,
- means zero defects as a production standard,
- is measured by the price of non-conformance, not indices.

Companies which have implemented quality management systems compatible with ISO 9001 are obliged to use process management. In the subject literature, various definitions of the concept of 'process' are given. R. L. Manganelli and M. M. Klein believe that process is a sequence of interrelated activities which lead to the transformation of all the inputs into a final effect [Manganelli, Klein, 1998, p. 27]. On the other hand, E. Pająk defines it as each successive change of the status quo in a cycle of activities that take place one after another [Pająk, 2006, p. 85]. According to B. R. Kuc, processes are strings (sequences) of logically structured activities that generate a certain effect (result) of an activity (product, service), which is used by a consumer (external or internal) [Kuc, 2017, p. 15]. For R. Ryńca, it is a sequence of implemented measures aimed at transforming a clearly defined initial state into a final state, by means of necessary resources [Ryńca, 2009, p. 9]. It seems that the definition proposed by R. Ryńca is the most complex and universal one as the author takes into account the following elements: a clearly defined initial state and final state, as well as the resources that are necessary to achieve the purpose.

In accordance with the requirements of the ISO 9001 standard, companies ought to define numerous interrelated measures and manage them in order to ensure the efficiency and effectiveness of the realized processes because from the perspective of activities it is possible to see things more precisely [Kaplan, Cooper, 2000, p. 123]. The ISO 9004 standard recommends that processes in a company include activities associated with management, provision of resources, product realization, monitoring, measuring, and auditing [PN-EN ISO 9004, 2010, 7.2, p. 29].

[3] These assumptions are termed as 'Crosby's four quality attributes'.

A measure is most frequently defined as a sequence of deliberate actions taken over time and leading to the desired effect of an undertaking [Kolman, 2013, p. 26]. Activities undertaken as part of particular processes can be divided into active and passive ones. The former either introduce a modification or create added value, whereas the latter involve checking of active measures, without creating added value. The division of measures into active and passive ones is particularly useful for control and analysis of each process connected with ensuring quality. Active measures include preventive activities, which are regarded as the most profitable in economic terms. They concern events that have not taken place, when potential non-conformance has not yet occurred. Measures of the passive type, on the other hand, include auditing activities, regarding both supplies and finished products. According to the ISO 9000 standard, companies may destroy a product or rectify it in order to eliminate the detected non-conformance. The rectification can involve repairing[4] the product or its reclassification[5].

One must agree with the opinion of R. Ryńca, who claims that the knowledge of processes and activities which results from the analysis of measures implemented by a company constitutes a particularly important factor that can be used to manage both activities and their costs [Ryńca, 2009, p. 11]. According to P. B. Crosby, management of an organization should focus on the measurement of costs, especially the costs of errors which arise in the course of processes. For managers, costs are a comprehensible measurement unit that enables them to observe problems that require improvement and undertake activities which will guarantee substantial results, with relatively few resources necessary. The costs of mistakes made during processes have an impact on the results obtained by an entire organization and on satisfying consumer requirements [Dobrowolska, 2017, p. 107].

The term 'quality costs' has functioned both in the literature and in business practice since the second half of the twentieth century. A review of the literature on the subject reveals that authors do not agree as to the definition of this concept. Quality costs are interpreted both as the sum of outlays on producing a product characterized by a certain quality and as an element of the costs of manufacturing a product. There are four different views regarding the essence of quality costs [Szafrański, 2007, p. 75]:

- quality does not cost anything (expenditures related to quality result solely from inefficiency of activities and should be regarded as losses),
- quality costs constitute part of company costs,

[4] Repair is the activity undertaken towards a deficient good in order to make it acceptable for intended use [PN-EN ISO 9000, 2016, 3.12.9, p. 34].

[5] Reclassification involves changing the class of an improper good in order to make it compatible with requirements that differ from the earlier requirements [PN-EN ISO 9000, 2016, 3.12.4, p. 33].

– all the accountancy costs of a company are quality costs,
– quality costs of a company may be higher than the costs documented in the accountancy system.

On the basis of his own research, R. Wolniak concludes that the second of the above-mentioned views is currently the most popular [Wolniak, 2011, p. 311]. In business practice, the category of quality costs (for record-keeping and analytical purposes) is broken down into two, three, or even four groups. Some authors, e.g. P. B. Crosby, distinguish two categories: costs of consistency and costs of inconsistency. The classification comprising three groups, proposed, among others, by J. M. Juran, takes into account: costs of prevention, costs of control, and costs of deficiencies. The division suggested by R. Kolman takes into consideration four sets of costs: costs of prevention, costs of evaluation, costs of internal deficiencies, and costs of external deficiencies [Schiffauerova, Thomson, 2006, pp. 649–653; Hamrol, 2017, pp. 199–201; Kolman, 2009, pp. 398–399].

The present norms prescribed in the ISO 9000 standards do not include issues regarding the classification of quality costs and ways of using them in quality management processes. It needs emphasizing that the already out-of-date standards ISO 9004-1:1994 and ISO 9004-3:1994 contained models of quality costs with separate elements of their classification. According to Z. Zymonik, the aforementioned models are still used in the business practice of companies [Zymonik, Hamrol and Grudowski, 2013, p. 140], as a result of which they are regarded as part of the field of qualitology[6].

Specification of particular categories of quality costs depends on the decision of company management. Priority should be given to information needs regarding the process of ensuring quality and evaluation of the economic efficiency of realized quality activities. A detailed classification of quality costs constitutes the starting point, both for defining the principles of record-keeping and for the ways of analyzing this group of costs in a business entity.

