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QUALITY COSTS MONITORING – PILOT PROJECT IN LASSELSBERGER'S PRODUCTION PLANT

Jaroslava HYRŠLOVÁ[a], Marie BEDNAŘÍKOVÁ[b1]
and Patricie TESNEROVÁ[c]
[a]Centre for Economic Studies of the College of Economy and Management, CZ–158 00 Prague,
[b]Department of Economy and Management of Chemical and Food Industry, The University of Pardubice, CZ–532 10 Pardubice,
[c]Department of Economy and Management of Chemical and Food Industry, Institute of Chemical Technology, CZ–166 28 Prague

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The costs of quality play an important role in the management system, as they indicate the level of management in relation to quality, reveal potential possibilities for savings and help to raise the effectiveness of the decision-making in the area of quality management. The aim of this article is to present the pilot project of the quality costs monitoring system in the production plant of a company that produces ceramic tiling. The company is the largest manufacturer of ceramic tiles and paving in the Czech Republic and one of the biggest European manufacturers of tiling materials.

[1] To whom correspondence should be addressed.

Introduction

Quality costs are perceived in various ways (with regard to historical development, authors' approach and the requirements of company management). Nenadál speaks about quality costs as *financial measurements in quality management systems.* In his approach, the quality costs are *all financial resources that the supplier or customer has to spend on the processes of the securing and/or improving of the quality of its products* [1].The definition provided by Wong corresponds to this approach: *The costs of quality are all costs spent by the company to ensure that the overall concept of the product provided to the customer really meets their requirements* [2]. On the other hand, Crowley states that *the costs of quality are the difference between the current revenues and the revenues at the moment when all customers are always satisfied* [3]. The essence and importance of the monitoring of the costs of quality as a management tool (and not just quantification of value) was captured by Atkinson, who regards quality costs as *the link between quality management and financial targets and company targets* [4].

The content of quality costs — i.e. their internal structure (see, e.g., Refs [5-7]) — is also perceived differently. As a rule, the formulation of the structure of quality costs is based on the following prerequisites [3,6]:

- Low quality costs the company money, while good quality earns money for the company.
- It is usually cheaper to provide high quality products. The costs of improvement are spent only once, while the costs of the removal of insufficiencies and/or defects are spent repeatedly.
- Each flaw (defect) has its cause; these causes may be removed – flaws (defects) may be prevented. Prevention is always cheaper.
- The cost incurred by the customer may be substantially higher than the cost of the rectification of the defect; to satisfy the customer's requirements, it is not sufficient to monitor the company's costs and revenues, but the costs that the customer will have to spend on the product over its entire life cycle must be monitored as well.

In order to be able to play the role of a management tool (to provide information that supports decision-making), the cost monitoring system has to cover all substantial costs related to the quality management system in the company, the costs of internal and external defects (i.e. costs of non-quality), as well as the costs incurred by the users of the product. The system set in this way forms an important part of the quality management (and management in general). It enables the setting of an optimal quality management system, contributes towards the elimination of costs related to low quality production and helps to identify the possibilities for improvement and to optimise company activities

(processes). In order for the cost monitoring system to be of benefit for the company, significant cost items must be identified and relevant responsibilities must be defined, with the aim of using the acquired data for the improvement of individual corporate processes [3,5,8].

The company may use various models within the quality costs monitoring system (see, e.g., Ref. [1]):

- PAF (Prevention, Appraisal, Failure) model. This model focuses on the monitoring of the costs of internal defects, the costs of external defects, control costs and prevention costs.
- COPQ (Cost of Poor Quality) model. The model is based on the prerequisite that the failure to meet the requirements causes substantial economic losses to producers; the model recommends monitoring the costs of internal defects, the costs of external defects, the costs of wasted investments and environment damages (the costs incurred in relation to the non-compliance with environment protection laws and its return to the original condition; these include also the costs of the treatment of job-related illnesses etc.).
- Process costs model. The model works with the costs of compliance (i.e. real cost for the transformation of inputs into outputs in the most effective manner) and the costs of non-compliance (wasted time, material and capacities — related to the creation of non-compliances within processes).
- Lifecycle costs model. This model focuses also on the costs incurred by the user; this model makes sense only by a limited group of products with foreseen usage period of more than a year, where the costs of assembly, operation and maintenance are not negligible in comparison to the acquisition price of the product.

