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# Applicable quality management tools in a production cycle of a selected company

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**Abstract**

The paper deals with quality control in a Czech manufacturing company, especially at its quality department. The objective is to define the identified production failures, using selected quality management tools, and to determine the causes of technological problems. The following methods and tools were used: cause and effect analysis—Fishbone diagrams (Ishikawa diagrams); Pareto charts, flowcharts and others methods, whose results have been visually displayed. Based on a detail analysis of the production failures, the proposal to eliminate them as well as a draft implementation of the corrective action and its effect on enhancing quality in the production company are presented. The elements such as frequency of controls, adherence to regular inspections and replacement of filters in air conditioning units, cleaning and compliance with the work rules were monitored, as these elements have an impact on product quality and customer satisfaction. The implementation of the corrective actions and the related financial estimate are presented.

**Keywords**: Quality, production process, quality management tools, quality management, implementation, Pareto diagrams, cause and effect diagrams, safety.

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## 1. Introduction

Quality and monitoring quality in the manufacturing sector represent one of the main factors of economic growth of companies that aim at improving manufacturing processes. These become more effective with decreasing costs and increasing productivity. The subject of quality management affects virtually all corporate processes. Companies base quality management mainly on standards and norms or on the total quality management (TQM). The attitude to quality management differs for manufacturing companies and those that provide services. The quality management system (QMS) makes use of complex methods, analytical techniques, standards and norms. Using these tools hinders negative phenomena over time such as incompatibility of products, errors and risk or excessive costs.

Since customers do not tolerate the above-mentioned negative phenomena, producers should not do so either. A customer (purchaser) seeks to be satisfied with the product while the producer aims at higher productivity. Another aspect of the negative phenomena may include low quality that could jeopardise human lives (health). This means dangerous products (as regulated by the Directive 2001/95/EC of the European Parliament and of the Council, 2002) that should not enter the market at all.

For this reason, it is desirable to be constantly improving production flows and eliminating errors and imperfections of production to make customers satisfied. Companies with functional system of quality management reach considerably better results in the long run, which can manifest itself by, e.g., more effective processes, reduction in costs and increased productivity.

The person responsible for quality management and coordination in companies is Quality Manager.

In the manufacturing sector, it is the customer who determines standards and specifications of a product, focusing on the quality of the processes (during the manufacturing process) as well as other parameters (e.g., speed of delivery, etc.).

## 2. Objective

The author of the paper aims to point at the importance of quality management in the manufacturing sector. Using carefully selected tools of quality management, they define production shortcomings (specific defects) that they have identified within the selected company and formulate their findings concerning the causes of the technological problems.

## 3. Methodology

The aim of the research is to use quality management tools to define the production shortcomings (specific defects) that have been identified; and formulate findings concerning the causes of the technological problems. For the research, the following tools—methods have been used: the cause and effect diagram, i.e., the Ishikawa diagram, the Pareto chart, development diagrams and other methods. The use of these tools is demonstrated on a specific example depicted in the results and discussion section. On the basis of a thorough analysis of the productions defects (flaws), measures have been suggested to eliminate these.

### *3.1. Material and methods*

#### *3.1.1. Input material*

- Legislation and standards (dealing with quality control, safety, etc.): EN ISO 9001 (ISO 9001:2001) QMSs; ISO 14001 Environmental Management System
- The thesis (Mrtva, 2015)

- Quality department: Optical Components Coating Department: the department deals with coating of optical components (production company XY)
- Overview of the most common defects: defects that exceeded the limit of 3% of the total number of products over the corresponding period)
- Statistics of the most common defects over individual periods: statistics for 2012, 2013, 2014 and 2015

### *3.2. Methods*

#### *3.2.1. Methods used*

- Pareto diagram
- Fishbone diagram—the cause and effect diagram

## 4. Theoretical Foundations

Quality and responsible attitude to it originate from philosophy. Another point of view in the current industrial economic times is based on experience (of manufacturing processes) on real work and also, on increasing demand of customers for quality of a product, goods or other.

