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Quality Cost Account as a Framework of Continuous Improvement at Operational and Strategic Level

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Abstract
The aim of the article is to present an exemplary system for recording and analyzing quality costs and to demonstrate that it is helpful in planning and assessing the effectiveness of continuous improvement processes at the operational and strategic level. Various approaches to defining quality costs are described, followed by indicators for assessing effectiveness and tools to collect data on the values of individual groups of quality costs and compare them with financial indicators. The practical part presents a case study on the quality cost accounting system in a medical company and the possibility of using quality cost accounting to plan and evaluate continuous improvement processes and make managerial decisions.

Keywords
Quality costs, Improvement projects, Quality management, Operational, Strategic decisions.

Introduction

Fulfilling a customer's quality requirements should be the overriding idea of every modern enterprise (Omar & Murgan, 2013). This idea should be taken into account at the stage of product design and production planning by organizing, producing and controlling internal processes (Zonnenshain & Kenett, 2020; Razfeld et al., 2015). Since the quality of products and services is an inherent element of the abovementioned processes, it has a significant impact on the economy of the enterprise (Lawrence & Hannelie, 2019, Ocampo & Clark, 2017). This influence is manifested in many ways, including (Hamrol, 2012):

- By influencing revenues – higher quality of products may make the enterprise increase its share in the market turnover and obtain more durable prices with a favourable relation to quality.
- By influencing costs – in order for the quality of products to be at the appropriate level and to maintain or even improve this level, the organization must incur certain expenditure: designing, purchasing equipment allowing for higher design quality, as well as controlling and improving manufacturing processes. Costs are also incurred due to failure to meet quality obligations.

It should be noted that the impact of quality on the economy of the enterprise is quite complex, and the basic economic effects of improving quality management are:

- reducing the social costs of quality for producers, intermediaries and consumers,
- lowering the costs of producing goods and services (Ocakci et al., 2021),
- the emergence of opportunities to offer customers products and services at a lower price,
- the increase in the marginal utility of the product as perceived by their consumers,
- positive product evaluations, thanks to exceeding customer requirements and needs (surprise effect),
- thanks to prevention and planning, the costs of manufacturing products and logistic costs are minimized,
- increase in sales volume,
- increase in profit on sales,
- raising funds for further development.

The above economic consequences of improving quality management benefit both the producer and consumer (Cheah et al., 2011; Sansalvador & Brotons, 2018). The producer can achieve its assumptions and goals because the position of the organization on the market increases, while the customer achieves greater satisfaction and satisfaction with the purchased prod-

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ucts. This fact also benefits intermediaries and other stakeholders who accompany the producer and customer of a given product throughout its life, from concept through design, production, use, and disposal. Therefore, it can be concluded that quality improvement on a microeconomic scale translates into quality of life, as well as economic growth and economic development (Wawak, 2016).

It should be noted that the research on the impact of the quality of the product that reaches the consumer on the company's financial result should take into account the costs of all phases of the product lifecycle (Alglawe et al., 2019). These are the costs of compliance that arise early in the stage of designing the product and in its production, as well as the costs of non-compliance that may arise within the organization or after the sale of the product, the so-called external non-compliance costs. In order to manage quality costs and study their impact on the financial result, it is necessary to measure and monitor them (Eid et al., 1997; Grabowska & Takala, 2018). Many methods proposed in literature consist an extensive mathematical complexity (Chen & Tang, 1992; Campi et al., 2020), a lack of documentation to accompany the implementation or incompatibility with the existing corporate cost structures (Yasin et al., 1999; Šatanová et al., 2015; Sansalvador & Brotons, 2013).

The aim of the article is to demonstrate an example that monitoring of quality costs gives valuable hints in the context of continuous improvement at operational and strategic level. The goal is a response to the business demand for practical solutions and the willingness to support managers in the decision-making process regarding the selection of areas for improvement.

