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COSTS OF QUALITY AND THEIR IMPACT ON THE BULDING SEKTOR

KOSZTY JAKOŚCI ORAZ ICH WPŁYW NA SEKTOR BUDOWNICTWA

Streszczenie

Jakość oraz koszty jakości powstające podczas inwestycji są bardzo istotnym czynnikiem, który w globalnym otoczeniu wpływa na pozycje rynkową wielu firm. Jakość w sektorze budownictwa dotyka wielu obszarów, zaczynając od projektowania poprzez wykorzystanie gotowych obiektów. Odnosi się do materiałów, technologii, procesów, których jakość wpływa na produkt gotowy, przedstawiając kompleksowy obraz oczekiwań klienta. Utrzymanie odpowiedniej jakości jest procesem kosztownym, który generuje koszty, tzw. koszty jakości. Jak pokazuje praktyka, wiele firm ciągle nie wie, czym są koszty jakości oraz nie widzi korzyści, jakie może osiągnąć wprowadzając ewidencje kosztów jakości. W związku z tym prezentowany artykuł porusza problematykę optymalizacji poziomu kosztów jakości.

Słowa kluczowe: jakość, koszty jakości, optymalizacja kosztów jakości

Abstract

Quality and costs which come into beginning during investing into quality are the basic factors which have influence on the market position in global environment. Issue of quality in building industry is very broad – from the design, through the used products, materials and technologies of processing to the final product which represents the complex with requested functions that must fulfil. Assurance of quality level generates cost which theory calls quality costs. Practice shows that many companies still do not know what the costs of quality are, and do not see the benefit from recording them. In this paper we are dealing with the ways how to optimise these costs.

Keywords: quality, costs of quality, optimisation of quality costs

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1. Introduction

Increasing turbulence in environment cause, that anticipating of the consequences the actions undertakes by companies and behaviors another's market participants are often very hard. One of the most important dilemmas, which should be taken into account by company management is to find effective ways of understand management in turbulent environment. One of this ways can be rational approach to problematic of quality. Quality is defined as fitness to purpose, e. g. providing a product (a building) which gives an appropriate service for which is intended. The prime justification for quality programmes and quality management systems must be economic. However, most quality management programmes and activities do not focus on the economic aspect of quality. The price to be paid for a building is a reflection of the expectation of the quality. Prolonged construction time and duration can affect the quality of construction products. Quality can affect also the costs of construction works. Poor management practices can cause an increase in construction costs. Good technical skills do influence proper quality outcome and better value for money in the construction industry. Quality depends entirely on performance, cost and time in the construction industry.

2. Costs associated with the quality

In professional literature we can meet with many models of quality costs. Variety of actions related with production process causes the lack of one standardized division of quality costs [12]. Juran said that the quality costs are "the gold of mine". He emphasizes that a goal of each organization should be minimizing the costs related with low quality, he also thrusts on necessity of aspiration to discover sources of mistakes and eliminate them. Efforts lead to reduce quality costs at the beginning are very hard, but practical experiences showed that tendency of the level of CoQ is falling when company overtakes actions to disclose them. Accurate define quality costs is difficult, because of existing many areas in which actions connect with quality overlap each other, and are accurate related with the process of production [18].

Table 1

Various division to CoQ

J. Juran	**J. Bank**
– Failure Costs – Scrap, rework, corrective actions, warranty claims, customer complaints and loss of customers – Appraisal Costs – Inspection, compliance auditing and investigations – Prevention Costs – Training, preventive auditing and process improvement implementation	– Conformance costs, – prevention costs, and appraisal costs, – Incompatibility costs; Costs of internal failures, Costs of external failures, costs of requirements crossing, – Opportunity costs