The term quality is defined by the currently valid CSN EN ISO 9001:2016 (01 0321) standard of QMSs—Requirements, or more specifically, by the ISO 9001:2015 QMSs—Requirements. The standard specifies requirements expected of the QMS that companies can use for internal application, certification or contractual purposes with suppliers and customers, when meeting regulatory requirements, and for their own requirements determined to ensure effective operations of all processes and continuous improvement of QMS. The requirements of the standard are applicable to any organisation irrespective of its type, size, products or the services they provide. The international standard makes use of procedural approach and risk assessment (CSN EN ISO 9001, 2016).

Apart from the above mentioned, there are other definitions and various concepts of the term 'quality'. In a simplified way, according to Juran, quality is **fitness (convenience) for use** (Nenadal, Noskievicova, Petrikova, Plura & Tosenovsky, 2008).

Dr. Joseph Juran is the author of the so-called **Juran Trilogy of Quality** which encompasses planning, management and improvement. One of his important definitions claims that quality consists of such aspects that satisfy customers' needs. The second definition infers that quality is represented by eliminating shortcomings (Nenadal et al., 2008).

Another significant figure, Philip Crosby (1996), defines quality as conformance to the requirements of a customer. Requirements must be expressed explicitly and must be measurable.

Taguchi's concept of quality claims that any deviation from the target value represents a loss; quality is thus expressed as the loss function (Janicek & Marek, 2013). Should we simplify the concept, the quality of a product is represented by a loss caused to the society by using a product from the moment it is delivered to the buyer.

Ishikawa's concept of quality puts customer requirements and customers themselves at the forefront. It is a customer-oriented concept, where the aim is not to meet the standards but to satisfy the customer as the end-user (Bradik & Novotny, 2003).

Quality is characteristic of features defined, e.g., by Janicek and Marek (2013).

The current concept of quality management derives from three basic quality management concepts: Corporate standards, the TQM concept and the ISO concept. TQM utilises the concept of total, complex and absolute quality management based on the expressions by which it is described:

- **Total**—this includes complete involvement of all workers of an organisation.
- **Quality**—understanding quality in all its forms (customer expectations, product, service, activity, etc.).
- **Management**—this is management from strategic, tactical and operational perspectives as well as from managerial perspective (management, control, motivational tools, etc.).

The origin of the **TQM concept** dates back to the 1970s in Japan. It was considered a kind of 'philosophy of management' since its content was not closely determined by regulations or norms. Nenadal et al. (2008) interprets this as a shaping, customer-oriented and learning company aiming at complete satisfaction of customers by constantly improving the effectiveness of corporate processes.

The basic activities of quality management include planning, managing, proving and enhancing quality. These activities represent a set of processes and activities that must be conducted in harmony and in mutual coordination. Janicek and Marek (2013) claim that it is the reason why the product QMS, i.e., the QMS is used.

The system is composed of individual quality management processes that, as a unit, ensure maximum customer satisfaction concerning product quality by minimising consumption of material, technical and other sources. In a simplified way, this is a method of company management focusing on customer satisfaction (Janicek & Marek, 2013).

**The ISO concept** is of universal character since it is applicable to any company irrespective of its size or focus. The ISO 9000 standards are in principle recommendatory, defining minimum requirements that companies should aim to meet.

The basic activities of **quality management** should be mutually coordinated. This is reflected by the QMS (Janicek & Marek, 2013).

Nenadal et al. (2008) also defines activities encompassed in quality management. These include: quality planning, quality management, evidencing and enhancing quality.

**Quality assurance** has undergone significant development on the global level. Quality assurance is supported by international regulations and norms. According to Zidkova and Zvonecek (2001), the norms, on a general level, offer producers validated solutions; however, should other convenient solutions exist, these are not excluded, provided they meet the defined requirements of directives.

Quality management makes use of countless tools. These are mainly simple tools such as Ishikawa diagrams, control charts, development diagrams, histograms, Pareto diagrams, correlation diagrams, regulation diagrams and others.

### *4.1. Ishikawa diagram*

Ishikawa diagram has been known since the 1960s when it was used in Japanese companies of **Kaoru Ishikawa, Ishikawa**. The term is better known as the Fishbone diagram and has been used up to this day, serving as a suitable tool in searching for causes and effects (Figure 1).