Literature analysis – quality cost analysis

The concept of "cost of quality" was first introduced into the literature by Joseph M. Juran and Armand V. Feingenbaum in the 1950s. Juran stated that high-quality products would bring many benefits to the organization (Juran, 1951). Feingenbaum, on the other hand, described the costs of quality as a connection with pro-quality activities, i.e. prevention, assessment, and control, as well as actions related to the effects of errors in relation to the entire product lifecycle (Feigenbaum, 1991; Sadowski, 2017; Omar & Murgan, 2013; Junior, 2016).

The success of a given company on the market is determined by the way it is able to meet the needs of its customers. To do this, the organization should offer products that meet the quality requirements of customers, taking into account the optimal costs that it can incur for this purpose. An important element of the overall manufacturing costs are quality costs, which are the sum of all operational costs related to quality management. They enable the quantitative assessment of the effectiveness of the systems that are designed to ensure an appropriate level of quality in the enterprise. Accordingly, it can be concluded that quality costs are all kinds of inputs and losses incurred by the organization to ensure a certain level of quality of the offered products (Sturm et al., 2019).

Quality cost analysis enables the evaluation of both the effectiveness and efficiency of a quality management system with specific numbers. Knowing the financial measures of the enterprise, it is possible to balance the expenditures that have been allocated to quality with the effects that have been achieved. The collected data can be greatly useful when formulating parametric quality goals and also enable the assessment of their implementation. In addition, the analysis of quality costs shows the weaknesses of the company and thus can be used to improve the quality management system (Hamrol, 2012; Hamrol et al., 2020).

It is important that in order for the sum of quality costs to become useful for a manager, it is necessary to adopt a certain base for comparisons and to determine the indicators that will show the relationship of quality costs with other costs or other financial measures, or between the components of individual quality costs.

Examples of such indicators are (Hamrol, 2012):

- W_{k1} – total quality costs/sales revenues;
- W_{k2} – total quality costs/financial result;
- W_{k3} – assurance costs/manufacturing costs;
- W_{k4} – evaluation costs/total quality costs;
- W_{k5} – non-compliance costs/total quality costs;
- W_{k6} – assurance costs/total quality costs.

Indicators must be selected according to the needs and the purpose for which the analysis is conducted. It should be realized that for the company's management it is important to know that the value of the indicator means that the cost relations are correct, and that the quality management system is ineffective and requires implementation of corrective actions. Unfortunately, the answer is not unequivocal, but it is assumed that one should strive for a situation in which the indicators of total quality costs related to costs or revenues reflecting the revenues or production volume of the enterprise will be minimized. At the same time, efforts should be made to minimize the costs of internal and external non-compliance in relation to the total cost of quality (Hamrol, 2012).

The relationships that may exist between the individual cost indicators are important for the enterprise as they indicate whether the quality management system is effective. The figure below shows four areas that determine the values of I_{QP} indicators for the ratio of total quality costs (QC_c) to the costs reflecting production volume (VP) and I_{NQ}, which determines the ratio of the costs of internal and external non-compliance (QC_n) to the total cost of quality (QC_c). These indicators can be considered borderline. Due to certain criteria, they divide the states into favourable and unfavourable (Hamrol, 2012).

The four areas highlighted in Fig. 1 show four possible situations and at the same time indicate the possibility of improving economic effects (Hamrol, 2012):

- Area A – can be considered neutral, and in certain cases as optimal. Pro-quality activities should focus primarily on quality control in such a way as to maintain the existing relationships.
- Area B – shows a situation in which the total quality costs are relatively low, but in relation to them, the costs of non-compliance are high. In some cases, this is acceptable, provided that the ratio of the costs of non-compliance to the revenues of the entire organization is acceptable. Usually, however, in such a situation it is advisable to take actions that will lead to the improvement of the design quality of both the product and implementation processes.
- Area C – in this case the non-compliance costs are relatively low, but it is also associated with relatively high total quality costs. Improvement actions may consist in consideration of, and possible implementation of, improvements to the existing control methods.
- Area D – indicates a greatly unfavourable situation. If the value of the I_{QP} and I_{NQ} indicators indicate this area, it means that although the quality costs are relatively high, it does not result in the correspondingly low costs of non-compliance. In such a case, it is necessary to introduce radical remedial actions.