cd. tab. 1

P. Crossby – Conformance costs; include expenses bears on assurance of product conformance to requirements, – No conformance costs includes expenses, which affect to failures	**A. Iwasiewicz** – Control costs; prevention costs and costs of examination and appraisal, – Costs of failures: loses on external failures and loses on internal failures.
B. Oyrzanowski – Prevention costs include: quality of managing, control and motivation, education and trainings, another costs, ex. costs of computer purchase; – Costs of describing the level of quality control/inspection of products, a control during the process of production; – Costs of internal failures; lowering the type of product, secondary process, appraisal of failures reasons, improvement each phase of production process, secure product by special action; – Costs of external failures; study of complaints, guarantee services, returned products, compensation, exchange of defective products resignation from defective products	**E. Skrzypek** – Direct quality costs: quality appraisal and prevention activity; internal and external failures and instruments of quality studied; – Indirect quality costs; customer risk – costs, connected with risk, in situation when product is not attend to proper function; consumer dissatisfaction; lost company reputation
Costs in TQM 1. Conformance costs: a) prevention costs • training of workers, • a study and implementation of procedures. b) inspection and control costs 2. Costs of failure conformance: a) Costs of failure repaired • internal failures disclosed before delivered product to consumer, • external failures disclosed before delivered product to consumer. b) Costs of production surpluses: • reprising, • liquidation (insolvency) c) Costs of no repaired failures d) legal cases, recompenses 3. Costs of lost of possibilities; a) lost markets, b) lost orders and revenues, c) lower prices, d) bigger costs of sale.	**Costs in BS 6143 norm** 1. Prevention costs, appraisal, failures. a) prevention costs, b) appraisal costs, c) failures costs 2. Process costs. a) costs of fulfill requirements, b) costs of no fulfill requirements.

cd. tab. 1

Costs of quality in ASQC • Prevention costs, • Appraisal quality costs, • Costs of the lower quality (internal), • Costs of the lower quality (external) • In 90 years of XX sentry this classification was enlarge by: Opportunity costs	

Fig. 1 presents approach to various divisions of quality costs. It lir classifies several authors and them points of view according to several CoQ assembled in literature.

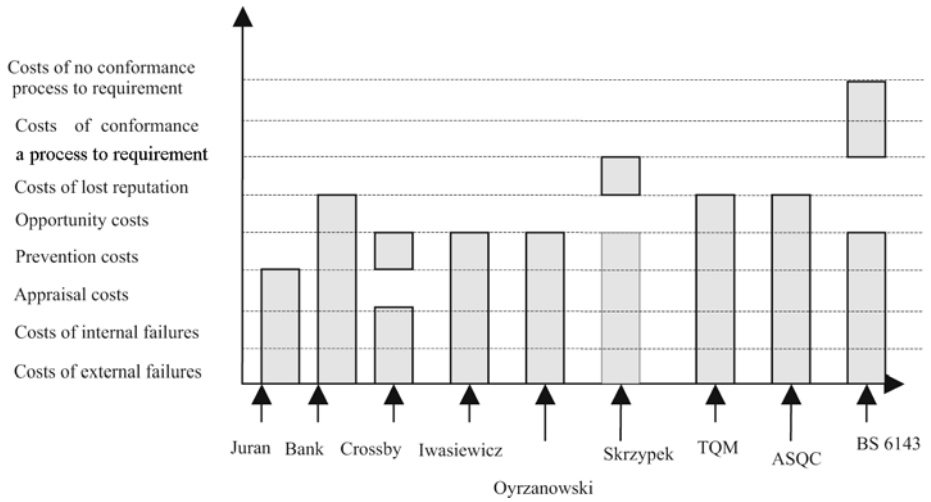

Fig. 1. Various approaches to quality costs[1]

Rys. 1. Rózne podejścia kosztów jakości

As we see the common way of categorizing quality costs is dividing them into prevention, appraisal, internal failure, and external failure costs. However, two main approaches to quality costs exist there. Those who use the concept of quality costs include (prevention, appraisal and failures) costs, while those who use concept of PQC – poor quality costs – usually do not include prevention costs. The reason for not including

[1] Individual categories of quality costs are: Costs of external failures: costs of incompatibility (Bank), costs of no conformance (Crossby), direct costs (Skrzypek), costs. of lack of conformance (TQM), costs. of low external quality (ASQC). Costs of internal failures: costs of incompatibility (Bank), costs of no conformance (Crossby), direct costs (Skrzypek), cost. of lack of conformance (TQM), cost. of low external quality (ASQC). Appraisal costs – costs of agreement (Bank), control costs (Iwasiewicz), costs of describing of the quality level (Oyrzanowski), direct costs (Skrzypek). Prevention costs costs of incompatibility (Bank), costs of conformance (Crossby), control costs (Iwasiewicz), direct costs (Skrzypek), conformance costs (TQM).

prevention costs is that prevention prevent poor quality and therefore this category is not a cost of poor quality. Conventional approach to the quality costs declares that quality cots are expenses invested by manufacturer, user and society which are associated with the quality level of construction during the life cycle.

