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# Contribution of the quality costs to sustainable development

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**Abstract**
This paper presents a framework of contemporary quality costs concept contributing to a more sustainable society regarding an integrated view of quality costs in all phases of the product life cycle (engineering, production, use, and end-of-life) by all stakeholders in the supply chain. The development of this framework is viewed through the complementarity of the sustainability dimensions and the circular economy concept understood as a waste management concept, which represents a solid basis for the development of a novel approach to understanding quality costs which, in turn, reflects the sustainable quality concept. By providing sustainable criteria (economic, environmental, and social) as an integral part of the quality costs concept, this framework will improve the sustainability performance in the early phases of product design, increase the added value of the products and the duration of the added value, and strengthen the responsibility of all stakeholders beyond the limits of their organizational processes. This will inevitably lead to changes to the quality cost structure, dominated by new quality costs elements which reflect sustainability. This research demonstrates the findings that should support the setting the theoretic assumptions for the development of a sustainable quality cost generic model.

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## 1. Introduction

The concept of quality has always been considered and existed in relation to the product (service). Nevertheless, different circumstances and requirements in different time periods lead to different viewpoints, aspects, concepts whereby the researchers who elaborated this concept, suggested how one should understand the product quality concept.

The traditional approach to understanding product quality (current until the 1950s) understands product quality as quality defined by product inspection and control once the product is ready for delivery to the customers, thus, the costs of quality were equated to inspection of the finished product (Šunjić-Beus and Martinović, 2007) and the costs for scrap, rework and the cost of running the quality department (Giakatis, et al., 2001).

On the other hand, the modern approach (philosophy) to understanding quality (in the second half of the 20th century and the beginning of the 21st century) relates to continuous improvement of quality by preventive measures that will not only prevent failure occurrence, but will also preclude the causes for such failures during the manufacturing and delivery of the product to the customers (Šunjić-Beus and Martinović, 2007). In other words, quality should be planned, designed and built-in in the product rather than be controlled only after the product is finished. This represents a pillar in understanding modern quality management (Stanciuc and Branzas, 2014). The modern approach to quality suggests a separate category of costs related to the attainment of quality, known as quality costs, as well as the development of theoretic knowledge related to the need for quality costs definition models.

The initial beginnings of quality costs knowledge originate as far back as the 1930s with the first indirect representation of the costs of quality noted in the work of Shewhart (1931) who writes about the financial effects arising from quality, and in the writings of Miner (1933) and Crocket (1935) where the expression "quality costing" appears for the first time. The second half of the 20th century features the initial scientific findings about the quality costs concepts, developed and pro-

moted in the theoretical works of the famous quality researchers such as Joseph M. Juran (Schiffauerova and Thomson, 2006), W. J. Masser, Armand V. Feigenbaum (Giakatis et al., 2001) and Philip B. Crosby (Sower et al., 2007), who laid the foundations for the development of the quality costs concept and the interpretation of the quality costs structure definition models expressed by the quality costs categories.

The analyzed literature presents several interpretations of the quality costs definition models. These include the descriptive interpretation, describing the quality costs categories, starting with generic models: PAF model (prevention-appraisal-failure costs), Crosby model (conformance and non-conformance costs related to requirements), Intangible costs models (opportunity/hidden cost), Process cost model (conformance and non-conformance costs related to processes), ABC model - Activity Based Costing (value-added and non-value added activities costs), Taguchi loss function model (loss of sales revenue, process inefficiencies and losses due to deviation from the target) (Omar and Murgan, 2014), and Hybrid models (classical PAF model with the ABC approach; classical PAF model with Crosby's opportunities lost costs and elements from the process cost models) (Czajkowski, 2017).