The quality costs monitoring system is usually implemented in the following steps [6,1,2]:

1. Appointment of team and proposition of the basic concept of the quality costs monitoring system.
2. Presentation of the concept to top management.
3. Creation of implementation plan.
4. Selection of a part of the company for the pilot project.
5. Presentation of the aim of the system to the management of the part of the company selected for the pilot project.
6. Identification of major quality costs and a proposal of their internal structure.
7. Collection of required data (available from the existing company information system).
8. Proposal of the system output format.
9. Proposals of adjustments of the information system in the company so that additional relevant data may be obtained.

10. Selection of a period for which the data will be collected and evaluated.
11. Compilation of a quality costs report (incl. assessment) and presentation of the report to the management.
12. Modification of the monitoring system and cost reporting so that it supports decision-making.
13. Implementation of the system into the entire company.
14. System maintenance (regular processing and reporting of the detected information).

The entire quality costs monitoring system is useful only if the acquired information is evaluated and used by the management to support the decision-making processes in the company.

The following text focuses on the system of quality costs monitoring in a company that produces ceramic tiles. It presents the existing method used for the monitoring of quality costs and proposals of adjustments, so that the system depicts all major cost items related to the quality and represents an effective management tool. The article presents the pilot project of costs monitoring in one of the company's production plants. The attention focuses on the identification of major quality costs, the proposal of their internal structure and collection of the required data (see steps 4-7 of the implementation process).

Quality Costs Monitoring in the Company – Current State

LASSELSBERGER is a family company owned by Austrian group LASSELSBERGER GmbH Pöchlarn, which does business in the production of ceramic tiles, as well as the mining and adaptation of raw materials and production of building materials. LASSELSBERGER is currently the largest manufacturer and supplier of ceramic tiles on the Czech market. Its products are produced and sold under two business brands: RAKO and OBJECT objektová keramika. In 2008, the company supplied over 27 mln m^2 of ceramic tiles and pavings on all markets. Almost 11.4 mln m^2 of ceramic materials were supplied to the Czech market. Europe remains the traditional export market — Germany, Austria, France, as well as the Netherlands and Scandinavian countries. The company's aim is to maximise the effort at satisfying the growing customer requirements.

The quality management system in LASSELSBERGER complies with the requirements of the ČSN EN ISO 9001:2009 norm. The company has created, documents, applies and adheres to a quality management system and is continually improving its effectiveness. The company has defined processes that secure the activities of the quality management system, defined how they are applied, and introduced their monitoring, if and where these processes may be measured and analysed.

Systematic monitoring of quality costs is non-existent in the company. Only the costs of complaints proceedings are regularly monitored and reported in the company (they are included in the Quality Information Summary). The complaints are sorted into complaints related to production flaws and complaints related to shipment, i.e. logistic complaints (shortages, product exchanges, break-ups etc.) The complaints are monitored acc. to period, plant, claim admittance, type of defect, country, warehouse (in the case of logistic complaints) and customers. The information is quantified in the amount of defects, m^2 as well as CZK. The report is discussed on management meetings.

Pilot Project of Quality Costs Monitoring System (Selected PRODUCTION PLANT)

One of the company's production plants was selected for the pilot project, in line with the progress of the implementation of the quality costs monitoring system (see above).

Characteristics of the Production Process, Quality Management and Cost Monitoring System

In order to be able to process a proposal for the monitoring of quality costs in the selected part of the company, we had to become acquainted with the production process in the plant, the methods used for quality management within production and the existing production costs monitoring system.