A. Feigenbaum [6] devised a model for measuring and managing the cost of quality. Feigenbaum's definition of the cost of quality recognizes three main families: (1) prevention costs, that is, the cost of infrastructure for a quality control system; (2) appraisal costs (inspection and testing); and (3) failure costs, that is, costs incurred to the organization due to poor quality. The sum total of the three families of costs is called `the cost of quality' (rather than the cost of non-quality, which relates to the third family alone). The first and second families (prevention and appraisal costs) are controllable by management, being organizational inputs, whereas the third family describes losses generated as outcomes of poor quality. Similarly F. Mesároš [13] has pointed the quality costs are costs related to production, identification, reparation or with the prevention from production the inadequate products. There are four groups of quality costs: a) prevention costs, b) costs for control and gauging, c) internal costs elicited by non-quality, d) external costs elicited by non-quality. Costs that are part of prevention, control and gauging groups represent the necessary ones for achieving and maintaining determined level of quality, whereas costs elicited by quality/non-quality are the consequences of specific level of quality/non-quality. Items pertained to the cost groups constitute:

1. Prevention costs – e. g. costs associated with activities of management quality unit, costs related to the development and implementation new methods of quality management, costs for purchasing of gauging devices, costs for manual creation, education and training, costs for information system, certification costs, consultation costs etc.
2. Control and appraisal costs – e. g. costs related to the input/output control, the control of design documentation, information and material inputs, operation costs, etc.
3. Internal costs elicited by non-quality – e.g. costs for complaints, costs for building (construction) scrap, costs elicited by loss from supplier inferior construction materials, poor and incomplete design documentation, downtime costs, costs for production substituting inferior products, costs for debased material, etc.
4. External costs elicited by non-quality – e.g. costs related to the complaints, travel expenses, wages for guarantee overhaul, penalty for supply lag, costs for action in court concerning the quality etc.

Feigenbaum˙s categorization of quality costs on prevention, appraisal, internal failures, and external failures was a basis for other authors who have followed his classification. One of those who use his categorization is Campanella. Sandholm and Sörqvist are authors who used categorization of PQC without prevention costs [1]. Another author discussing the concept of PQC and their classification was Harrington [9]. He presented slightly different model of PQC. He classified them into direct and indirect PQC. Direct costs are costs found in the ledger of company and they were verified by the accountants. They included all the costs that occur because of the risk that people will make errors, because some actually do make errors, and because people continuously need training to do their job properly. The direct PQC are divided into controllable, resultant, and equipment PQC. He divided controllable PQC costs on; prevention, appraisal costs and the resultant PQC divide on; internal error cost and external error cost. Indirect costs can not be found in the company ledger, there are more subjective, and therefore less usable for management in running the

business. They are the costs that occur when the company does not manage to completely satisfy the customers, but merely meet their requirements. The indirect costs are divided into customer-incurred, customer-dissatisfaction, and loss of reputation PQC. As we see Harrington includes prevention costs into PQC, because he wants to include all costs related to quality in his system for reporting and measuring such costs, but does not want to call them quality costs. The reason for this is that he sees the term quality cost as a negative expression that reflects the thinking of the1950s, when it was believed that it was more expensive to produce products with better quality, i.e. quality was seen to cause extra costs. Therefore he used the term PQC, even if he is talking about all costs related to quality, i.e. costs for ensuring quality, preventing poor quality, controlling quality, correcting errors, and all others costs for not being able to meet customer's needs [1]. It is necessary to add that very often we can meet with term hidden poor quality costs, for ex. A glass factory in France loses €600000 and 3 days of production due to the consecutive failure of two transformers. In a bank, a fire, resulting from neutral overheating, causes over € 1 milion damage [5]. These are not isolated events. Some of the publications (Technical report, CIGRE, 2001) lead to a global bill for poor power quality of 500 billion euro per year, i.e. 50% of the turnover of the global electricity sector. For many business uses, the costs of poor quality is higher than the electricity bill. Giakatis, Enkawa Washitani [8] claim that importance of the hidden costs that are the manufacturing loss or the design loss is stretched, as they are large and they cannot be overlooked. They classify prevention appraisal failure as quality costs and quality losses, so they introduce categories of prevention losses and appraisal losses.