The major contribution of the Ishikawa diagram is its application in searching for the most probable causes of problems and categorising and ranking the effects of the possible causes. Another advantage consists in the fact that the cause and effect diagrams need not necessarily deal with the negative aspects—shortcomings (defects) only, but they also allow focus on customer requirements, potential improvements (innovations), etc. (Zidkova & Zvonecek, 2001).

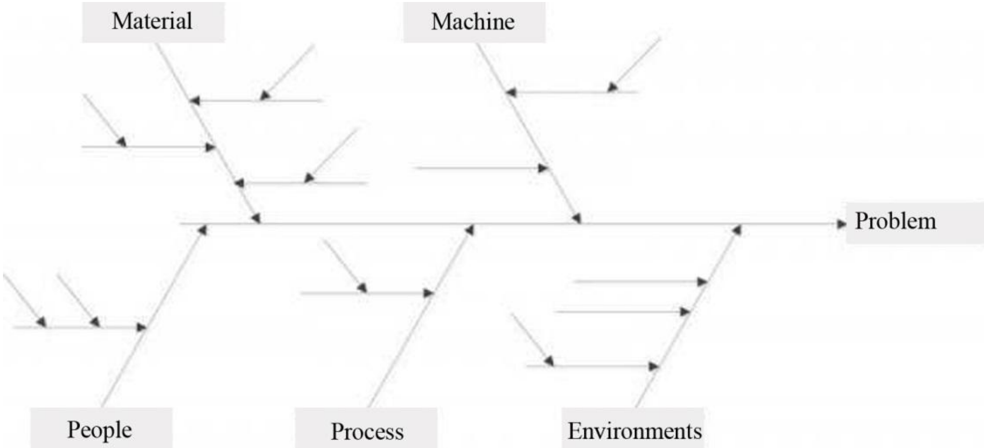


**Figure 1. Fishbone diagram model**

Source: Own processing

### *4.2. Pareto diagram*

Pareto diagram is used to control quality and identify the most crucial factors leading to the emergence of and the source of defects causing decreasing quality.

The diagram bears the name of Vilfredo Pareto, a famous Italian economist of the nineteenth century. It was him who described the asymmetry in wealth distribution amongst the inhabitants of Italy at that time; and on the basis of his observations, he constructed a mathematical model expressing the asymmetry of income and wealth distribution in all countries and at all times. He established that only a small group of people owned most of the wealth and presented a hypothesis claiming that approximately 20% of inhabitants possessed virtually 80% of all wealth (Janicek & Marek, 2013).

J. M. Juran applied Pareto principle to the area of quality management in 1941, which gave rise to the so-called Pareto principle. This states that 80% of effects is inflicted by 20% of causes.

He named the cause as 'the vital minority' (it is important that we spring to attention and focus on it) and the remaining 80% as 'the useful majority' (which does not cause serious or significant problems) (Janicek & Marek, 2013). Pareto diagram is depicted in Figure 2, where it is shown as a combination of bar and line charts.

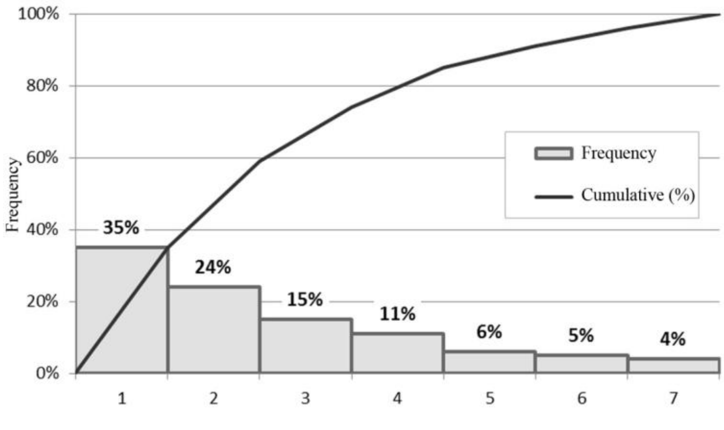


**Figure 2. Pareto diagram model**

Source: Own processing (Data: Mrtva, 2015)

The above-mentioned tools of quality management are suitable for application in the manufacturing sector, for identification of causes and effects and also for quality control and identification of the most fundamental factors concerning the origin and source of defects (flaws) that significantly impact the quality of a product.