The production process in the plant consists of the following steps (see Fig. 1):

1. Ensuring of input raw materials and their storage.
2. Wet milling in mills – homogenisation of raw materials. From the mills, the homogenised liquid mass is drained into reservoirs, from which it is transported through pipes for further processing.
3. Drying in a spray drier. Granulate with water content of cca 5.5 % is created. This granulate is then taken from the drier into a reservoir.
4. Press moulding. The granulate is transformed into a tile. The semi-finished products are transported via conveyors from the pressing machines for further processing.
5. Preparation of engobes and glazes. Engobes and glazes are readied in a separate production step. The amount of the waste created within the preparation of the glazes is not known and/or controlled. It is estimated that the waste amounts to ca. 9.5 % of the glazes and engobes put into the mills and subsequently 5 % of the suspensions produced in the glaze preparation

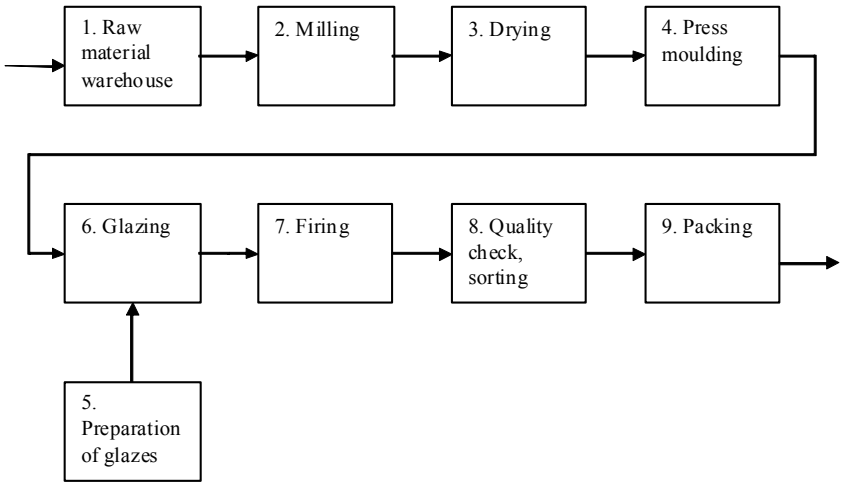

Fig.1 Production process scheme [9]

facility.

6. Glazing on glazing lines. Here the engobe, glaze and print are applied to the tile semi-finished product. All in all, the waste rate for the pressing and glazing production steps is reported to be 2 % of the total production. The production is monitored in the company in m^2 and in tons.
7. Firing in gas furnaces. The firing process takes 40-50 minutes.
8. Product control and sorting. The products are divided into three categories, which correspond to EN CSN 14411 (1^{st} class, 2^{nd} class and waste). The loss from the quality check amounts to 5 % of the total size of the surface of the production output.
9. Packing and subsequent dispatch to product warehouse.

The non-existence of waste in the classic sense of the word is a specific feature of ceramic production. All non-quality (defective) products (semi-finished or finished products) are recycled and put back into the first production phase.

The entire production process is monitored through 18 checkpoints (locations), where the product parameters are monitored and recorded and low-quality (defective) products are excluded. The nineteenth checkpoint (location) is the company laboratory. The location of the checkpoints within the production process and their functions are depicted in Fig. 2 and Tables I-III.

The monitoring of the flow of the material through the production is currently done through ERP (Enterprise Resource Planning) within the SAP system. According to the existing corporate management accounting system, the production is divided into three cost centres (see Fig. 3):

- Mass (raw materials) preparation – includes raw material warehouse, milling and drying;
- Glaze preparation and
- Production – includes pressing, glazing, firing, quality check and sorting and packing.

Table I Checkpoints – input control [9]

Operation	Checkpoint	No.	Value	Performed by
Plastic raw materials	Raw materials warehouse	1	Chemical analysis	Company laboratory
			Moisture	Company laboratory
			Firing shrinking	
			Absorbability	
Non-plastic raw materials	Raw materials warehouse	2	Chemical analysis	Company laboratory
			pH	Plant laboratory
Frita	Glaze warehouse	3	Look	Company laboratory
			Microscope	
			Alkali	
			Leaches	
Colouring devices	Colouring devices warehouse	4	Look	Company laboratory
Glaze	Glaze warehouse	5	Dilatation Chemical analysis	Company laboratory