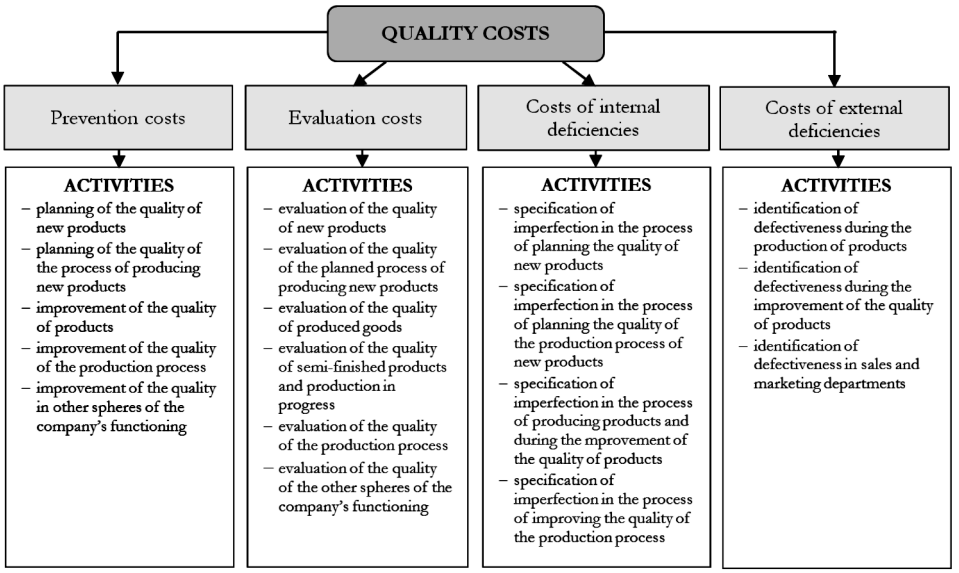
For the needs of this paper, it is assumed that quality costs do not comprise the total costs of producing goods, but only the part related to the producer's concern for their quality. These costs stem from the search for new or improved versions of goods, their preparation for production, as well as from preventive measures aimed at ensuring that the manufactured goods are characterized by the desired level of quality. Furthermore, quality costs include the costs of internal and external deficiencies resulting from failure to achieve the expected quality level.

[6] Qualitology is a science concerned with the various aspects of quality. Both the scope and basic principles of qualitology were developed by R. Kolman, who described them, e.g. in the publication entitled *Kwalitologia. Wiedza o różnych dziedzinach jakości*. According to W. Mantura, R. Kolman's pioneering solutions and concepts regarding qualitology, did not become particularly popular in Polish economic reality because of the difficult terminology involved [Hamrol, Mantura, 1998, p. 15].

Companies which have implemented quality management systems compatible with the ISO 9001 standard use process management, within the framework of which particular activities are identified. Therefore, it seems justified to provide an example of quality costs specification, according to type of activity (figure 1).

FIGURE 1

Types of activities creating the concept of quality costs



Source: own elaboration based on: [Szczepańska, 2009, p. 153].

The division of quality costs presented in figure 1 takes into consideration four basic categories: costs of prevention, costs of evaluation, costs of internal deficiencies, and costs of external deficiencies. For analytical and auditing purposes, it is frequently recommended that the first two components be combined into one category defined as 'costs of prevention', whereas the sum of the two remaining elements can be referred to as 'costs of deficiencies'. Such aggregation is justified from the point of view of the assumptions of quality economics, in accordance with which an increase in expenditures on prevention activity ought to result in lowering the costs of deficiencies. The first group of costs is always targeted at activities related to the quality-enhancing policies of a company, and thus should be considered from the perspective of the efficiency of outlays. On the other hand, the second group is, in a sense, an effect of the inefficiency of activities related to ensuring the desired level of quality and ought to be reduced to an economically justified minimum.

3. Factors in measuring the economic efficiency of quality activities

Issues related to efficiency are among the major problems of contemporary economic thought. According to P. A. Samuelson and W. D. Nordhaus, efficiency can be regarded as the main subject of economics because in a wider perspective it is tantamount to a lack of wastefulness [Rutkowska, 2013, p. 450]. R. Przygodzka believes that the concept of efficiency is usually analyzed with regard to specific activities [Przygodzka, 2008, p. 155]. Since the economic activity of the state and its entities is described through the prism of various types of activities, efficiency becomes one of the most crucial economic categories.

It is impossible to analyze efficiency without reference to the methods and possibilities of its measurement. Evaluation of efficiency in a quantitative perspective may be an essential factor behind economic decisions on the micro-, meso-, and macro-economic scale. Therefore, the more precise the measurement of efficiency, the more reliable and plausible the economic information [Ćwiąkała-Małys, Nowak, 2009, p. 169].

The commonly used methods for measuring efficiency are based on the indicator approach [Łukasiński, 2016, p. 17]. What is essential here is that both the number of indicators and the degree of their accuracy depend on information needs resulting from the purpose of a given study.

The concept of the efficiency of activities is usually understood as the qualitative characteristic of an activity that is reflected in the ratio of the results of the activity obtained over a certain time period to the outlays necessary for achieving these results. However, it has to be acknowledged that there is no universal criterion of the efficiency of an activity [Zapłata, 2009, p. 39]. An activity may be efficient from one perspective, but inefficient from another, depending on who makes the evaluation and on the basis of what criteria.

In general, in business practice the efficiency of activities is considered in combination with effectiveness. The effectiveness of an activity means that the obtained result is consistent with pre-determined objectives. Effectiveness can be, therefore, measured by the degree to which the desired state has been reached. Meanwhile, an efficient activity is one as a result of which the desired effect is achieved at the lowest possible cost. As a result, effective realization of an activity is not synonymous with maximum efficiency because the expenditures made in order to reach the desired effect may be disproportionately high.

Improving both the efficiency and effectiveness of processes and activities has a positive impact on the financial results of an organization. This influence can involve: a reduction in the number of mistakes in processes, activities, and products, preventing loss of material and working time, lower costs of compensation from warranty and guarantee, as well as decreased costs of lost customers and markets.

Assuming that the efficiency of a company is the combined efficiency of many activities, it is possible to state that rational allocation of available re-

sources depends on the results of the measurement of individual activities. High efficiency of activities constitutes, in fact, a justification for their further intensification, while low efficiency should be a warning signal informing that the activity must be limited or even abandoned.

E. Skrzypek claims that improvement of quality activities in a company can only take place when it is possible to measure the impact of quality on the efficiency of business activity [Skrzypek, 2000, p. 187]. A similar opinion is expressed by J. A. Miller, K. Pniewski and M. Polakowski, who believe that measuring the efficiency of processes and quality activities constitutes a crucial part of the system of measuring the efficiency of the entire organization [Miller, Pniewski and Polakowski, 2000, p. 180].