## 5. Results and Discussion

Production company XY makes use of the following management systems (certification):

- **QMSs:** the aim is to meet customer requirements with regard to the EN ISO 9001 (satisfaction and continuous improvement of the company's products).
- **Environmental management system:** based on the ISO 14001 certification, the aim is to improve and minimise averse influences that may affect the environment (the company premises and its immediate environment).

The coating department has detected several defects that occur in optical components. Table 1 shows the most frequent defects, including frequency of defects for individual years and its percentage on overall production.

Table 1. The most frequent defects detected at the coating department—the relation of frequency of defects to the overall production of pieces produced (over 3 years)

| The most frequent defects | Frequency 2012 (*year*) | Frequency 2013 (*year*) | Frequency 2014 (*year*) | Frequency total for 3 *years* | Share in 3 years (*%*) |
|---|---|---|---|---|---|
| Compatible pieces | 1,498,129 | 1,498,129 | 1,498,129 | 4,445,059 | 68.95 |
| Defect A: coat failures | 185,957 | 169,180 | 153,037 | 508,174 | 7.88 |
| Defect B: grey beneath the coat | 110,994 | 53,161 | 47,583 | 211,738 | 3.28 |
| Defect C: smudges beneath the coat | 100,907 | 64,264 | 40,980 | 206,151 | 3.20 |
| Defect D: coat outside tolerance level | 83,568 | 53,983 | 38,544 | 176,095 | 2.73 |
| Defect E: notch—scratched beneath the coat | 67,620 | 49,154 | 29,437 | 146,211 | 2.27 |
| Defect F: total of individual minor defects | 349,015 | 233,130 | 170,818 | 752,963 | 11.68 |
| Total number of pieces | 2,396,190 | 2,143,672 | 1,906,529 | 6,446,391 | 100.00 |

Source: Own processing (Data: Mrtva, 2015)

Table 2 shows specific components with the most common defects. Eleven most common types of defects of specific components are introduced. The most common defect is the one of coat failure. Figure 3 depicts the most common defect.

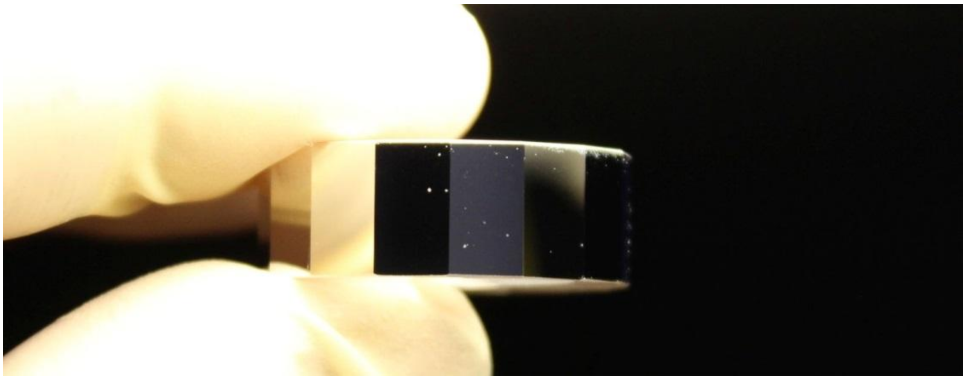

**Figure 3. Illustration: coat failure**

Source: Mrtva (2015)

Figure 4 shows the extreme coat failure.

**Figure 4. Illustration: extreme coat failure**

Source: Mrtva (2015)

Table 2. The most common defects at the coating department—specific items (in pieces)

| Defect description | Frequency 2013 (*year*) | Frequency 2014 (*year*) | Frequency 2015 (*year*) | Frequency total for 3 *years* | Share in 3 years (*%*) |
|---|---|---|---|---|---|
| Defect A: coat failures | 221 | 172 | 5 | 398 | 27.00 |
| Defect B: specks beneath the coat | 133 | 128 | 2 | 263 | 45.00 |
| Defect C: scratched through (on the coat) | 91 | 143 | 0 | 234 | 60.00 |
| Defect D: cement defects | 51 | 109 | 0 | 160 | 71.00 |
| Defect E: decementing | 49 | 55 | 2 | 106 | 78.00 |
| Defect F: scratched (damaged) | 35 | 43 | 6 | 84 | 84.00 |
| Defect G: notch beneath the coat | 13 | 25 | 4 | 42 | 87.00 |
| Defect H: scratched through (beneath the coat) | 23 | 15 | 0 | 38 | 90.00 |
| Defect I: grey beneath the coat | 25 | 4 | 0 | 29 | 91.00 |
| Defect J: unknown, other | 0 | 16 | 10 | 26 | 93.00 |
| Defect K: dust | 9 | 9 | 0 | 18 | 94.00 |
| Total number of pieces | 650 | 719 | 29 | 1398 | |