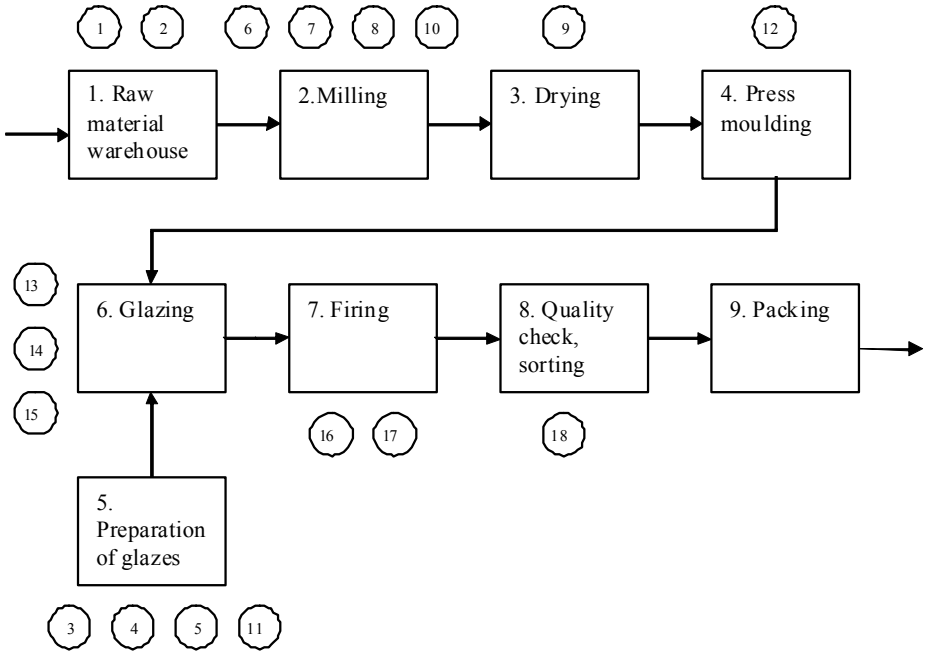

Fig. 2 Checkpoints (locations) within the production process [9]

Table II Checkpoints – interoperational check [9]

Operation	Checkpoint	No.	Value	Performed by
Preparation of masses	Raw material shot	6	Weight	Device operator
	Calcite management	7	Litre weight	Device operator
	Preparation of masses	8	Sieve residue	Shift foreman, mate
			Litre weight	
	Spray dryer (SD)	9	Chemical analysis	Company laboratory
			Moisture / SD	SD operator
			Moisture / shot	SD operator
Glaze preparation	Raw material shot	10	Weight	Mill operator
	Glaze operating laboratory	11	Sieve residue	Plant laboratory, operator
			Litre weight	Plant laboratory
			Glazing	
			Litre weight	Paste plant operator
			Flow	Paste plant operator
			Sieve residue	Paste plant operator
	Pressing plant	12	Strength control	Device operator
			Wedge-shapedness	
			Surface and edge control	
			Dimensions	
			Rigidity	Plant laboratory
			Penetrometrics	
			Moisture of pressing / dried out pressing	
			Dimensions	

Table II – Continued

Operation	Checkpoint	No.	Value	Performed by
Glazing	Glazing plant	13	Litre weight	Glazing plant operator
			Weight of water	
			Weight of glazing	
			Weight of engobe	
			Flow	
		14	Layer	
		15	Visual control	
Firing	Oven	16	Dimensions	Device operator
			Curving	
			Look	
			Temperature curve	Operator
	Plant laboratory	17	Parameters	Plant laboratory

Table IIICheckpoints – output control [9]

Operation	Checkpoint	No.	Value	Performed by
Palette inspection	Sorting room	18	Complaints	Output control
Inspection of features	Laboratory	19	Qualities acc. to EN 176, EN 159, PZN	Company laboratory

Identification of Major Quality Costs and Proposal of Their Internal Structure

Given the nature of the production, the PAF model was selected for the monitoring of the costs; the costs are sorted in classification to prevention costs, control costs, costs of internal defects and costs of external defects. The content of individual quality costs categories (incl. the characteristics of activities falling within individual areas) is apparent from Table IV.