The methodology of calculating the economic efficiency of quality decisions is consistent with the universal methodology of this calculation, appropriate to the type of undertaking and activity conducted by a company. Consequently, economic efficiency in the sphere of quality can either be expressed as a ratio or as a differential [Hamrol, Mantura, 1998, pp. 155–156]:

$$e_j = \frac{E(J_0)}{N(J_0)} \qquad \text{formula (1)}$$

or

$$e'_j = E(J_0) - N(J_0), \qquad \text{formula (2)}$$

where:

$E(J_0)$ – effect resulting from a quality decision referring to an object,
$N(J_0)$ – outlay regarding a quality decision referring to an object.

The threshold values of the indicators of (1) and (2) amount to: $e_j = 1$, $e'_j = 0$, but quality decisions are considered to be economically efficient when: $e_j > 1$, $e'_j > 0$.

In order to determine efficiency relations at the level of activities, it is necessary, above all, to define the desired effects. In the context of quality activities, effects can be divided into measurable and non-measurable ones [Szczepańska, 2011, p. 112]. The former include: effects that are measurable in terms of their value (costs, incomes, profits, profitability) and those measurable in terms of quantity (physical and chemical parameters, time, amount). Non-measurable effects include: quality effects evaluated with formalized methods (some quality parameters of the user) and quality effects that are not measured using formalized methods (some safety or ecological parameters).

At present, there is no single universally accepted model of measuring the efficiency of quality activities, owing to which it is difficult to create universal indicators. These difficulties are a consequence of the following facts [Szczepańska, 2009, p. 105]:

– correlation of both financial and non-financial measures requires interdisciplinary knowledge from the domains of economics, finance, and management;

– in practice, non-financial measures are highly changeable;
– information needed to create a system of measuring efficiency can be difficult to obtain because employees of particular departments of the company might not have adequate knowledge.

In order to evaluate the efficiency of quality activities, it is necessary to have reliable and up-to-date data, which, in turn, is dependent on the proper functioning of the mechanisms of generating and supplying such data. Because of this, the possibilities of measuring efficiency rely on how efficient the information system of the entire company is.

In practice, the most popular method of evaluating quality activities, taking into consideration both financial and non-financial criteria, is analysis involving the construction of indicators in which the dividend is associated with quality costs, whereas the divisor, which constitutes the point of reference, is, e.g. cost, revenue, profit, or the number of produced goods.

Evaluation of the efficiency of quality activities requires information regarding proper directions of changes of particular indicators, their threshold values, and acceptable span ranges. Evaluation of efficiency in the sphere of quality is individualized and dependent on the actual needs of an economic entity [Skrzypek, 2014, p. 585].

Besides the well-known published ideas, many companies have developed their own methods of indicator analysis of the efficiency of undertaken activities [Miller, 2011, p. 13]. However, it often happens in business practice that measurement regards only what is easily attainable and simple, but is not necessarily connected with the company's objectives, quality policy, or strategy. If such measures are used in the long term, they frequently become a source of misinformation, producing a false image of the company's activity.

The number of indicators used for the assessment of the efficiency of quality activities should always be adjusted to the actual record-keeping and analytical possibilities of the company. It needs to be emphasized that a properly selected set of indicators for the evaluation of the efficiency of quality activities can be used to diagnose the status quo, improve the efficiency of quality activities, and plan new solutions in the sphere of quality, with regard to selected quality activities.

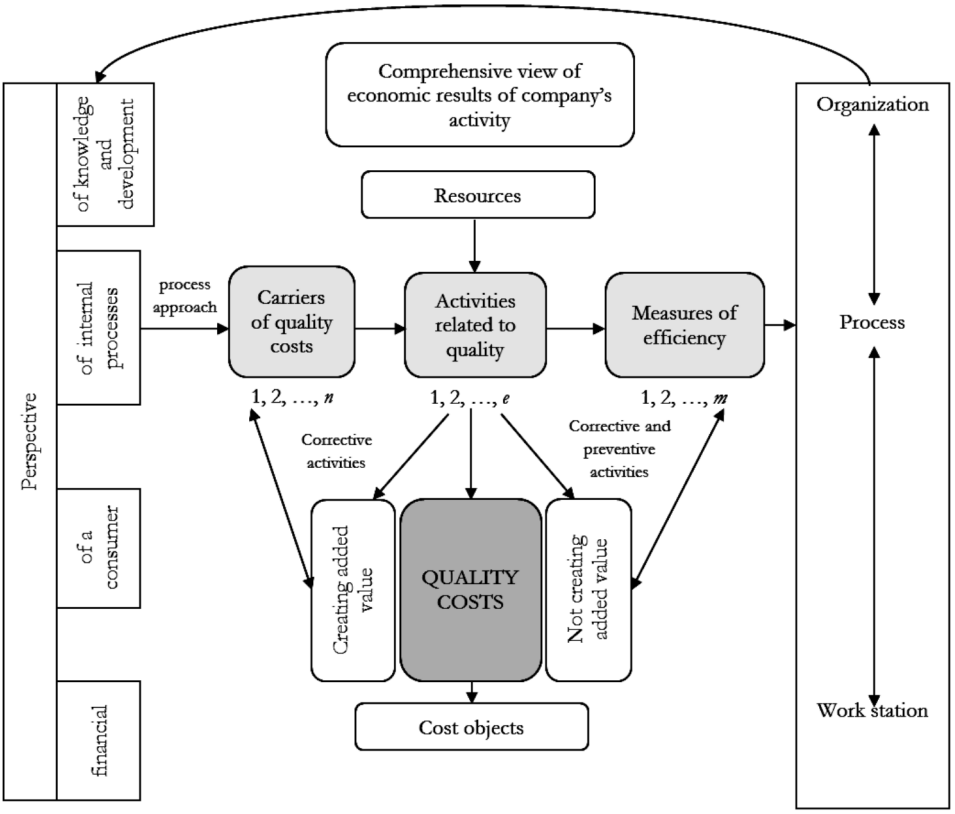
A. Szychta writes that in the management of a process-oriented company, it is necessary that managerial accounting provides clear, relevant information motivating the company to be active and regarding various aspects of realized processes. Of all the methods of managerial accounting, the process perspective of a company is best reflected by Activity Based Costing [Szychta, 2007, p. 253].