The Dahlgaard, Kristesen, Kanji in the face of COQ problems establish the new classification of complex costs of quality which includes: visible and invisible costs. This classification is presented in table 2.

Table 2

New classification quality costs in company

The category of costs	Internal costs	External costs	Total
Visible costs	1a. Repair and failures costs 1b. Prevention costs	2. costs of complaints and guarantee	1+2
Invisible costs	3a. Loss of efficiency as a result of low quality and incorrect management, 3b. Prevention and appraisal costs	4. Loss of credibility as a result of low quality and incorrect management	3+4
Total	1+3	2+4	1+2+3+4

As we see in table 2 total quality costs it possible to classify; that internal and external costs horizontally, and vertically we have visible and invisible costs. from crossing rows and columns we obtain 4 main groups of costs of quality and two subgroups (1a, 1b, 2, 3a, 3b and 4). With except for visible costs (1a + 1b + 2), the complex costs of quality stay unknown [4].

3. Methods of quality improvement

A traditional method of improving the quality of a product is the method of adjusting one factor at a time during pre-production experimentation. In this method, the engineer observes the result of an experiment after changing the setting of only one factor (parameter). This method has the major disadvantages of being very costly and unreliable. The Japanese were the first to realise the potential of another method using statistical design of experiments (SDE) – originally developed by R. Fischer. SDE, in contrast to the one factor method, advocates the changing of many factors simultaneously in a systematic way (ensuring an independent study of the product factors). Statistical methods were developed by Genichi Taguchi to improve the quality of manufactured goods, and more recently are also applied to construction industry, biotechnology, marketing and advertising.

Taguchi [20] argued that quality engineering should start with an understanding of quality costs in various situations. In much conventional industrial engineering the quality costs are simply represented by the number of items outside specification multiplied by the cost of rework or scrap. However, Taguchi insisted that manufacturers broaden their horizons to consider cost to society. Though the short-term costs may simply be those of non-conformance, any item manufactured away from nominal would result in some loss to the customer or the wider community through early wear-out; difficulties in interfacing with other parts, themselves probably wide of nominal; or the need to build-in safety margins. These losses are externalities and are usually ignored by manufacturers. Taguchi argued that such losses would inevitably find their way back to the originating corporation (in an effect similar to the tragedy of the commons) and that by working to minimise them, manufacturers would enhance brand reputation, win markets and generate profits. All these losses are unknown and unknowable but Taguchi wanted to find a useful way of representing them within statistics.

The quality is related to monetary loss and not to any other factors or conditions. Even though the actual loss may be the loss of functionality to the product, or other losses such as pollution, time, noise, etc., the overall effect is a financial loss. It can also be expanded to include the development, and manufacturing phases of a product. A poorly designed product begins to impart losses to society from the very start of the production stage, and continues to do so, until steps are taken to improve its functionality and performance.

The conventional method of computing the cost of quality is based on the number of parts rejected and reworked. This method of quality evaluation is incapable of distinguishing between two samples that are both within the specification limits, but with different distributions of targeted properties. The following figure illustrates the difference between the conventional method and Taguchi's view of the loss function.