The modern 21st century work is expected to create and develop "sustainable products" with a newly added value beyond functionality, cost and quality, related to durability, reliability, upgrade options, maintenance, reuse, recycle, disposal and energy consumption, as well as with the inclusion of all relevant stakeholders (government, non-governmental organization, investors, academia and industry association, financial institutions suppliers, competitors, customers and employees), concerned about the product life cycle, most of which not under the control of the producer, shifting the supply chain perspective towards a holistic stakeholder approach (Aschehoug and Boks, 2013). The transition from linear to circular economic business models (Drljača, 2016), considering remanufacturing (Li et al., 2018; Ponte et al., 2021), and including the environmental, social and economic aspects of the concept of sustainability in the initial product design stages (Schoggl et al., 2017), contribute in that direction. Basically, this reflects the appearance of a modern concept of sustainable quality that mobilizes scientific and practical knowledge with a view of minimizing the negative influence of quality loss expressed by the material waste, and other operational losses, on the life of present and future generations (Watson, 2015).

The quality costs and the models to define them need to follow the quality concept evaluation trends. Therefore, this research aims at analyzing whether the development of a descriptive interpretation of the quality costs currently introduces or indeed follows the contemporary perception of quality in relation to the sustainable product development. Hence, section 2 will present the specific quality costs concepts and the descriptive quality costs structure definition models. The analysis in section 2 showed that the understanding of the contemporary perception of quality still has not shaped the understanding of quality costs, except the initial understanding derived from the presented broader quality costs concepts. Thus, the authors of this paper recognized that the development of a framework of the contemporary concept of quality costs was necessary to, first to raise the understanding of quality costs from the aspect of sustainable development and, second to enable of the modern business and societies to internalize a contemporary framework of quality cost towards a more sustainable society. The ultimate goal of this research is creation a framework of the contemporary concept of quality costs that will make criteria of sustainability as integral part in structuring of the model of quality costs and will involve considering of the quality costs in all phases of product life-cycle (engineering - product design, production, use and end-of-life) by all stakeholders in the supply chain. This integral approach will improve sustainability performance in early phases of product design and the entire life-cycle of products, because will eliminate all the losses related to designing, production, use and disposal of the products and materials.

## 2. Descriptive interpretation of the quality costs models

Certain concepts that incorporated the understanding, approaches and aspects of quality costs preceded the development of the quality costs model. These represented a fundamental premise to defining the structure of the quality costs models represented by the quality costs categories, in turn represented by the quality costs elements. Table 1. shows the different quality costs concepts developed and promoted by renowned authors in different time periods. The concept analysis suggests that fundamental quality costs categorization includes three categories, namely prevention costs, appraisal costs and failure costs (internal and external);
it is recognizable and widely accepted as a generic quality costs model, PAF model (Schiffauerova and Thomson, 2006), and it represents a common denominator of all presented concepts. The PAF model relies on the main assumption that "investments in preventive and appraisal activities will reduce the failure costs and that further investment in prevention activities will reduce the appraisal costs" (Snieska et al., 2013).

Some authors still think that the failure costs category and the appraisal costs category draw the attention away from work productivity and that the prevention activities focus will replace the appraisal activities focus because, unlike the preventive costs, the appraisal costs and the failure costs belong to the group of non-value-adding quality costs. The conclusion regarding the appraisal costs seems to remain applicable in spite of the progress in the field of quality management, where statistical controls of the processes and quality failure prevention, featured in the modern quality management approach, have replaced the traditional finished product inspections (Nel and Pretorius, 2016). An especially important challenge refers to the notion that not all preventive activities and appraisal activities succeed, i.e. the prevention costs category and the appraisal costs category, in addition to featuring quality costs elements, should also feature quality loss elements, namely prevention loss and appraisal loss (Giakatis et al., 2001).