Activity Based Costing (ABC) assumes that costs do not stem directly from the manufacturing of products but from the activities undertaken in a company [Kobiela-Pionnier, 2010, p. 265]. Costs are treated as the financial measure of using certain resources (human labor, machinery, means of transport, or energy).

The solutions used in business practice combine Activity Based Costing with quality costs. One example is the model developed by Z. Zymonik: an elaborate concept combining the assumptions of ABC calculation, specification of quality costs, and evaluation of the efficiency of quality activities (figure 2).

FIGURE 2

Model of quality costs based on activities



Source: own elaboration based on: [Zymonik, 2003, p. 172].

It stems from the assumptions of the model of activity-based quality costs that the analysis of efficiency should take three levels into consideration: organization, process, and work station. In each case, account is taken of resources spent on various cost objects, which may include: a product, a system, or a customer. The calculating procedure comprises the financial perspective, the perspective of a consumer, the perspective of internal processes, and the perspective of knowledge and development. Each of these perspectives is directly related to quality costs. Evaluation from the financial perspective includes the share of quality costs in added value, operating profit, and revenue from sales. The perspective of a consumer is connected with the consumer's trust towards a given

product, which entails consideration of the risk of paying compensation when a product does not meet the quality requirements declared by the manufacturer. Meanwhile, the evaluation of internal processes makes it possible to identify those processes and, as a consequence, to identify the quality activities which most contribute to increasing the satisfaction of consumers. On the other hand, evaluation made from the perspective of knowledge and development allows for a diagnosis of the main factors behind the achievement of objectives specified in the quality policy of the company.

It must be emphasized that Activity Based Costing is far from easy to implement because it does not take into consideration the traditional, functional structure of a company, but is focused on activities which often take place at the interface of different organizational units. The implementation of this model of cost calculation frequently requires not only changing the method of calculating the costs of products, but also entails changes in the organizational structure of a company, production processes, circulation of documents, and recording of costs. A drawback of the ABC calculation is that it is likely to identify too large a number of activities of relatively little relevance to managing a company. Another disadvantage of ABC is its cost-intensive implementation. As confirmed by the subject literature, it might take from three months to two years to complete [Piechota, 2005, p. 37; Quinn, Elafi and Mulgrew, 2017, pp. 63–68]. The advantages of using ABC include [Skrzypek, Hofman, 2010, p. 21; Brandon, Drtina, 1997, pp. 171–207]:

- provision of precise data for determining unit costs,
- creation of a basis for finding optimal production programs,
- possibility of budgeting the costs of processes and activities,
- improvement of the efficiency of quality activities, profitability of products, consumers and distribution channels,
- possibility to verify company's price policies.

To sum up, it can be said that replacing the traditional system of calculating costs with the ABC system is purposeful in companies where:

- indirect costs have high and increasing share in total costs,
- production is complex, involves many types of products, manufactured in multiple series,
- products are vulnerable to aggressive price competition.

T. Wnuk-Pel has observed that in Poland the vast majority of companies make use of various types of traditional systems of calculating costs, whereas more modern methods, such as ABC, are still seldom used [Wnuk-Pel, 2010, p. 177]. R. Wolniak, on the basis of conducted research, claims that Polish companies have the tendency to use only those methods and instruments that are explicitly prescribed by standards. Others are used less frequently and, if so, only in organizations that are particularly advanced in terms of quality management [Wolniak, 2011, p. 245]. It needs to be stressed that in accordance with the ISO 10014 standard, Activity Based Costing is recommended as one of the instruments of constant improvement in the process approach [PN-ISO 10014,

2008, 5.4, p. 25 and 5.6, p. 29]. The aforementioned standard is addressed to top management and its main purpose is to provide instruments for improving quality management systems.

4. Measurement of the efficiency of quality activities in a production company

The aim of this analysis is to evaluate quality activities and measure their economic efficiency in a selected company that has operated in Podlaskie Voivodeship for 40 years. The company manufactures several dozen types of electric water heaters, heat pumps, and solar collectors for flats, detached houses, and public buildings. Half of the company's output is sold in foreign markets, mainly in Germany, Sweden, Russia, and Great Britain.

Constant enhancement of the quality of the offered goods is one of the basic priorities of the company. In 1998, they implemented a quality system consistent with the ISO 9001 standard. Following the principles of sustainable development, in 2016, the company implemented an integrated quality and environment management system that meets the requirements of the ISO 14001 standard, the main principle of which is strong commitment to environmental protection.

The analyzed company does not conduct measurement of economic efficiency of quality activities. Instead, monitoring and analysis of quality is based on effectiveness indicators (table 1).

Analysis of the information included in the above table reveals that non-financial, financial, and mixed values are used for measurement of quality activities. The indicators of non-financial nature include, among others, 'amount of used enamel in relation to good containers'. On the other hand, 'costs of internal deficiencies in relation to total sales' is an example of an indicator calculated on the basis of financial measurements. The group of mixed indicators includes, among others, 'costs of covering containers with one layer of enamel'. Of all the indicators from table 1, only WBW and WBZ, which account for costs of deficiencies in their construction, can be regarded as typical of quality evaluation. However, using revenue from sales as a point of reference for quality costs relation is not always a good solution because the indicators which account for turnover depend chiefly on the adopted price policy and market conditions, which distorts their actual value.