Depending on the industry in which the company operates, the relationship between quality costs and sales revenues may have different proportions. In Table 1, the exemplary relationships of quality costs and sales revenues depending on the nature of the industry are presented.

Table 1
Percentage share of quality costs depending on the sector

The nature of the industry	Percentage ratio of total quality costs to sales receipts
Simple production with low accuracy	0.5–2
Normal mechanical technology	1–5
Precision industry	2–10
Complex electronic products	5–25

(Source: Hamrol, 2012, p. 510).

Table 1 clearly shows the fact that the higher the manufacturing accuracy and the more precise the products, the higher the ratio of total quality costs to sales revenues (Naidu, 2008).

In the analysis of quality costs, it is also important to calculate indicators that show the relationships of individual groups of quality costs in relation to the total quality costs. The best value of these indicators for a given organization depends on a specific situation, e.g. the maturity of the management system and the industry. It can be assumed that if an enterprise is competitive and is at the forefront of its industry, it can be based on the values of the relationships presented in Table 2.

The above-described method of calculating individual indicators and analyzing the relationships that occur between individual groups of quality costs and the total quality costs, and between quality costs and the indicators of the company's financial evaluation are of great importance in the context of conducting quality cost analysis (Tsai, 1998). They provide valuable

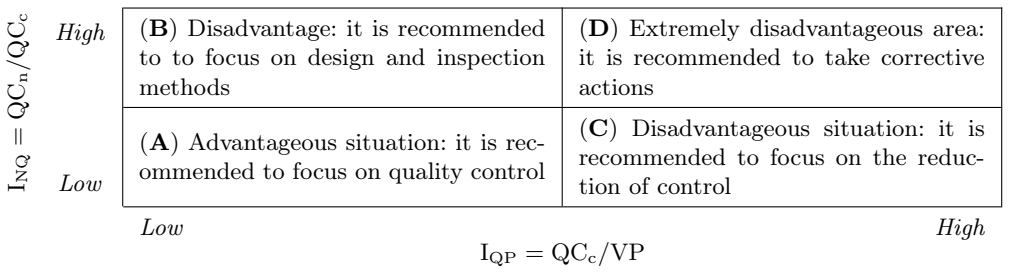

Fig. 1. Possible relationships between cost indicators (Source: A. Hamrol, Quality management with examples, Wydawnictwo Naukowe PWN, Warsaw, 2012, p. 509).

Table 2
A generic breakdown of quality costs

Cost category	Percentage of total quality costs
Internal costs of non-compliance	25–40
External costs of non-compliance	10–40
Assessment costs	10–50
Assurance costs	0.5–5

(Source: Hamrol, 2012).

information on an organization's quality management system and should be periodically presented to senior management in order to improve the quality management system (Chiadamrong, 2003). To this end, it is necessary to prepare periodical reports using specific methods and tools for visualization and data presentation.

Quality costs account in the medical company

The case study presents a design of a quality cost accounting system and cyclical data presentation to senior management in order to improve the quality management system and demonstrate how changes affect economic results. Running such a system makes it possible to estimate and check whether the costs associated with achieving and maintaining a certain level of quality over a longer period of time bring benefits in an economic sense, i.e. savings. The quality cost accounting system will also allow assessment of the effectiveness and efficiency of the quality management system in the enterprise by means of specific and reliable numbers. Due to the fact that the quality cost analysis also indicates weaknesses of the quality management system, it can be used to improve it by planning continuous improvement actions.

To calculate the relationship between individual quality cost groups and total quality costs, it is necessary to calculate the value of each cost group in a given area in a specific time period. To achieve the goal, methods such as a report, a managerial dashboard, and organizational tools such as Pareto analysis and a Microsoft Excel spreadsheet (sheet) should be used.

The research was conducted in one of the branches of an international concern operating in the medical industry. The company produces over 6,000 designs of medical tools with world-class quality parameters. In addition, the company is a distributor of a wide range of medical tools. The management system is based on the ISO 13485 standard "Medical devices – Quality management systems – Requirements for regulatory purposes". These requirements can be used by organizations to design and develop, manufacture, install and service medical devices, and to design, develop, and provide related services.