**Table 1.** Quality costs concepts

| Quality costs concepts | | | Author(s) of describing and developing the concepts | Reference |
|---|---|---|---|---|
| Unavoidable costs | + | Avoidable costs | Joseph M. Juran, 1951. | (Banasik and Beruvides, 2012) |
| Price of conformance to requirements | + | Price of non-conformance to requirements | Crosby P., 1979; Denton D.K., Kowalski T.P., 1988; Suminsky L.T. 1994. | (Omar and Murgan, 2014) |
| Costs of control (costs of conformance) | + | Costs of failure of control (costs of non-conformance) | Armand V. Feigenbaum, 1991. | (Omar and Murgan, 2014) |
| Voluntary costs | + | Involuntary costs | Campanella J., 1999. | (Cheah et al., 2011) |
| Costs of quality investment | + | Costs of quality disconnects | Armand V. Feigenbaum, 2001. | (Jeffery, 2003-2004) |
| **Prevention costs and appraisal costs** | **+** | **Failure costs** | | |
| **Descriptive interpretation of PAF model** | | | | |

**Table 2.** PAF Model modifications with additional quality costs categories

| | Additional categories of PAF model | Author(s) of additional categories of PAF model | Reference |
|---|---|---|---|
| PAF model (prevention-appraisal-failure) | Cost of inefficient utilization of resources and Cost of quality design | B. Modarress, A. Ansari, 1987. | (Modarress and Ansari, 1987) |
| | Costs of lost sales | Godfrey J.T., Pasewark W., 1988. | (Banasik and Beruvides, 2012) |
| | Cost of lost opportunities | Carr L.P., 1992. | (Schiffauerova and Thomson, 2006) |
| | Adjustment cost and quality design cost | Sugiura M., 1997. | (Giakatis et al., 2001) |
| | Cost of lost opportunities (under-utilization of installed capacity, inadequate material handling and poor delivery service) | Sandoval-Chavez D.A, Beruvides M.G., 1998. | (Cheah et al., 2011) |
| | Hidden failure quality costs (costs of lost image and lost sales) | Tsai W., 1998. | (Snieska et al., 2013) |
| | Quality management system costs | Hwang G., Aspinwall E.M., 1996. | (Hwang and Aspinwall, 1996) |
| | Hidden failure quality costs (loss of customer's goodwill, loss of organization's image and lost sales) | Campanella J., 1999, Summers 2000. | (Snieska et al., 2013) |
| | Loss of inefficient work time | Krishman S.K., Agus A., Husain N., 2000. | (Snieska et al., 2013) |
| | Hidden failure quality costs (loss of organization's image, unsatisfied angry customers, lost sales and loss due to judicial claims) | Kaynama S.A., Black Ch.I., 2000. | (Snieska et al., 2013) |
| | Improvement costs – costs for attaining improved level of quality conformance | Waheba G. S., Elshennawy A. K., 2004. | (Weheba and Elshennawy, 2004) |
| | Hidden external quality costs: extra resultant quality costs and estimated hidden quality costs | Yang C.-C., 2008. | (Yang, 2008) |

The research community dissents about the ease of determining a unique classification of the quality costs elements, especially considering the difficulties in defining and measuring the prevention costs category (Nel and Pretorius, 2016), as well as in delineating the quality improvement costs, which differ from the costs of preventive maintenance of a specific quality level (Jeffery, 2003-2004). An overwhelming challenge when researching the PAF model categories presents the exclusion of the intangible quality costs in the structure of the model (Snieska et al., 2013).

These dilemmas and challenges arising from the continuous changes in perception, knowledge and understanding of quality, stimulated the researchers (theoreticians-authors) to improve the PAF model or, put another way, to adapt the PAF model application so that it reflects the current approaches, needs, requirements and expectations related to quality. The added quality costs categories to the existing PAF model structure modified the PAF model, Table 2. The added quality costs categories will mark the end of the 20th and the beginning of the 21st century and arise as a direct consequence from the strong focus on fulfilling the needs and expectations of the

customer and the focus on reducing the variations of the processes that add value to quality.

Because the perceived significance of the hidden external failure quality cost, which remain excluded and far greater than the visible external failure costs structured in the PAF model, some authors, when descriptively interpreting the proposed models, propose a quality cost category for the visible (measurable) costs and a category for the hidden quality costs, difficult to quantify objectively (Giakatis et al., 2001). Other authors also add a separate category for lost opportunity costs, Table 3. Thus, quality costs are seen as costs that should create the needs of the customer (market). This give rise to the standpoint that the quality costs should be considered ex-ante and not ex-post (Stanciuc and Branzas, 2014), i.e. bridge the gap between viewing quality costs more as a thing of the past and viewing them as a driver of continuous improvement (Sower et al., 2009).