Within the framework of quality costs, the studied company only keeps a record of the costs of deficiencies. For this purpose, account 509 is used: 'Costs of service repairs and production deficiencies', which uses expanded analytics. For this reason, executive managers receive information about the level of both the costs of internal and external deficiencies. The accounting records do not include costs of prevention despite the fact that some elements traditionally included in this group are recorded in accounts 502, 'Department costs' and 530,

TABLE 1

Indicators of efficiency in quality processes, calculated and monitored in studied company

Symbol	Name of indicator	Measuring unit
Technical indicators		
WBE	Indicator of the number of deficiencies in relation to the number of enamelled containers	%
WEZ	Indicator of the amount of enamel used to cover containers with one layer	kg/m^2
WED	Indicator of the amount of used enamel in relation to good containers	kg/m^2
WKZ	Indicator of the costs of covering containers with one layer of enamel	PLN/m^2
WKD	Indicator of the costs of enamelling in relation to good containers	PLN/m^2
WPW	Indicator of the number of corrections in relation to the number of produced containers in particular welding lines	%
WZS	Indicator of the number of all scrapped containers in relation to the welded containers	%
WPZ	Indicator of the number of leaks in relation to the number of installed containers	%
WNM	Indicator of the number of containers with deficiencies in relation to the number of installed containers	%
Other indicators		
WKM	Indicator of the costs of purchased materials in relation to total sales	%
WZP	Share of the number of normalized processes in the total number of processes identified in the company	%
WWN	Indicator of standard achievement with regard to particular production segments	%
WEB	Indicator of efficiency (gross value)*	%
WEN	Indicator of efficiency (net value)**	%
WBW	Indicator of the costs of internal deficiencies to total sales	%
WBZ	Indicator of the costs of external deficiencies to total sales	%

* The indicator of efficiency (gross value) is calculated as the ratio of normative working time to statutory working time.

** The indicator of efficiency (net value) is calculated as the ratio of normative working time to actual working time.

Source: own elaboration based on information obtained from the analyzed company.

'Costs of auxiliary activity'. Account 502 is used for recording costs related to the planning of the quality of new products, improvement of the quality of produced goods and control of production quality, whereas account 530 comprises costs regarding the control of the quality of supplies and laboratory analyses. For the needs of this paper, the mentioned positions of costs in accordance with their economic character are classified as costs of prevention and costs of evaluation[7], respectively.

On the basis of research conducted by the author of this paper and analysis of the subject literature, a set of indicators was identified, which can be used for evaluating the efficiency of quality activities in a production company. The construction accuracy of these indicators was verified for the analyzed economic entity, using numerical data for the period of four subsequent years (table 2).

In 6 of the 10 proposed indicators, both the numerators and the denominators include quality costs. These indicators measure the efficiency of preventive activities by means of the ratio of the costs of deficiencies (which constitute a reflection of the inadequate quality level of produced goods) to the costs of preventive and controlling activities aimed at ensuring conformity of the achieved quality level with the desired level. In the four remaining indicators, the costs of quality are only represented in the numerator, whereas the denominator takes into consideration the number of employees directly involved in the production process and the value of controlling and measuring apparatus.

A straightforward interpretation of all the indicators presented in table 2 allows for an unambiguous evaluation of the efficiency of activities aimed at enhancing the quality of produced goods, which enables the management to make day-to-day decisions regarding necessary improvements and changes. Indicators BWKP and BZKP have a synthetic character because they inform of the efficiency of preventive activities, which comprise both activities related to the prevention of deficiencies and to control of the quality of produced goods. Other indicators (BWKO and BZKO, as well as BWKZ and BZKZ) have an analytical character since they represent the impact of partial elements of the costs of preventive activities on the reduction of the value of deficiencies observed both at the production stage and on delivery to the customer/recipient. These analytics can be expanded, depending on the needs of the company, to consider a variety of assortments of produced goods or more detailed categories of costs (planning of the quality of new products, control of supply quality, laboratory analyses of finished products) and places of their production.

[7] Undoubtedly, the adopted solution is rather simplified. Presumably, if the prevention costs of the analyzed company were identified in accordance with the principles of the quality cost calculation, their sum would be far higher. Both the issue of underestimated quality costs and the problem of proper usage of this category of costs in making decisions has been the subject of many scientific studies [Cheah, Shahbudin and Taib, 2011, pp. 405–421; Pires, Cociorva, Saraiva, Novas and Rosa, 2013, pp. 782–795; Raßfeld, Behmer, Dürlich and Jochem, 2015, pp. 1071–1081].

TABLE 2

Indicators of economic efficiency of quality activities in selected company in years A–D

Symbol of indicator	Formula	Value of indicator				Dynamics (in %)		
		A	B	C	D	B/A	C/B	D/C
BWKP	costs of internal deficiencies / prevention costs	1.75	1.46	1.08	0.60	83.43	73.97	55.56
BZKP	costs of external deficiencies / prevention costs	1.81	2.31	2.00	1.24	127.62	86.58	62.00
BWKO	costs of internal deficiencies / evaluation costs	2.24	2.01	1.45	0.78	89.73	72.14	53.79
BZKO	costs of external deficiencies / evaluation costs	2.32	3.19	2.69	1.61	137.50	84.33	59.85
BWKZ	costs of internal deficiencies / prevention costs	7.97	5.28	4.20	2.64	66.25	79.55	62.86
BZKZ	costs of external deficiencies / prevention costs	8.27	8.35	7.78	5.47	100.97	93.17	70.31
KBLP	costs of deficiencies / number of employees directly involved in production	5 157.82	6 621.98	6 365.89	4 563.33	128.39	96.13	71.68
BWLP	costs of internal deficiencies / number of employees directly involved in production	2 530.48	2 563.86	2 230.92	1 485.17	101.32	87.01	66.57
BZLP	costs of external deficiencies / number of employees directly involved in production	2 627.34	4 058.13	4 134.97	3 078.17	154.46	101.89	74.44
KBAP	costs of deficiencies / value of control and measurement apparatus	4.59	5.11	5.33	3.34	111.33	104.31	62.66

Source: own elaboration based on data concerning the analyzed company.

By using indicators BWKP and BZKP for evaluation of the efficiency of quality activities, the analyzed company would have been aware of the unfavorable situation reflected in the fact that the indicator BWKP had always been lower than BZKP. This means that throughout the analyzed period, for each 100 PLN of the costs related to preventive and controlling activities, there were 122 PLN worth of costs of internal deficiencies (revealed at the stage of production, prior to placing products on the market) and as much as 184 PLN of internal deficiencies (revealed only at the stage of exploitation). On the other hand, changes in the values of indicators BWKO and BWKZ ought to be assessed positively because over the four years in question, both of them showed

a constant downward trend. The first decreased from 2.24 to 0.78, whereas the second – from 7.97 to 2.64. However, taking into consideration the fact that in the same period the indicators BZKO and BZKZ stood at a relatively high level, one should assume that controlling and preventive activities realized in the company were not particularly efficient. The areas where the observed irregularities occurred ought to be subject to constant monitoring and must be analyzed at least on a monthly basis.