The fact that the analyzed company is a manufacturer of medical devices means that the quality requirements set by customers, legal requirements and those imposed by the company itself, provide for the achievement of all properties ensuring patient safety when used by a doctor for surgical and diagnostic procedures, if the product has influence on it. The quality requirements are specified both in national and international standards, in legal provisions and, moreover, in internal quality regulations. To facilitate their fulfilment, the company has implemented the Integrated Management System, which applies to all employees. Integrated Management System includes management processes, operational processes and supporting processes. Management processes include strategy and management, as well as measurement, analysis and improvement. The operational processes include innovation management, warehouse supply, order management, and product return. Supporting processes include processes such as human resource management, resource management, marketing communication, environment, health protection and work safety.

A diligent quality cost accounting can provide managerial staff with valuable information on a company's quality management system (Khataie & Bulgak, 2013). Its implementation in an enterprise is time-consuming and requires the involvement of not only the quality engineer who carries it out, but also managers, production masters, foremen and leaders. Joint involvement of all of the above-mentioned people is essential and can bring tangible benefits to the organization. This article presents how, step by step, the system for quality cost analysis was implemented at the chosen production department (PR department) in medical company.

In the case of the PR department, the value of each cost group are calculated:

- compliance costs: assurance costs and assessment costs,
- non-compliance costs: internal costs and external costs of non-compliance,

for three organizational units: ZPD1, ZPD2, ZPD3. For this purpose, a Microsoft Excel sheet for quality cost analysis was created, which contains the following sheets:

- *Data*,
- *Account_ QC_ year*,
- *Financial_ indices_ QC_ year*,

for the entire PR department and individual ZPD1, ZPD2, ZPD3 units. There is a record of quality costs in the data sheet. *Data* in this register are entered manually by a quality assurance employee. The *Account_ QC_ year* sheet contains calculations of indicators of individual quality cost groups in relation to the total quality costs. The *Financial_ indices_ QC_ year* tab shows calculations of total groups of quality costs in relation to financial indicators. Fig. 2 shows sample items to demonstrate how the file is structured.

In this file, in the tab labelled "Data", there is a record of quality costs. Data in this register are entered manually by the quality assurance employee. In the Account_QC_year sheet, formulas were used that retrieve the data entered into the register and automatically calculate and update the values of individual quality cost groups in the entire PR department and in individual organizational units. Thus, they convert the percentage share of individual quality cost groups in the entire PR department and separately for each cell in relation to the total quality costs in the PR department and in individual cells, determining the indexes W_{k1}, W_{k2}, W_{k3}, W_{k4}. The results of these calculations are presented in Table 3.

The indicators calculated in Table 3 present the following relations:

- W_{k1} – Assurance costs/Quality costs;
- W_{k2} – Assessment costs/Quality costs;
- W_{k3} – Costs of internal non-conformities/Quality costs;
- W_{k4} – Costs of external non-conformities/Quality costs.

Information on which value of these indicators is the best can be taken from the literature, but it should be taken into account that in some cases these values are too general and universal, and therefore should be adapted to a specific situation. This is why in the case of a company that produces medical devices that affect the health and life of patients, as well as the safety of users (i.e. doctors), the value of these indicators was determined based on historical data. In individual groups and areas of quality costs, an average value was determined, not taking into account the extreme values. On this basis, the following values were determined for individual groups of quality costs:

W_{k1} – Assurance costs/Quality costs:

- $25\% > W_{k1} > 15\%$ – analysis of the legitimacy of exceeding the set value of the indicator;
- $W_{k1} > 25\%$ – analysis + possible implementation of activities.

This means that if the value of the indicator exceeds 15%, but is less than 25%, it is necessary to check what is causing it and whether it is justified. In this case, the file has a conditional formatting tool that highlights the cell light blue. Such a procedure is aimed at drawing the recipient's attention and analyzing a given situation. If the indicator is greater than 25%, the cell will be highlighted in dark blue. In this case, the user should analyze the situation and consider whether the increase in quality assurance expenditure was justified and necessary, and whether it is possible to implement any measures that will result in a lower level of this indicator. However, it should be remembered that the costs incurred on quality assurance, especially in a company that produces medical devices, is not a negative phenomena, especially if the expenditure on quality assurance reduces the remaining cost groups.