Source: Own processing (Data: Mrtva, 2015)

The values stated in Table 2 have been subsequently subjected to Pareto analysis. For the results, see Pareto diagram in Figure 5.

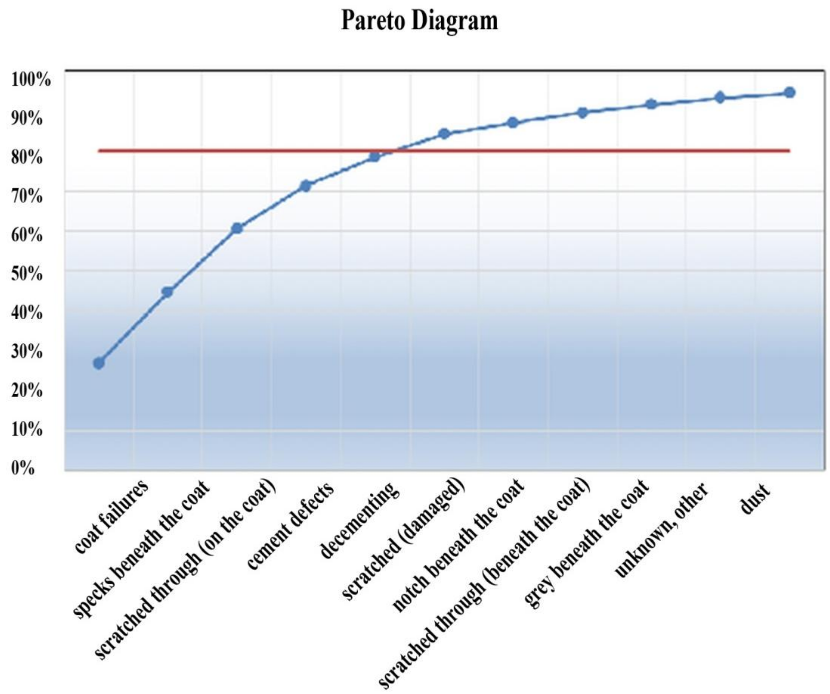


**Figure 5. Pareto diagram**

Source: own

The Fishbone diagram (Figure 6) illustrates the method of searching for the causes of inquality of coated components. It draws from a simple analytical technique of depiction and subsequent analysis of causes and effects. Figure 6 clearly shows that the causes of inquality of the coated components lie in optical components being supplied to the coating department in a substandard condition, i.e., not clean, cleaned imperfectly, etc.