It should be noted that the aforementioned descriptive interpretations of the quality costs models (Tables 1-3) refer to the company activities and we call such models activity-oriented models. The quality costs generic model development also features more advanced quality costs models (Table 4), namely the process model, which, within its structure, integrates two quality costs categories: process conformance costs (the action process costs of producing products including prevention and appraisal costs) and process non-conformance costs (the failure costs associated with a process), and is applied to each and every process in the company and to every step of the process (Porter and Rayner, 1992).

The process model differs from the PAF model because it focuses more on the product creation processes, rather than the products themselves. It is a simpler model with respect to the identification and the distribution of the quality costs elements into the two categories described above and it is far more adequate for environments that have already implemented total quality management (Tang et.al., 2004). Furthermore, the process model can also apply for appraisals of investments in preventive activities and estimations of the required investments in preventive activities for every discrete company process. All of this makes the process model more applicable to modern company operations, unlike the PAF model (Schiffauerova and Thomson, 2006).

Other noteworthy quality costs models focus on the customer and the impact of poor quality. These are known as poor quality costs models, in which PAF model categories are including as categories of the direct costs related to poor quality Table 5. The structure of these models reflects the category of indirect costs of poor quality, which, in turn, emphasizes the prevailing impact of poor quality on the reputation, survival and the future development of companies, wherefore the indirect poor quality costs gain much support from many researchers. The supporters of these models think that focusing on the indirect poor quality costs will automatically eliminate the other cost elements such as the direct prevention and appraisal costs, which will simplify the structure of the model and make it easier to understand and apply.

**Table 3.** Descriptive interpretation quality costs models focusing on hidden quality costs

| Descriptive interpretation of quality costs models | | | | | Author(s) of describing and developing the models | Reference |
|---|---|---|---|---|---|---|
| Tangible costs | + | Intangible costs | | | Joseph M. Juran, 1951. | (Schiffauerova and Thomson, 2006) |
| Tangible factory costs Tangible sales costs | + | Intangible costs (loss of customer goodwill, delays by stoppages and loss of morale amongst staff) | | | Juran J. M., Gryna F.M., Bingham R., 1975 | (Porter and Rayner, 1992) |
| Identifiable quality costs | + | Hidden quality cost | | | Lesser W.H., 1954. | (Banasik and Beruvides, 2012) |
| Visible costs (prevention, appraisal, internal failure and external failure) | + | Invisible costs (prevention, appraisal, loss of efficiency, loss of goodwill) | | | J.J.Dahlgaard, K.Kristensen G.H. Kanji, 2000. | (Cheah et al., 2011) |
| Visible costs (prevention and appraisal) | + | Invisible | + | Opportunity costs | Chiadamrong N., 2003. | (Chiadamrong, 2003) |
| Production visible quality costs | + | Production invisible (hidden) quality costs | + | Opportunity costs | Omar M.K., Murgan S., 2014. | (Omar and Murgan, 2014) |
| **Prevention costs, appraisal costs and failure costs (visible)** | + | **Failure costs (invisible)** | **+** | **Opportunity costs** | | |
| **Categories of PAF model** | | **Additional categories of PAF model** | | | | |

**Table 4.** Process quality costs models

| Descriptive interpretation of process cost models | | | Author(s) of describing and developing the models | Reference |
|---|---|---|---|---|
| Cost of conformance of process | + | Cost of non-conformance of process | Ross D.T., 1977; Marsh J., 1989; Crossfield R.T., Dale B.G., 1990; Goulden C., Rawlins L., 1995.<br>S.L. Tang, Raymond T. Aoieong, Syed M. Ahmed, 2004.<br>Philip B.Crosby, 1984. | (Schiffauerova and Thomson, 2006)<br>(Tang et.al., 2004)<br>(Lari and Asllani, 2013) |
| Costs of productive work, support and checks | + | Costs of systematic weakness, internal and external error and waste | Bland F.M., Maynard J., Herbert D.W., 1998. | (Jeffery, 2003-2004) |
| Agreement costs (effort to meet customer's requirements) | | Disagreement costs (non-meeting customer's requirements) | Lari A, Asllani A., 2013. | (Lari and Asllani, 2013) |
| **Prevention costs and appraisal costs** | + | **Failure costs** | | |
| **Categories of PAF model** | | | | |