The system collects and registers data about individual cost categories, monitors the development of total quality costs, as well as individual cost items, in the monitored period, and compares the share of individual cost groups on total costs. The system provides information supporting decision-making, with the aim of improving production and other company processes.

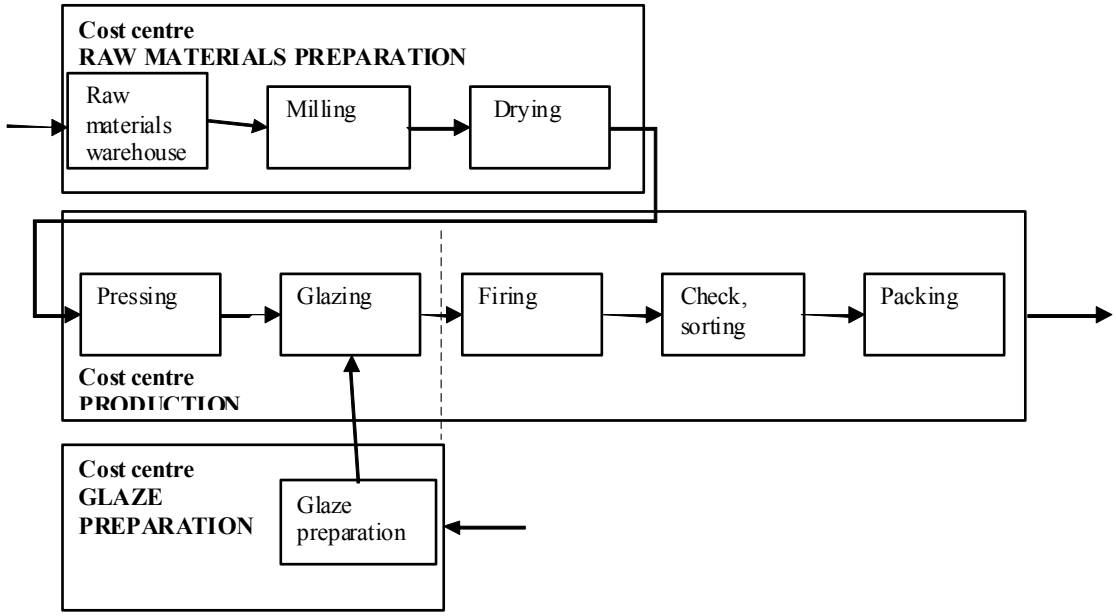

Fig. 3 Cost centres within monitored plant [10]

Table IV Quality costs structure [9]

Prevention (prevention costs)	Control (control costs)	Internal defects (costs of internal defects)	External defects (costs of external defects)
Quality information system and documentation maintenance	Input, intraoperational and output control	Irreparable rejects minus utilisable waste	Irreparable external rejects
Quality management section	Laboratory tests	Internal rejects reparable (reworking and adjustments)	External rejects reparable (reworking and adjustments)
Training and educational programs	Metrology	Deficits and damages	Damage liability
Development of new control and test methods	Expert opinions	Discounts on non-compliant products	Compliants solution
	Procurement of services from external testrooms and laboratories	Removal of irreparable defective products	Minus accepted compensations from employees, suppliers, sales agents, insurers
	Production of samples for destruction tests	Minus accepted compensations from employees, suppliers, sales agents, insurers	

Collection of Required Data

The quality costs for 2008 and 2009 were calculated within the pilot project. The main source of data was the existing management accounting system. The pilot project used also information from intracompany quality reports (information on complaints) and data from production reports.