When costs of deficiencies are prevalent in the structure of the total costs of quality (which was observed in the analyzed company), it is recommended that a more detailed analysis of this group of costs be made. The indicator KBLP informs that each employee directly involved in production in the analyzed period generated, on an annual basis, from 4,563 PLN to 6,622 PLN of the costs related to deficiencies. It needs to be observed that in the first three years of the analysis, the costs of deficiencies per one employee were more than 2 times higher than the average monthly wages of the employees directly involved in production for the actual working time[8], which in that period ranged from 2,247 PLN to 2,733 PLN. In the last year of the analyzed period, this relation slightly improved.

The costs of internal deficiencies and the costs of external deficiencies per one employee require further analysis. The average value of BWLP in the analyzed period amounted to 2,203 PLN, whereas the average indicator BZLP was almost 60% higher and amounted to 3,475 LN. It was indicated once again that top managers ought to make appropriate decisions aiming at the improvement of the economic efficiency of quality activities, not only by reducing the costs of internal deficiencies, but above all by minimizing the costs of deficiencies revealed outside the company[9].

While evaluating the costs of deficiencies, it is also necessary to consider the value of controlling and measuring apparatus used in the process of ensuring quality. Hence, indicator KBAP was calculated, which in the first three years of the analyzed period showed an upward trend, ranging from 4.59 to 5.33, whereas in the last year it fell to the level of 3.34. It needs to be noted that the value of controlling and measuring apparatus in the analyzed time period remained at a similar level, while the decrease in the analyzed indicator in the last year was caused by a radical reduction of the costs of deficiencies.

In view of the above, it can be said that the proposed set of indicators can be useful for standard reports, which are the basic instrument in the process of making a rational decision, as well as for special reports, made only under

[8] Wages for actual working time do not include remuneration for leaves of absence, sick leaves, and other benefits.

[9] This issue was analyzed by K. Lisiecka, who writes that organizations that are capable of applying knowledge gathered from data and information from customer complaints for repair work and product innovations have a stable basis for gaining competitive advantage. [Lisiecka, 2017, p. 105].

certain circumstances, i.e. when a serious deviation from planned values is observed. It needs emphasizing that depending on the actual needs related to making decisions, the proposed indicators may be in each case modified so as to take into consideration the indicators directed at specific areas of quality activities.

It seems that in order to precisely monitor and evaluate the efficiency of quality activities in production companies it is advisable to implement Activity Based Costing (ABC). At the basis of this concept is the perception of a company through the prism of processes (activities) necessary for production and sales of certain products. In accordance with the ABC concept, it is activities, and not products, that generate costs. Therefore, correct identification of activities taking place in a company is taken as the starting point for calculations based on activities.

In the analyzed economic entity, twenty one processes were identified within the framework of the process approach. They include: 1. Process of generating demand; 2. Process of production planning; 3. Process of supply; 4. Process of production; 5. Process of realizing sales; 6. Process of warranty service; 7. Process of post-warranty service; 8. Process of storing; 9. Process of ensuring quality; 10. Process of technological support for production; 11. Process of construction support for production; 12. Process of maintaining movement; 13. Process of supplying media; 14. Process of product development; 15. Process of analyzing customer satisfaction; 16. Process of infrastructure supervision; 17. Process of supervision of finances; 18. Process of supervision of IT; 19. Process of personnel management; 20. Process of administration; 21. Process of supervision of quality assurance system.

The study of the subject literature as well as direct interviews conducted with the management in the analyzed company made it possible to design a matrix showing the relations between the suggested activities regarding assurance of quality and the processes already functioning in the company (table 3). The activities were classified under particular categories of quality costs in order to facilitate the implementation of the proposed solution in practice.

TABLE 3

Matrix of relations between quality activities and identified processes in analyzed company

No.	Activities	Processes																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
COSTS OF PREVENTION																						
A.	Quality planning of a new product									×	×	×			×	×						
B.	Improvement of the quality of produced goods				×		×	×		×	×	×										

No.	Activities	Processes																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
COSTS OF PREVENTION																						
C.	Analysis of quality capacity				×		×	×		×												
D.	Evaluation of suppliers and counseling for suppliers			×					×	×												
E.	Planning of quality control			×	×					×	×	×			×							
F.	Audit of quality			×	×	×	×	×	×	×	×	×				×						
G.	Management of quality segment									X												
H.	Steering of quality				×					×												×
I.	Training regarding quality assurance			×	×					×	×	×									×	
J.	Quality improvement programs									×												×
K.	Comparison of quality levels with products made by competitors						×			×					×	×						
L.	Realization of programs for quality (bonuses for employees, promotion of quality enhancing activities)				×					×	×											
EVALUATION COSTS																						
M.	Control of supplies			×	×				×	×												
N.	Control during production				×					×												
O.	Control of finished products				×				×	×												
P.	Equipment for monitoring and measurements				×					×	×	×										
Q.	Maintenance of equipment for monitoring and measurement									×			×	×								
R.	Evaluation of quality				×					×												
S.	Laboratory analyses									×	×	×										
T.	Documentation of control				×					×												
U.	Quality and safety labels									×	×	×			×							
COSTS OF DEFICIENCIES																						
V.	Elimination of products in case of irreversible deficiencies (e.g. recycling or destruction)				×					×												

No.	Activities	Processes																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
COSTS OF DEFICIENCIES																						
W.	Reclassification of products into lower quality class						×			×	×	×										
X.	Repair work				×		×															
Y.	Repeated control				×					×												
Z.	Warranty and liability claims						×	×		×												

Source: own elaboration based on: [Jabłoński A., Jabłoński M., 2005, p. 46; Szczepańska, 2009, pp. 200–202] and interviews conducted directly with management of the analyzed company.

Examined horizontally, table 3 reveals that the company conducts activities which are elements of many different processes. For example, the activity 'quality audit' is associated with as many as 10 processes, whereas the activity 'repair activities' occurs only in two processes. However, when seen vertically, the data included in the table indicates that among twenty-one processes as many as fifteen comprise issues related to concern for quality, which constitutes more than 70% of the total number of processes.