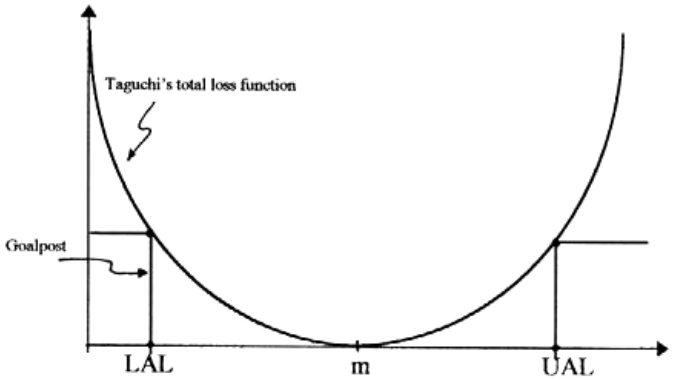

Fig. 2. Taguchi and The Conventional Loss Functions

Rys. 2. Funkcja strat jakości – Genichi Taguchi

The figure depicts the loss function as a function of deviation from an ideal, or the target value of a given design parameter. Here m represents the target value, or the most desirable value, of the parameter under consideration. This parameter may be critical dimension, colour of the product, surface finish or any other characteristics that contributes to the customer's conception of quality. UAL and LAL in the figure 2, represent, upper and lower acceptable limits of a design parameter, respectively. Normally, the product is functionally acceptable if the value of the specified parameter is within the range between the UAL and LAL limits. No societal loss is assumed to occur and the product is accepted for further processing. However, if the product (a building) lies outside these limits, it is either discarded or subjected to salvage operations. Every attempt is made to control the building process to maintain the product within these limits. However, according to Taguchi, there is no sharp cut-off in the real world. Performance begins to gradually deteriorate as the design parameter deviates from its optimum value. Therefore, he proposed that the loss function be measured by the deviation from the ideal value. This function is continuous as shown by the dotted line in figure 3. Product performance begins to suffer when the design parameters deviate from the ideal or the target value. This loss function takes the following basic quadratic form:

$$L(x) = k(x - m)^2$$

Where L is the loss in monetary unit, m is the point at which the characteristic should be set, x is where the characteristic actually is set, and k is a constant that depends on the magnitude of the characteristic and the monetary unit involved. This basic loss function is used if no other function based on data is available. However, when no market research data is available, the next best option is to use the quadratic loss function. From the quadratic loss function, the total loss increases parabolically as the deviation from the target value increases. This loss represents a continuous function. This indicates that by making a product within the specification limits, it does not necessary mean that the product is of good quality, since good quality is now defined as keeping the product characteristic on target with low variation. Taguchi emphasis on optimum customer satisfaction is by

developing products which meet the target value on a consistent basis. Thus, the most important aspect of Taguchi's quality control philosophy is the minimisation of variation around the target value. Taguchi realised that the best opportunity to eliminate variation is during design of a product and its manufacturing process (Taguchi's rule for manufacturing).

4. The cost of quality approach

The cost of quality (COQ) approach to the measurement, management and control of quality defects in the production process is well established in manufacturing and service industries generally, having been in place in its current form for five decades. It forms part of a collection of management methods, which have been introduced to industries around the world, and is related to, and forms a subset of, total quality management (TQM) [22]. One industry in which the potential of COQ is beginning to be recognized is construction. COQ derives from the philosophy, espoused by Philips Crosby and others, that 'quality is free', because it is the lack of quality that increases costs [3]. Joseph Juran [11] defined the cost of poor quality as 'those costs that would disappear if our products and processes were perfect'. Estimates of the cost of quality (or, more accurately, the cost of poor quality or non-conformance with specification) vary across industries and between companies. In general, unless focused efforts are taken to minimize them, they are estimated to fall between 10% and 30%, with most analyses putting them at around 20%. The COQ methodology is based on the process cost model and prevention, appraisal and failures (PAF) model. They stress the link between cost and quality: it is of little use to achieve the required quality at a cost that is prohibitively high and uncompetitive. Equally, achieving a competitive cost by degrading quality also is inappropriate. The Lundvall–Juran curve (Figure 2) illustrates the traditional theory underlying COQ and shows how cost and quality operate as a trade-off within COQ methodology. Together, costs that arise through the need for prevention and appraisal activities and costs due to failures represent the unnecessary additional cost incurred in the product if all processes could operate correctly the first time.