Notes on the determination of individual cost items:

- The costs of the quality information system and the maintenance of the documentation and the costs of the quality management section were determined by an expert estimate; this is a portion of the cots of the relevant company sections that carry out the monitored activities for all production plants of the company.
- The costs of the quality management section include also the cots of the training and education programs and the costs of the development of new control and test methods.
- The costs of the input, interoperational and output control are a part of the costs of the Technologies centre. This centre carries out the technological aspects of the production preparation; it prepares, e.g., the technological documents (bills of material, work procedures) for the given production lines or the production processes, cooperates on the setting of the production equipment, tests and evaluates the production samples, cooperates on the selection and assessment of input raw materials.
- The laboratory tests are carried out in laboratories which perform this activity for all production plants in the company (they are a separate cost centre). The costs of the laboratory tests allocated to the monitored production plant were determined by estimation (acc. to the plant production/total company production volume ratio).
- The costs of laboratory tests include also the costs of metrology, expert opinions and purchased external services (external test rooms and laboratories).
- No products are produced specifically for destruction tests. Destruction tests, as well as other tests, are performed on finished products in the laboratories (the used amount is negligible). The losses on finished products due to tests are a part of the total losses of finished products and the cots of these losses are part of the cost item Irreparable rejects (see costs of internal defects).
- Certain losses are incurred in each production step of the tile production. Four types of defective products were identified within the entire production process, all of them return back into production (as input raw materials); the flows are depicted in Fig. 4 with a dashed line. Flow 1 (between the glazing and pressing processes) consists of pressed, wet and unglazed defective tiles. Flow 2 consists of defective tiles with a glaze layer. Flows 1 and 2 are created through the sorting of non-quality products on the belt, or they are tiles that

were used for the purpose of quality control. Flow 3 consists of finished fired tiles that do not comply with the rigidity parameters. Flow 4 consists of completed fired tiles that were excluded due to low quality. The costs related to these flows are classified as the so-called costs of internal defects.

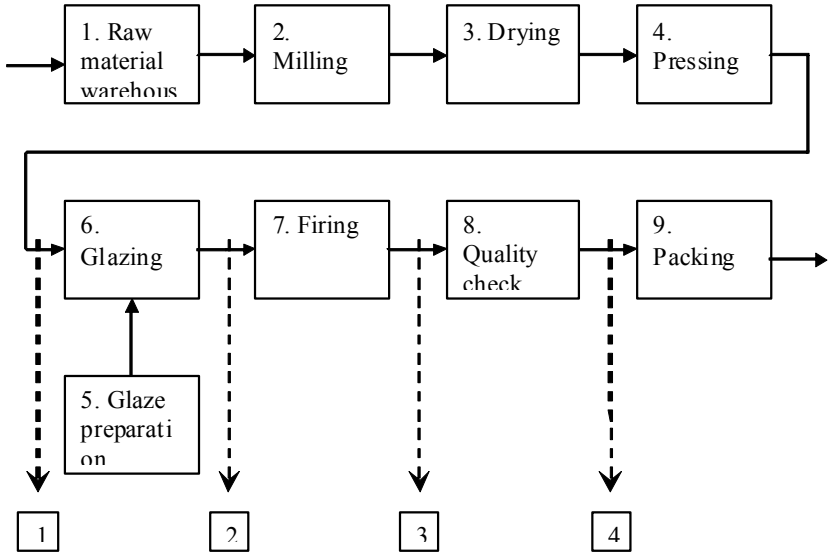

Fig. 4 Depiction of the creation of non-quality products for the purpose of calculation of the costs of internal defects [9]

- The calculation of the costs of internal defects must be based on the data from the cost centres that monitor the production process. The MFCA calculation can be used with an advantage (see Refs [10,11]). The costs of internal defects do not include the costs of the raw materials used, as non-quality products are returned back into the production process (as input raw materials).
- Deficits and damages are monitored directly in the accounting system.
- 1st and 2nd class tiles, as well as non-quality products, are created within the production of tiles (see above). As the plant's aim is to produce 1st class products, the discounts on 2nd class products are included into the costs of internal defects (2nd class products are sold for half the price of 1st class products).
- The calculations of the costs of external defects (costs related to complaints) were taken over from the intracompany quality report.

Quality Costs Calculation

Within the pilot projects, the quality costs in the selected part of the company (selected production plant) for 2008 and 2009 were calculated using the methodology described above (see Table V).