As it stems from the above analysis, numerous relationships between quality activities and particular processes indicate that the studied company would benefit from introducing Activity Based Costing[10]. Before making the decision to implement ABC, it is necessary to [Czyż-Gwiazda, 2010, pp. 184–196]:

- identify essential activities taking place in a company,
- determine the costs of identified activities,
- specify the measuring units of the volume of each activity,
- convert the costs of particular activities into products.

It is often suggested that a pilot scheme should first be introduced, i.e. that the ABC system is used for a selected segment of the company. Thus, the model of Activity Based Costing ought to be implemented gradually, beginning from the endeavors for improving the quality of produced goods. Such a solution makes it possible to increase the quality of products and decrease the costs of quality activities, which can consequently contribute to improvement of economic efficiency, both in the process of quality assurance and in the entire company.

[10] Assuming that it is activities that generate costs, the best solution would be to estimate all the activities identified during the analysis of processes in order to first know their costs and later to make decisions to group certain activities in order to streamline the accounting procedure related to calculation of costs.

5. Conclusions

In a competitive market economy an essential role is played by efficiency, which is a tangible measure of undertaken activities and which enables their assessment. Therefore, measurement of efficiency should not only apply in the basic spheres of a company's functioning, but also in those fields without which it would be impossible to conduct business activity. Hence, company management should take rational decisions aimed at intensification of those quality activities that guarantee the maximization of economic efficiency, changes in the quality level of produced goods, and optimization of both the level and structure of quality costs.

For the sake of ensuring high efficiency of quality activities, a company ought to aim towards constant reduction of the costs of deficiencies, at the same time maintaining an appropriate relation between the costs of internal deficiencies and the costs of external deficiencies. From the point of view of the principles of quality economics, the majority of goods which fail to meet the quality requirements ought to be detected already in the company (before they are offered for sale), and not by consumers/recipients[11]. The reversal of proportions within the internal structure of the costs of deficiencies results in loss of reputation on the market, and thus lower revenues from sales and worse financial results.

It needs emphasizing that it is important to analyze not only information that is available in the company, overlooking information desired by managers [Hammer, 2006, p. 144]. The measurement of economic efficiency of quality activities should not merely describe the results of an activity, but must focus on improving these results. Therefore, the modern information systems of companies ought to provide numerical data useful for monitoring and assessing the realization of the assumptions of the quality policy, which frequently entails the necessity to identify four groups of quality costs: costs of prevention, costs of evaluation, costs of internal deficiencies, and costs of external deficiencies. These categories of costs can be successfully used for the construction of indicators that provide a basis for assessment of quality activities and the model assumptions of Activity Based Costing in a production company. In both cases, the information that constitutes the basis for monitoring and analysis ought to be measurable, reliable, and credible. It should facilitate the implementation of corrective activities if obtained effects are not consistent with the objectives and it needs to be useful for improving the effectiveness and efficiency of processes [PN-EN ISO 9004, 2010, 8.3.2, p. 33].

The conducted literature study and the analysis of the case demonstrate that the evaluation of economic efficiency of activities related to quality, using

[11] The cost of removing the consequences of a fault in a product increases rapidly along with the number of production and trade stages between the time when the fault occurred and the time of its detection [Blikle, 2017, p. 358].

methods based on identified quality costs, generates a comprehensive set of information necessary for making rational decisions in a production company. Hence, it can be concluded that the hypothesis proposed at the beginning of this paper was confirmed.

The author is aware that the tentative nature of this study, based on empirical data from only one economic entity, does not permit any firm conclusions or generalizations. However, the conducted analysis makes it possible to identify factors that have an impact on correct measurement and evaluation of the economic efficiency of quality activities.

References

Blikle A. J., 2017, *Doktryna jakości. Rzecz o turkusowej samoorganizacji*, Wydawnictwo Helion, Gliwice.

Brandon Ch. H., Drtina R. E., 1997, *Management Accounting: Strategy and Control*, McGraw-Hill Companies, New York – Toronto.

Bugdol M., 2011, *Zarządzanie jakością w urzędach administracji publicznej. Teoria i praktyka*, Difin, Warszawa.

Cheah S.J., Shahbudin A.S.M., Taib, F.M., 2011, *Tracking hidden quality costs in a manufacturing company: an action research*, "International Journal of Quality & Reliability Management", Vol. 28, Issue 4.

Crosby Ph. B., 1979, *Quality is free. The Art of Making Quality Certain*, McGraw-Hill, New York.

Czyż-Gwiazda E., 2010, *Kalkulacja jednostkowego kosztu wytworzenia produktu według rachunku kosztów działań (rachunku ABC)*, [w:] *Menedżer jakości. Podejście procesowe*, Lisiecka K. (red.), Wydawnictwo Akademii Ekonomicznej w Katowicach, Katowice.

Ćwiąkała-Małys A., Nowak W., 2009, *Wybrane metody pomiaru efektywności podmiotu gospodarczego*, Wydawnictwo Uniwersytetu Wrocławskiego, Wrocław.

Dobrowolska A., 2017, *Podejście procesowe w organizacjach zarządzanych przez jakość*, Wydawnictwo Poltext, Warszawa.

Hammer M., 2006, *Sztuka konkurowania w gospodarce XXI wieku. Plan działania*, Wydawnictwo Helion, Gliwice.

Hamrol A., 2017, *Zarządzanie i inżynieria jakości*, Wydawnictwo Naukowe PWN, Warszawa.

Hamrol A., Mantura W., 1998, *Zarządzanie jakością. Teoria i praktyka*, Wydawnictwo Naukowe PWN, Warszawa – Poznań.

Jabłoński A., Jabłoński M., 2005, *Rachunek kosztów jakości w strategii przedsiębiorstwa*, "Controlling i Rachunkowość Zarządcza", nr 5.

Kaplan R. S., Cooper R., 2000, *Zarządzanie kosztami i efektywnością*, Dom Wydawniczy ABC, Kraków.

Karaszewski R., Skrzypczyńska K., 2013, *Zarządzanie jakością*, Wydawnictwo "Dom Organizatora", Toruń.