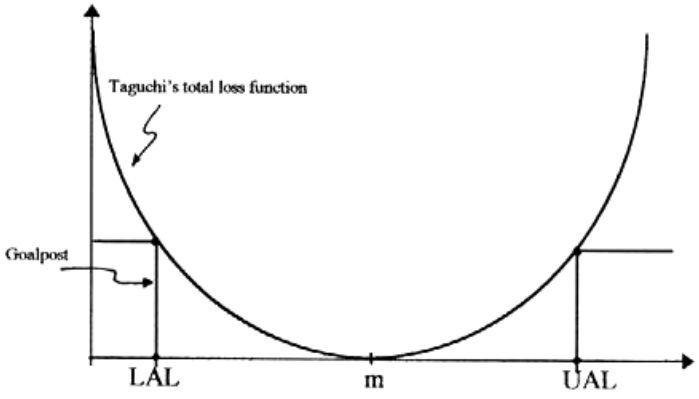

Fig. 3. Optimisation of quality and cost

Rys. 3. Wykres optymalizacji jakości i kosztów

The optimum defect level, shown in figure 3, is where the increasing costs of the prevention and appraisal curve converges with the decreasing failure costs curve. This optimum point will vary according to the nature of the project: the more severe the consequences of failure, the higher the requirement for quality performance. The quality axis should be defined more precisely as the percentage conformance to specification, and then one should recognize that, although the relationship in fig. 3 is broadly appropriate for expressing static relationships, one must, over a longer timeframe, recognize the dynamics of changing technology and knowledge, and how even the acceptable degree of compliance with specification can change. Recognizing these dynamics, the objective is not just to estimate the cost curves for prevention appraisal and failures in order to find the optimal level of quality, but to link identified failures and their causes with technological or work process improvements such that failure costs are driven, over time, to be as near zero as possible (perhaps also with a tighter agreement on specifications). If materials and processes can be relied upon to radically reduce the incidence of failures, this will enable a reduction of prevention and appraisal activities such that almost all the PAF costs can be removed (although there will always be some prevention costs associated with).

Global decreasing of costs is an effort of each building firm which is thriving toward competitiveness. The integral part of the total costs of building is the quality/non-quality costs elicited by poor preparation and realisation of construction process. Survey has demonstrated [13] relative high non-quality costs in the construction process, which are generated by insufficient design documentation and low costs on appraisal (preliminary control of designs), respectively. The lessening of quality/non-quality costs is possible by their optimisation in order to achieve the low cost level on the non-quality and appraisal as well as the prevention (fig. 4). The improvement of quality is possible by implanting the total quality system in organisation that could have a positive impact on all building firm processes. As tools for quality improvement are suitable international standards, ISO norms, systems of quality management, for instance TQM, KAIZEN, knowledge management [15]. Quality based on knowledge is typical for knowledge organisations [19]. These organisations have ability exploit information and knowledge in order to be competitive.

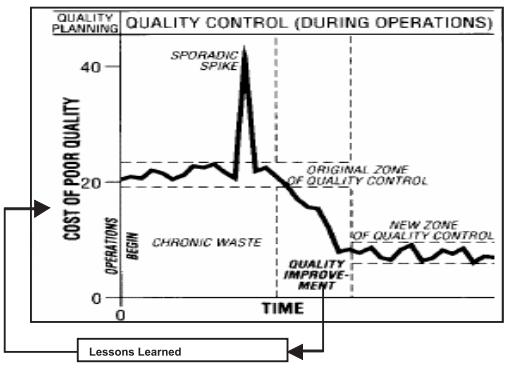

Fig. 4. Juran's Quality Trilogy

Rys. 4. Trylogia Jakości Jurana

5. Recording the costs of quality in the sector of medium-sized companies in Slovak Republic

In this part authors present methodology of research which was applied in research of quality costs in medium sized Slovak companies. This methodology can be used in future to describe interest of recording quality costs in building sector in Poland and in Slovakia. In this part we also show partial results of research.