W_{k2} – Assessment costs/Quality costs:

- $75\% > W_{k2} > 65\%$ – analysis of the validity of exceeding the set value;
- $W_{k2} > 75\%$ – analysis + possible implementation of activities;
- $W_{k2} > 50\%$ – checking why such a small investment was spent on control.

A	B	C
Short description of the quality cost component	**Quality cost group**	**Quality cost subgroup**
in-process control of the product X	compliance costs	assessment costs
defective components supplied by the supplier	non-compliance costs	internal costs of non-compliance
repairable and non-repairable deficiencies - materials	non-compliance costs	internal costs of non-compliance
repairable and non-repairable deficiencies - other costs	non-compliance costs	internal costs of non-compliance
correction orders	non-compliance costs	internal costs of non-compliance
microbiological testing of personnel	compliance costs	assessment costs
microbiological testing of infrastructure	compliance costs	assessment costs
microbiological testing of products	compliance costs	assessment costs
particulate measurement	compliance costs	assessment costs
calibration of control and measurement equipment	compliance costs	assessment costs

Data • Account_QC_year • Financial_indices_QC_year PR ZDP1 ZPD2 ZPD3

Fig. 2. File for the analysis of quality costs at the PR department (own elaboration)

Table 3
Indicators W_{k1}, W_{k2}, W_{k3}, W_{k4} at the PR department

Quality costs	January	February	...
Quality costs of the PR department			
Cumulative Costs			
Quality costs of the ZPD1 department			
Cumulative Costs			
Quality costs of the ZPD2 department			
Cumulative Costs			
Quality costs of the ZPD3 department			
Cumulative Costs			
...			
Compliance/assurance/quality costs	January	February	...
Assurance costs of the PR department			
Cumulative Costs			
W_{k1} – Assurance costs/quality costs PR			
Assurance costs of the ZPD1 department			
Cumulative Costs			
W_{k1} – Assurance costs/quality costs ZPD1			
Assurance costs of the ZPD2 department			
Cumulative Costs			
W_{k1} – Assurance costs/quality costs ZPD2			
Assurance costs of the ZPD3 department			
Cumulative Costs			
W_{k1} – Assurance costs/quality costs ZPD3			
...			
Compliance/Assessment/Quality Costs	January	February	...
Assessment costs of the PR department			
Cumulative Costs			
W_{k2} – Assessment costs/quality costs PR			
Similarly for other units			
...			
Non-compliance/internal costs/quality costs	January	February	...
Costs of internal non-conformities of the PR department			
Cumulative Costs			
W_{k3} – Costs of internal non-conformities/quality costs PR			
Similarly for other units			
...			
Non-compliance/external costs/quality costs	January	February	...
Costs of external non-conformities of the PR department			
Cumulative Costs			
W_{k4} – Costs of external non-conformities/quality costs PR			
Similarly for other units			
...			

(Source: Own elaboration based on data from the company).

If the indicator value is in the range of 65%–75%, the cell would be highlighted in light blue. This means that a value above 75% is approaching. If this value is exceeded, it should be analyzed whether the expenditure allocated to evaluation is not too high and whether it can be reduced. Due to the fact that medical devices are produced in the PR department, a fairly large expenditure on evaluation is inevitable in order to produce the products in the required quality. Therefore, a lower limit of 50% has also been estab-

lished in this case. If the W_{k2} indicator would be below 50%, the cell would be highlighted in orange. This means that it is necessary to check why a relatively low expenditure on evaluation was incurred in a given period and whether it was justified.

W_{k3} – Costs of internal non-conformities/Quality costs:

- $30\% > W_{k3} > 20\%$ – alert level, process check, implement preventive actions,
- $W_{k3} > 30\%$ – action level, preventive/corrective actions should be implemented.