**Table 5.** Poor quality costs models

| Descriptive interpretation of poor quality costs models | | | Author(s) of describing and developing the models | Reference |
|---|---|---|---|---|
| Direct poor quality costs | + | Indirect poor quality costs | | |
| Prevention costs<br>Appraisal costs<br>Failure costs<br>Equipment poor quality costs | + | Customer-incurred costs<br>Customer dissatisfaction costs<br>Loss of reputation | Chen Y.-S., Tang K., 1992. | (Jaju, 2009) |
| Direct failure costs<br>Consequence costs<br>Inefficiency costs | + | Customer costs<br>Intangible costs<br>Environmental costs | Moen R.M., 1998. | (Jeffery, 2003-2004) |
| Prevention costs<br>Appraisal costs<br>Non-value added costs<br>Failure costs (internal and external)<br>Equipment poor quality costs | + | Customer-incurred costs<br>Customer dissatisfaction costs<br>Loss of reputation and loss opportunity poor quality cost | Harrington H.J., 1999. | (Cheah et al., 2011) |
| Prevention costs<br>Appraisal costs<br>Non-value added costs<br>Resultant poor quality (Failure costs)<br>Equipment poor quality costs<br>Costs of quality improvement | + | Customer-incurred costs<br>Customer dissatisfaction costs<br>Loss of reputation and opportunity costs | Arthur B. Jeffery, (2003-2004). | (Jeffery, 2003-2004) |

The quality improvement costs related to the efforts to enhance quality to a higher level using specifically designed enhancement programs need to be distinguished from the poor quality prevention costs and the routine prevention activities (Jeffery, 2003-2004).

It is worth mentioning that all aforementioned descriptive interpretations were considered from the "cost" viewpoint, are related to one entity, usually the producer, as well as to the usable of the product.

A significant advancement of the quality costs definition models relates to the presentation of broader quality costs definition concepts starting from the early 1980s, which expand the existing producer level quality costs framework to also include the quality costs (in some concepts known as losses) of the supplier, customer and the community - society (Table 6). In this line, the model for supply chain design that computes the cost of quality as a global performance measure for the entire supply chain (Castillo-Villar et al., 2012), capacitated single product four echelon supply chain for minimizing the quality costs and evaluate the influence of investment to increase overall quality and operation (Alglawe et al., 2019), convey the message that all entities in the supply chain are responsible for product quality, as well as for the quality costs. The descriptive interpretation of the quality costs concepts and models, suggests that the quality costs concept is considered for each supply change entity separately, similar to the linear economy concept (Figure 1).

**Table 6.** Broader quality costs concepts

| Broader quality costs concepts | Author(s) of describing the concepts | References |
|---|---|---|
| Quality losses producer + + Quality losses customers + Quality losses society | Genichi Taguchi, 1980. | (Pacana and Stadnicka, 2009) |
| Quality costs of suppliers + Quality costs of producer + Quality costs of customers | Gryna F. M., 1988; Dale B. G. Plunkett J. J., 1991; G. H. Hwang, E. M. Aspinwall, 1996. | (Jaju, 2009); (Lorente et al., 1998); (Hwang and Aspinwall, 1996) |
| Quality costs of suppliers + Quality costs of producer + Quality costs of traders | Krystel K. Castillo-Villar, Neale R. Smith, James L. Simonton, 2012. | (Castillo-Villar et al., 2012) |
| Quality costs of suppliers + Quality costs of producer + Quality costs of traders + Quality costs of customers | Alglawe A., Schiffauerova A., Kuzgunkaya O., Shiboub I., 2019. | (Alglawe et al., 2019) |