5.1. Research Methodology[2]

Data presented in the article were got from individual interviews with personal workers in individual companies from area of Eastern Slovakia region. The interview was structured and perpetrated as a questionnaire. The questionnaire had seventeen questions, eleven of them were open and the rest had form closed questions. For faster processing data we used internet. The internet form was available on the university websites (http://dotazniky.euke.sk/?d=48). Database was created automatically after completed and sent the survey. Authors collected the data from September 2007 to January 2008. Individual companies from region of Eastern Slovakia (self region of Prešov and Košice) were chosen random selection. Companies which employ 25 to 250 workers took a part in presented research. Research sample contained 61 companies. Figure 5 shows the representation of sectors in our sample.

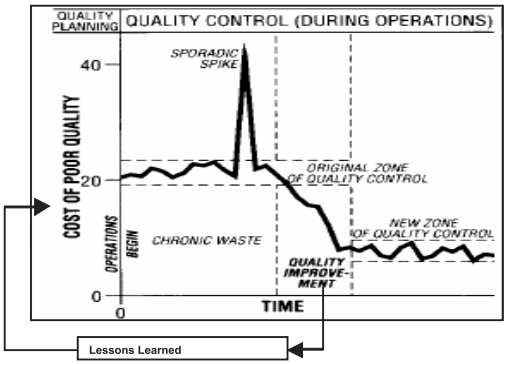

Fig. 5. Research Sample – sectoral view (absolute values and percentage)

Rys. 5. Przykład badań – spojrzenie sektorowe (wartości absolutne i procentowe)

The main issues of presented survey were to find answers the questions:

- What is an interest of recording COQ in companies from individual sectors?
- What is the structure of total costs in companies from different sectors?
- What is the structure of total costs in companies which recording the COQ?

[2] More information in: Pudlo P., Mesaroš P., Mesaroš F., *Influence of quality costs on the structure of total costs in medium sized companies*, in: Acta Oeconomica Cassoviensia, PHF Košice, Vol. II, No. 1, Košice 2009.

4.2. Data Analysis and Results

Research conducted at the beginning of 2008 on group of 61 medium size companies from production services and trade sectors in area of Eastern Slovakia showed that problematic of quality costs are still not known. Almost 40% of all companies declared the lack of recording costs of quality (CoQ). For the main reasons of this situation companies showed: not enough knowledge and models which would be helpful with recording CoQ – 25,81% of all answers, recording this cost do not bring lowering total cost 29,03%, companies know what are the CoQ but they were not interested of recording them 35,48%, companies do not know what categories of quality cost they have 9,69%. If we look at interest of quality cost in individual sectors we see that the biggest interest of recording this costs are presented in production and mix companies adequately 70% and 71,43% from all examined companies. Less interest we observe in companies from sector of services 57, 89% and the least from trade sector 37,50% (fig. 5). Many answers showed that companies are not interested in recording cost during investing into high quality product or services. Those companies who are interested in recording COQ and want to try record this cost don't have enough information or there is not enough of accounting solutions which would be successful applicant in practice.

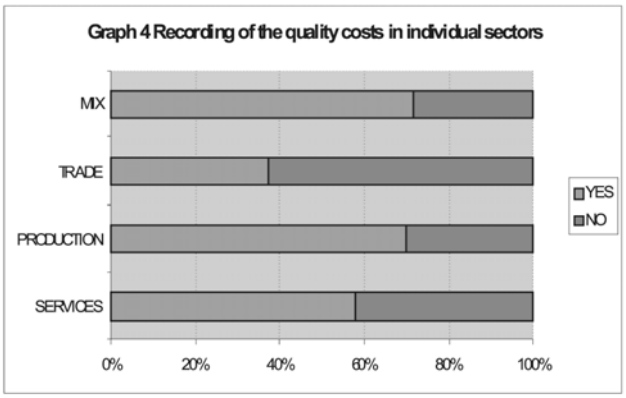

Fig. 6. Recording of the quality costs in individual sectors

Rys. 6. Ewidencja kosztów jakości w poszczególnych sektorach

5. Conclusions

In conditions of global competition market position individual companies depend on the level and structure of production costs. Assurance costs on appropriate level influences on profitability and competitive ability of firm. Presently lowering the costs is possible by taking into account quality, and quality costs. The debates on quality in building firms are focused toward the level and direction of their influence on quality cost optimisation of building production. Development, implementation and improvement of effective quality management system in construction companies can lead to the better functioning of building process, as well as to the higher competitiveness and productivity [14]. Mainly the

knowledge systems will be very helpful in process of required information level of quality in building firm.