Two levels have been set for W_{k3}. If the indicator is in the range between 20%–30%, the cell in Microsoft Excel sheet will be highlighted in orange, which means an alarm level for which the process should be checked, and possible preventive actions should be considered. If the indicator level is higher than 30%, the cell will be highlighted red, which is the action level. This indicates a disturbance in the process, and that the process should be checked, and corrective and preventive actions should be implemented.

W_{k4} – Costs of external non-conformities/Quality costs:

- $15\% > W_{k4} > 5\%$ – alert level, process check, implement preventive actions,
- $W_{k4} > 15\%$ – action level, preventive/corrective actions should be implemented.

Two tiers have also been set for the W_{k4} indicator. In the range between 5%–15%, the cell in Microsoft Excel sheet will be highlighted in orange, which means an alarm level for which the process should be checked, and possible preventive actions should be considered. If the indicator level is higher than 15%, the cell will be highlighted in red, which is the action level. This indicates that the process is unstable, and should be checked, and corrective and preventive actions should be implemented. In the case of non-compliance costs, the colours orange and red were intentionally used as a warning that we are approaching a dangerous level.

Quality costs analysis at the operational level

Based on the above ranges of relations between the indicators analyzed in Table 3 in the medical company were observed different situations, for example:

- overruns were noticed for assurance costs of the first tier for ZPD1 area. This was caused by the fact that it is the largest unit that employs the largest number of employees in the PR department. Therefore, the expenditure on training these employees is certainly greater than in the case of other units.
- in the case of assessment costs it was seen that the first level was exceeded in the entire PR department and in the ZPD3 cell, as well as the second level requiring analysis and implementation of actions if the ZPD2 cell is exceeded. In the case of ZPD2, large expenditure is directed to the assessment, which is visible in the internal and external costs of non-compliance. A correct relationship can be noticed here, because there is a lot of control in this cell, but the deficiencies are excluded from the process and do not reach the customer, as evidenced by the relatively high level of costs of internal non-conformities and zero cost level of external non-conformities. However, in the case of this cell, one would thoroughly consider and check the process to determine why so many non-compliant units were produced. Perhaps too little expenditure is allocated to the costs of providing, for example, employee training or validation. In the case of the costs of external non-compliance, it is also noticeable that the alarm level is exceeded in the case of ZPD1 cell. In this case, the process should be analyzed at and implementation of preventive actions should be considered. An example of such activities may be increasing employee awareness by discussing complaints, showing photographs or complaint causes, etc.
- ZPD3 department largely contributed to the increase in the costs of external non-conformities, one month. After checking in the records in the *Data* sheet occured that the reason was a complaint from an external customer.
- In May there was a noticeable increase in quality costs in the PR department in relation to the remaining months. This was due to a significant increase in assessment costs and costs of external non-conformities. Based *Data* it can be concluded that this increase was largely present in the ZPD2 department.

The value of individual quality cost groups, cumulative cost and the value of the W_{k1}, W_{k2}, W_{k3}, W_{k4} indicators in individual areas are presented in the charts. For example the costs of quality and the cumulative cost at the PR department in the period from January to June 2020 are presented (Fig. 3).

Fig. 3 shows that the total quality costs are at a similar level in individual months, except for January and May. In January, the total cost of quality was much lower than in the remaining months. It was certainly caused by the fact that the production volume was reduced due to the Christmas and New Year break. This translated into significantly lower assess-

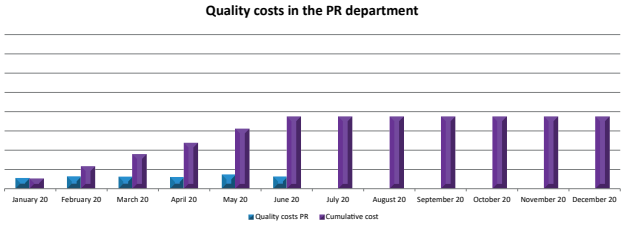

Fig. 3. Quality costs in the PR department (Source: Own elaboration)

ment costs and costs of internal non-conformities. The fact that the costs of external non-conformities are quite high is disadvantageous.