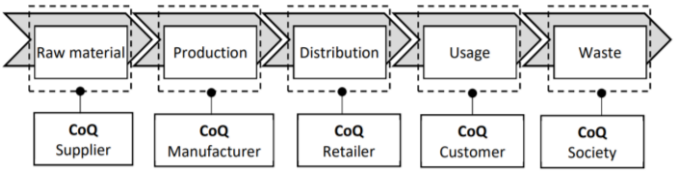


**Fig.1.** The concept of quality costs in line with linear economy (CoQ – total quality costs)

In addition, the quality costs categories in the descriptive interpretation do not demonstrate that the quality costs were considered from the point of view of the environmental, economic, and social dimension of the sustainability.

## 2. A framework of the contemporary concept of quality costs

The framework of the contemporary concept of quality costs (Figure 2), includes (integrates) three levels:

1. All three dimensions of the concept of sustainability: environmental, economic and social are involved in consideration of the quality costs;
2. Equal consideration of the dimensions in all phases of the product life cycle: engineering - product design, production, use and end-of-life, seen in synergy with the concept of circular economy;
3. This integrated approach enables all stakeholders in the supply chain to be considered the quality costs incurred at all stages of the product life cycle. By establishing feedback, each stakeholder knows the cost of quality of the other stakeholders in the supply chain.

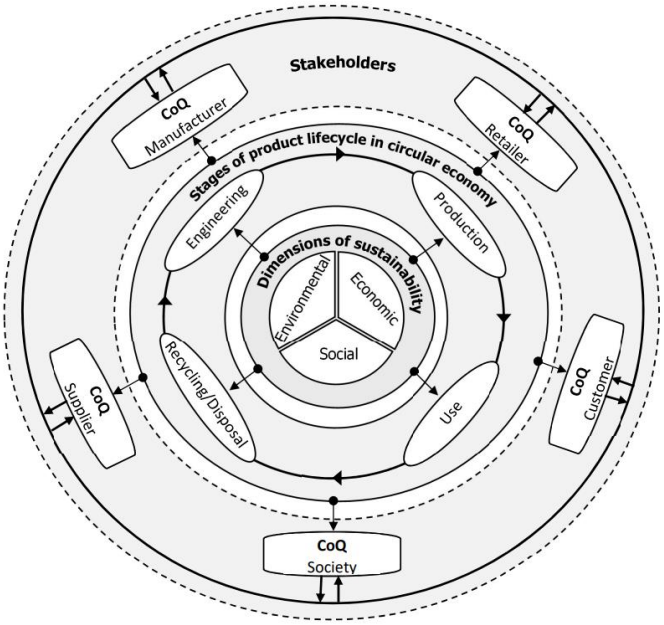


**Fig. 2.** A framework of the contemporary concept of quality costs

## 3. Results and discussion

The quality costs concepts and the quality costs models have a dualistic nature (Tables 1-5), i.e. their structure features two opposing aspects converging to a common goal, namely quality evaluation. One aspect represents the proactive side of the quality costs concept, expressed by the prevention costs category, while the other aspect reflects the reactive side of the quality costs concept, expressed by the appraisal costs, failure costs, loss costs, lost opportunity costs, lost reputation costs category etc. The proactive aspect refers to activities with added value and reflects the current quality and the reactive aspect refers to non-value-adding activities and reflects past

quality. The persistence of the concept's reactive aspect is mostly due to the notion that product quality failures can be identified mostly by the customer, by identifying and reporting failures, which failures cost the most and threaten the survival of companies due to the higher quality costs. But, by continuously applying advanced methodologies like Six Sigma, Design for Six Sigma, Lean Production, Design for Sustainability Concept and others, which promote the approach that "quality should be built-in", the companies will, at the earliest possible phase, prevent the risks of failure, reduce the customer failure costs, to achieve sustainable product design, thus suppressing the reactive aspect at the expense of the development of the proactive aspect. The graphical illustrations (Tables 1-5) clearly show the quality measurability aspect expressed through the presence and the domination of the PAF model categories and the more difficult to measure aspect of quality expressed through the hidden external costs of failure and opportunity costs.