Table V Quality costs in 2008 and 2009 (in thousands of CZK)

Cost item	Year 2008	Year 2009
Prevention costs	3 091.4	2 294.8
Control costs	3 340.1	4 052.1
Costs of internal defects	76 636.5	57 342.9
Costs of external defects	556.3	522.9
Total quality costs	83 624.3	64 212.7
Production volume, mln m^2	6.6	6.1

The total quality costs dropped by almost CZK 19.4 mln between the years of 2008 and 2009; the production in the same period decreased as well, though (from 6.6 million m^2 to 6.1 million m^2 — i.e. almost by 8 %).

Figure 5 depicts the structure of quality costs in the monitored period. It is apparent from the figure that the structure of the costs has changed. The share of the costs of internal defects has decreased, while the control costs on total quality costs has increased.

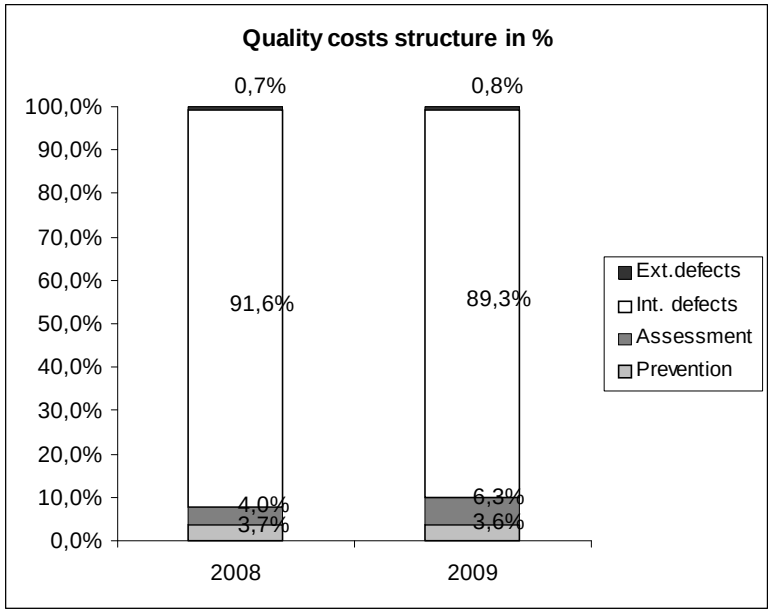

Fig. 5 Structure of quality costs in 2008 and 2009 (in %) [9]

Conclusion

The quality management system is an essential part of the management of every company. The article focused on the monitoring of quality costs, which forms an

integral part of quality management and may represent a very effective management tool.

The quality costs monitoring system in the selected Lasselsberger plant has the aim of providing information about major cost items that the company's management will be using to support its decision-making process. The proposal within the pilot project is based on the PAF model. Quality costs are sorted into prevention costs, control costs and the costs of internal and external defects. The basic source of the relevant data is the management accounting system and the ERP system. The pilot project involved the determination of the costs of quality in the 2008-2009 period. The collected data clearly indicate that the most significant cost item is the costs of internal defects, which account for ca. 90 % of all quality costs. In order to be able to cut the costs, one must focus on individual production operations (input raw materials, production recipes, tuning and setting of production equipment). The lowest cost item is the cost of external defects.

The main advantage of the quality costs monitoring system is the fact that the level of quality of company activities, products and services (incl. quality management) is quantified in monetary units. As a rule, each operation that is not carried out in appropriate quality leads to the creation of a non-quality product; the system quantifies the economic losses incurred by the company. This may contribute to a change in the perception of the errors within the company processes by the company's management, and primarily employees. Thanks to the obtained information, the places where the biggest economic losses are incurred may be identified, and, on this basis, rectifying measures may be proposed and implemented – their efficiency may be defined very precisely. The aim of the measure is to improve individual company processes, and thus also the company's economic results. The implemented measures are systemic and systematical.

For a successful implementation of the quality costs monitoring system, the system must be supported by the company's top management, the implementation must be handled by a professional interdisciplinary team, the system must gradually be expanded to the entire company and, in many cases, adjustments to the company's information system are required. It should also be noted that the system in itself does not solve the problems with the quality, does not offer specific solution and does not eliminate the company's costs.

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