Fig. 4 shows the assurance costs in the PR department, the cumulative cost and the value of the W_{k1} ratio. There are no significant deviations for this cost group. Assurance costs are very similar from month to month.

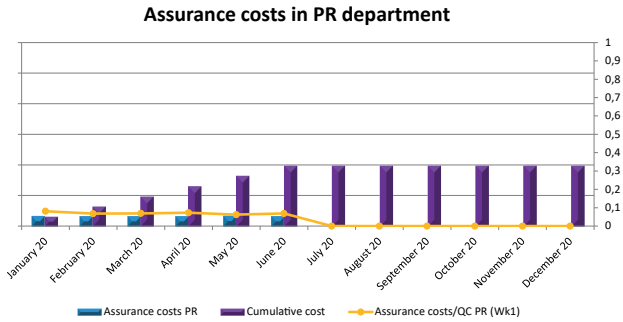

Fig. 4. Assurance costs in PR department (Source: Own elaboration)

The same graphs are automatically generated for W_{k2}, W_{k3}, W_{k4} ratios, and the the same set of data for cells ZPD1, ZPD2, ZPD3. Macros were used to efficiently move between the charts saved in sheets labelled "PR", "ZPD1", "ZPD2", "ZPD3" and the *Account_ QC_ year* sheet. By clicking the appropriate button in the *Account_ QC_ year* sheet, the charts of individual cells are easy to move between.

Quality costs analysis at the strategic level

In the medical company the following indicators are also calculated in the system for the analysis of quality costs at the PR department. They show the relationship between the total quality costs and financial indicators in individual areas:

- W_{k5} – Assurance costs/Manufacturing costs,
- W_{k6} – Quality Costs/Manufacturing Costs.

For this purpose, in the file for the analysis of quality costs, a sheet labelled *Index_ of financial_ QC_ year* has been designed. In this sheet, data such as the costs of ensuring quality and the costs of quality in individual cells are drawn automatically from the *Account_ QC_ year* sheet. The production costs are entered manually by the employee conducting the analysis at the end of a month. Manufacturing costs are obtained from controlling department. Thanks to the application of appropriate formulas, after entering these data into the sheet, the W_{k5} and W_{k6} indicators are calculated automatically. The values of these indicators also update in the charts.

Cells in which data should be entered automatically are filled in gray, while cells in which data must be entered manually are in white. The W_{k5} indicator was intentionally marked in blue and the W_{k6} indicator in maroon, because the curves in the line graphs of these indicators are in such colours. This procedure will make it easier for the user to read the data. Figure 5 shows the value of the W_{k5} and W_{k6} ratios in the entire PR department. When analyzing Fig. 5 it can be seen that the value of the W_{k5} indicator is

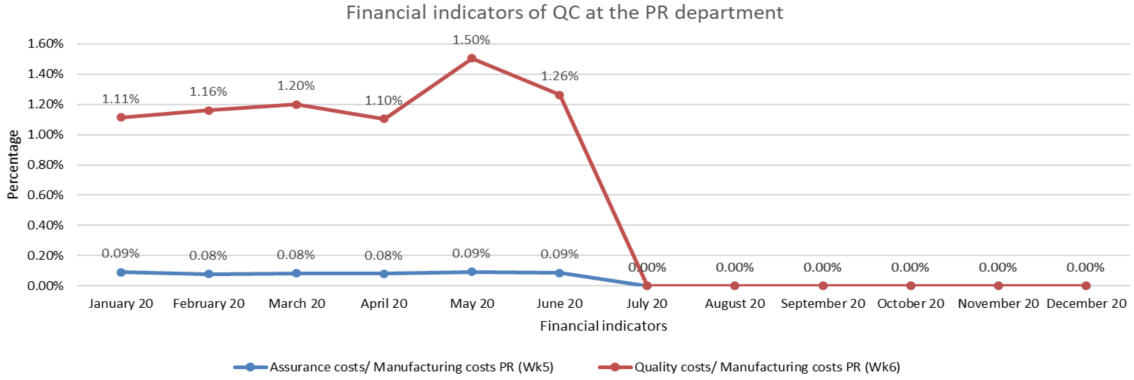

Fig. 5. Financial indicators of QC at the PR department (Source: own elaboration)

at a low and even level in the first half of 2020. The value of the W_{k5} index is between 0.08% and 0.09%. The W_{k6} index ranks between 1.11% and 1.26%. The value of this indicator is the lowest at the beginning of the year, and then it systematically grows. There is also a slight decline at the beginning of the second quarter and a rather sharp increase in May, then June saw a decline in the W_{k6} index. It was checked that the value of the W_{k6} indicator is influenced by the size and type of production in a given month.