On one hand, contemporary companies face the need for programs for waste reduction, designing environmentally friendly products, energy efficient applications, the obligatory environmental protection regulations, while, on the other hand they face the impossibility to quantify all external failure costs and therefore the quality costs models become more or less non-feasible. We can expect that the dramatic development of industries with a view of smart technologies and smart growth, knowledge and innovation-based economy, can provide the prerequisites for the contemporary quality costs concept to focus mostly on the measurable part of the quality costs with new quality costs categories and elements.

All of the presented descriptive interpretations (Table 1-5) refer to quality costs incurred during product creation and utilization while the contemporary concept framework refers to the costs of quality during the whole product life cycle.

The contemporary concept differs from the presented concepts (Table 1-5) with respect to the following features: the integrated view, at a macro level, of the quality costs occurring in the supply chain enables an increased product added value focusing on the whole product life cycle and not the usable life of the product Drljača (2016) and imposes responsibility to all stakeholders beyond their organizational processes.

The contemporary concept framework should give rise to the new quality costs model structures of all stakeholders in the chain, dominated by the new quality costs elements reflecting the economic, environmental and social sustainability. For example, the quality costs model structure of the supplier and the producer should contain elements related to waste reduction program design, designing environmentally friendly products, energy efficient applications, the obligatory environmental protection regulations, reuse, recycling, further processing (Schoggl et al., 2017), elements reflective of the user costs, such as search cost, information cost, cost of disposal, cost of serviceability (Aschehoug and Boks, 2013), as well as elements reflective of the costs for deviating from the sustainability requirements regulated by the community when dealing with the waste management programs. Nevertheless, obtaining important and relevant sustainability information still remains the main challenge facing the contemporary concept.

## 4. Summary and conclusion

The research presented in this paper provides a better understanding of the future development of the quality costs structure definition models, looking through the prism of the policies for the sustainable development of companies and, more broadly, of communities (nations) with the concept of circular economy through holistic approach. This research confirmed the primary goal of this paper to develop a framework of the contemporary concept of quality costs towards a more sustainable society. Finally, we can conclude that if the contemporary quality costs concept is accepted as a representative of the stakeholders dealing with responsible decisions for sustainable, smart, and inclusive development of the social and economic community, then the challenge related to the need for sustainability through promoting products, people and the planet, will be successfully overcome.

Future research should focus on setting the theoretic assumptions for the development of generic model for the cost of sustainable quality, comprising two main categories: quality costs that provide for sustainable development and quality costs that do not provide for sustainable development.

One limitation of this research is that there are quality cost models interpreted from a profit view point, and they are known as "cost-benefit" models (Nel and Pretorius, 2016) and do not fall within the scope of this paper.

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# 质量成本对可持续发展的贡献

**關鍵詞**
可持续的质
质量成本概念
可持续性
产品生命周期
循环经济

**摘要**
本文提出了一个当代质量成本概念的框架，它通过对产品生命周期（工程、生产、使用和报废）各个阶段的质量成本的综合观点，为更可持续的社会做出贡献。供应链中的所有利益相关者。该框架的发展是通过可持续性维度的互补性和被理解为废物管理概念的循环经济概念来看待的，这代表了开发一种理解质量成本的新方法的坚实基础，这反过来又反映了可持续发展质量理念。通过提供可持续标准（经济、环境和社会）作为质量成本概念的组成部分，该框架将提高产品设计早期阶段的可持续性绩效，增加产品的附加值和附加值的持续时间重视并加强所有利益相关者的责任，超越其组织流程的限制。这将不可避免地导致质量成本结构发生变化，以反映可持续性的新质量成本要素为主。这项研究证明了应该支持为开发可持续质量成本通用模型设定理论假设的研究结果。