References

[1] Andersson S., Ryfors S., *Poor quality costs - a case study in VBS*, , Graduate Business School, Göteborg 2001, 62-63.

[2] Bank J., *Zarządzanie przez jakość*, Gebethner i S-ka, Warszawa 1999.

[3] Crosby P.B., *Quality is Free: The Art of Making Quality Certain*. Maidenhead, McGraw-Hill, 1979.

[4] Dahlgaard J.J., Kristesen K., Kanji G.K., *Podstawy zarządzania jakością*, Wyd. PWN, Warszawa 2004.

[5] De Keulenaer H., *The hidden costs of poor power quality*. European Cooper Institute October 31, 2003_http://www.google.com/search?q=cache:i5VvtJwLRwUJ: repository.copperwire.org/Library/Papers/CostPPQ.pdf+hidden+poor+quality+costs 19.08.2007.

[6] Feigenbaum A.V., *Total Quality Control*, 3rd ed. New York: McGraw-Hill 1983.

[7] Foster S.T., *An examination of the relationship between conformance and quality-related costs*, International Journal of Quality and Reliability Management, 13, 1996, 4, 50–63.

[8] Georgios G., Enklawa T., Washitani K., *Hidden quality costs and the distinction between quality costs and quality loss*, Total Quality Management & Business Excellence, Volume 12, Issue 2, March 2001, 179-190.

[9] Harrington H.J., *Poor- Quality Cost*, Mercel Dekker, New York 1987.

[10] Iwasiewicz A., *Zarządzanie jakością*, Wyd. PWN, Warszawa–Kraków 1999.

[11] Juran J.M., *Juran on leadership for quality, an exclusive handbook*, The Free Press; Collier Macmillan Publ., New York, London 1989.

[12] Makarski S., *Uwarunkowania i koszty jakości produktywność rynku*, [w:] praca zbiorowa pod. red. S. Makarski, *Rynkowe mechanizmy kształtowania jakości*, URZ, Rzeszów 2005.

[13] Mesároš F., *Vzťah kvality a nákladov v stavebníctve*, In: Kvalita 2008, 17. Mezinárodní Konference, Ostrava, 2008.

[14] Mesároš P., Sudzina F., Mesároš F., *Úspešnosť slovenských stavebných podnikov za rok 2007*, In: Eurostav, 14, 2008, 6, 91-97.

[15] Mesároš P., Mesároš F., Čarnický Š., *Manažment znalostí a perspektívy jeho uplatnenia v slovenských podnikoch*, Vydavateľstvo Ekonóm, Bratislava 2008.

[16] Oyrzanowski B., *Jakość dla konsumenta producenta i gospodarki narodowej*, PWE, Warszawa 1989.

[17] Pudło P., *A Review of research on the definitions and models of quality costs*. In Acta Oeconomica Cassoviensia: czasopismo naukowe, PHF EU, Košice 2008.

[18] Skrzypek E., *Jakość i efektywność*, Wyd. Uniwersytet Marii Curie-Skłodowskiej, Lublin 2002.

[19] Stričík M., *Financovanie inovačných aktivít malých a stredných podnikov*, In: SEMAFOR '09 – Slovenská ekonomika, mýty a fakty o realite: zborník príspevkov z medzinárodnej vedeckej konferencie, Michalovce, 17–18.9.2009, Vydavateľstvo EKONÓM, Košice 2009, 212-223.

[20] Taguchi G., *System of Experimental Design*, New York, McGraw Hill, 2003.
[21] Task force 38.06.01, *Methods to consider customer interruption costs In Power system analysis*, Technical report, CIGRE, 2001.
[22] Tomkins C., Madigan D., May B., Steckelmacher P., *Modern developments in cost management: implications for management accounting in the civil engineering industry*, Agile Working Paper, University of Bath, 1997.