Summary and conclusion

The theoretical part of the article describes such issues as the impact of quality on the economics of the organization, the concept of quality costs, the division of quality costs, quality cost accounting, quality cost indicators along with possible relationships that may occur between them. The characteristics of the selected company and the PR department are described in the further part of the article. System for quality cost analysis which was prepared and developed for the medical company was presented. For this purpose, a file in Microsoft Excel was created, in the sheet indicators (W_{k1}, W_{k2}, W_{k3}, W_{k4}) are calculated, showing the percentage share of individual quality cost groups in the total quality costs in individual areas. At the same time, charts are generated that show the values of individual groups of quality costs in the areas ZPD1, ZPD2 and ZPD3 and the values of the W_{k1}, W_{k2}, W_{k3}, W_{k4} indicators. Valuable data to plan and minitoring improvement projects at the operational level are delivered. An example may be the ZPD2 cell in which approximately 80% of all quality costs are generated by assessment costs. Costs of internal nonconformities account for approximately 20% of total costs. This means that the relationship between these values is correct because employees perform a lot of checks and exclude non-conforming units at the production process stage. As a result, defective products do not reach the customer, as evidenced by very low, and in most of the analyzed months, zero costs of external non-conformities. On the other hand, it is puzzling why so many non-compliant units are produced. Something negative is probably occurring in the process and it is unstable. The process should be checked, and corrective actions implemented to improve the quality of manufactured products.

The next sheet by applying appropriate formulas, calculates the indicators W_{k5} (assurance costs / manufacturing costs) and W_{k6} (quality costs/manufacturing costs) for the analyzed areas, and generates graphs at the same time. Quality costs in the context of manufacturing processes deliver data to plan and minitoring improvement projects at the strategic level. For example it can be analyzed if the costs related to achieving and maintaining a certain quality level over a longer period of time are not too high. If they are, if it is possible to introduce measures that will reduce them without having a negative impact on the quality management system, and in some cases activities that will improve the functioning of the quality management system.

The system and data collection resulted in the creation of an advanced managerial dashboard, which consists of tools for data analysis as well as visualization and presentation of data to senior management in order to improve the quality management system. This data will be periodically presented to the management in order to jointly analyze, draw conclusions and implement corrective and preventive actions in areas where such a need arises.

In addition, the managerial panel significantly improves the work of the quality assurance employee who implements and coordinates the functioning of the quality cost analysis system, which is influenced by the formulas used in the file's sheets for the quality cost analysis. Thanks to this solution, the employee conducting the analysis only enters the data manually into the records. On the basis of these data, the formulas convert the values of individual quality cost groups in individual areas and the values of individual indicators, thus generating charts. Such a solution is a great convenience for an employee who conducts a quality cost analysis and certainly has a positive impact on the effectiveness of the work performed. In summary, it should be stated that the designed system for recording quality costs at the PR department, over time and with the commitment of all employees, will certainly benefit the company. The research (Ciechan-Kujawa, 2004) shows that after introduction of the quality cost account in the enterprise, favourable changes in their structure are observed. The share of non-compliance costs is decreasing, in favour of quality assurance costs (Plewa et al., 2016). Benefits will be seen thanks to the monitoring of improvement of processes and quality management system (Dahlgaard-Park et al., 2015). More effective work will result in financial benefits, as well as external benefits such as competitiveness and providing the customer with the expected quality. Both internal and external benefits will have an impact on the prestige of the company and the trust of customers, which in the case of the production of medical devices is of utmost importance, because products produced in the PR department protect health and, in some cases, human life.

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