Kobiela-Pionnier, 2010, *Rachunkowość w zarządzaniu kosztami i wynikami przedsiębiorstwa*, VIZJA PRESS & IT, Warszawa.
Kolman R., 2009, *Kwalitologia. Wiedza o różnych dziedzinach jakości*, Wydawnictwo PLACET, Warszawa.
Kolman R., 2013, *Różne odmiany jakości i ich praktyczne wykorzystanie*, Wydawnictwo PLACET, Warszawa.
Kuc B. R., 2017, *Wartości, oceny i pomiar w zarządzaniu procesowym*, [w:] *Perspektywy rozwoju podejścia procesowego. Szanse i ograniczenia*, Bitkowska A., Weiss E. (red.), Vizja Press & IT, Warszawa.
Lisiecka K., 2017, *Zarządzanie reklamacjami z tytułu jakości produktów*, [w:] *Jakość zarządzania – refleksje, wymiary i problemy*, Bugdol M., Jedynak P. (red.), Wydawnictwo Uniwersytetu Jagiellońskiego, Kraków.
Łukasiński W., 2016, *Dojrzałość organizacji zarządzanej projakościowo*, PWE, Warszawa.
Manganelli R. L., Klein M. M., 1998, *Reengineering. Metoda usprawniania organizacji*, PWE, Warszawa.
Miller J. A., Pniewski K., Polakowski M., 2000, *Zarządzanie kosztami działań*, WIG-Press, Warszawa.
Miller P., 2011, *Systemowe zarządzanie jakością. Koncepcja systemu, ocena systemu, wspomaganie decyzji*, Difin, Warszawa.
Pająk E., 2006, *Zarządzanie produkcją. Produkt, technologia, organizacja*, Wydawnictwo Naukowe PWN, Warszawa.
Piechota R., 2005, *Projektowanie rachunku kosztów działań. Activity Based Costing*, Difin, Warszawa.
Pires A. R., Cociorva A., Saraiva M., Novas J. C., Rosa A., 2013, *Management of quality-related costs. The case of Portuguese companies*, "Total Quality Management", Vol. 24, No. 7.
PN-EN ISO 9000:2015-10, 2016, *Systemy zarządzania jakością. Podstawy i terminologia*, Polski Komitet Normalizacyjny, Warszawa.
PN-EN ISO 9001:2015-10, 2016, *Systemy zarządzania jakością. Wymagania*, Polski Komitet Normalizacyjny, Warszawa.
PN-EN ISO 9004:2010, 2010, *Zarządzanie ukierunkowane na trwały sukces organizacji. Podejście wykorzystujące zarządzanie jakością*, Polski Komitet Normalizacyjny, Warszawa.
PN-ISO 10014:2008, 2008, *Zarządzanie jakością. Wytyczne do osiągania korzyści finansowych i ekonomicznych*, Polski Komitet Normalizacyjny, Warszawa.
Przygodzka R., 2008, *Efektywność sektora publicznego*, "Optimum. Studia Ekonomiczne", nr 4.
Quinn M., Elafi O., Mulgrew M., 2017, *Reasons for not changing to activity-based costing: a survey of Irish firms*, "PSU Research Review", Vol. 1, Issue 1.
Raßfeld C., Behmer F., Dürlich M., Joche R., 2015, *Do quality costs still matter?*, "Total Quality Management", Vol. 26, No. 10.
Rutkowska A., 2013, *Teoretyczne aspekty efektywności – pojęcie i metody pomiaru*, "Zarządzanie i Finanse", nr 1(4).

Ryńca R., 2009, *Zrównoważona karta działania jako metoda pomiaru efektywności procesów i działań*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław.
Schiffauerova A., Thomson V., 2006, *A review of research on cost of quality models and best practices*, "International Journal of Quality & Reliability Management", Vol. 23, Issue 6.
Skrzypek E., 2000, *Jakość i efektywność*, Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej, Lublin.
Skrzypek E., 2014, *Dojrzałość jakościowa organizacji w świetle teorii i doświadczeń organizacji*, "Marketing i Rynek", nr 5.
Skrzypek E., Hofman M., 2010, *Zarządzanie procesami w przedsiębiorstwie. Identyfikowanie, pomiar, usprawnianie*, Oficyna a Wolters Kluwer business, Warszawa.
Stecyk A., 2016, *Doskonalenie jakości usług edukacyjnych w szkolnictwie wyższym. Podejście metodyczne*, Wydawnictwo Uniwersytetu Szczecińskiego, Szczecin.
Szafrański M., 2007, *Elementy ekonomiki jakości w przedsiębiorstwach*, Wydawnictwo Politechniki Poznańskiej, Poznań.
Szczepańska K., 2011, *Zarządzanie jakością. W dążeniu do doskonałości*, C.H. Beck, Warszawa.
Szczepańska K., 2009, *Koszty jakości dla inżynierów*, Wydawnictwo PLACET, Warszawa.
Szychta A., 2007, *Etapy ewolucji i kierunki integracji metod rachunkowości zarządczej*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź.
Świtalski W., 2008, *Czy kategoria jakości jest ważna w ekonomii?*, "Ekonomista", nr 2.
Wnuk-Pel T., 2010, *Pomiar sukcesu wdrożenia rachunku kosztów działań w przedsiębiorstwach działających w Polsce*, "Zeszyty Teoretyczne Rachunkowości", nr 59 (115).
Wolniak R., 2011, *Parametryzacja kryteriów oceny poziomu dojrzałości systemu zarządzania jakością*, Wydawnictwo Politechniki Śląskiej, Gliwice.
Wronka A., 2016, *Certyfikaty produktowe i systemowe na rynku B2B*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź.
Zapłata S., 2009, *Zarządzanie jakością w przedsiębiorstwie. Ocena i uwarunkowania skuteczności*, Oficyna a Wolters Kluwer, Warszawa.
Zymonik Z., 2003, *Koszty jakości w zarządzaniu przedsiębiorstwem*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław.
Zymonik Z., Hamrol A., Grudowski P., 2013, *Zarządzanie jakością i bezpieczeństwem*, PWE, Warszawa.