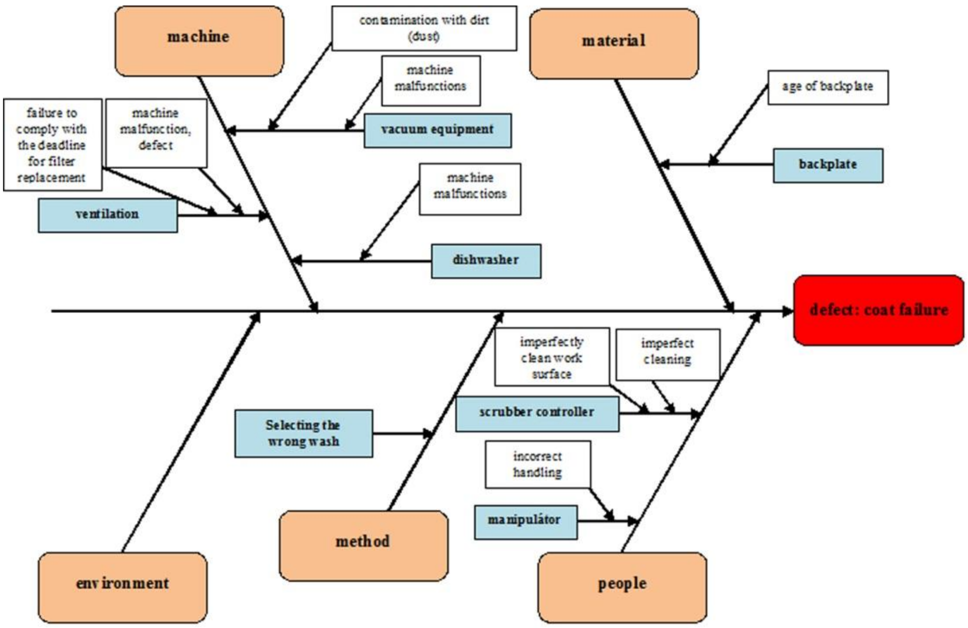


**Figure 6. Fishbone diagram**

Source: own

### 5.1. Results of the findings

When conducting the tests, it was established that the existing ultrasound washing line that cleans the cemented components off impurities had been overloaded. The cause of the overload lies in continuous operation of the line, which leads to non-maintenance of the water-wash medium. This leads to the instability in the washing results (Mrtva, 2015).

#### 5.1.1. Proposal to eliminate the defects: coat failure (frequency of defects 7.88%)

To ensure that production continuity is not disrupted, which would result in delay in delivery to customers, **measure no. 1** has been proposed to eliminate the defect: **Developing facilitative environment and purchasing a new ultrasound washing line** (dishwasher). Table 3 shows the estimated cost of the purchase of a new washing line.

Table 3. Investment: proposed measure no. 1

| Proposed measure no. 1.: Activities planned | Estimated price (*CZK*) | Estimated price (*EUR*) |
|---|---|---|
| Purchase of a new ultrasound water dishwasher—the Durr Group | 6,500,000.00 | 240,741.00 |
| Water treatment | 1,500,000.00 | 55,556.00 |
| Production of washing frames and other agents | 200,000.00 | 7,407.00 |
| Premises required and their adjustment | 800,000.00 | 29,630.00 |
| Estimated investment total | 9,000,000.00 | 333,333.00 |

Source: Own processing (Data: Mrtva, 2015)

The implementation of this measure is rather costly from the processional perspective and unfeasible in the current time horizon. Company XY can, however, implements the measure in the longer run.

#### 5.1.2. Measure no. 2: Coating in cemented condition

It is easier to manipulate and clean individual components. This proposal requires a change in the manufacturing process [in the succession of processes: 1) Cementing and 2) Coating]. In addition, it is desirable to enlarge the bevel on the diverging lens which can prevent decementation of components. When changing the manufacturing process, this used to occur with cemented components.

To examine the feasibility of implementating measure no. 2, a test, i.e., coating in cemented condition, was conducted. For this (see Table 4).

Table 4. Coating in cemented form: proposed measure no. 2

| Proposed measure no. 2: newly selected procedure | The number of components (*pieces*) | Conversion to % (*%*) |
|---|---|---|
| Components without defects (complying with quality) | 106 | 86.00 |
| Components with a defect (repairable) | 17 | 14.00 |
| The number of monitored elements in total | 123 | 100.00 |

Source: Own processing (Data: Mrtva, 2015)

The implementation of the proposed measure no. 2 does not require significant financial means that would need to be invested to change the production process.

On the basis of the data gathered and the detailed analysis conducted, specific ways of improving the yield rate of a specific component by eliminating the cause of the most common defect affecting the quality of the product itself have been proposed. The above-mentioned proposals of quality improvement (by eliminating the most common defect) will subsequently be consulted with representatives of the XY production company team.

## Acknowledgements

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## References

Bradik, J. & Novotny, R. (2003). *Rizeni a zabezpecovani jakosti* (1st ed.). Brno, Czech Republic: VUT.

Crosby, P. B. (1996). *Philip Crosby's reflections on quality: 295 inspirations from the world's foremost quality guru*. New York, NY: McGraw-Hill.

*CSN EN ISO 9001 (01 0321): systemy managementu kvality—Pozadavky: idt ISO 9001:2015*. (2016). Praha, Czech Republic: Urad pro technickou normalizaci, metrologii a statni zkusebnictvi.

Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001, on general product safety. (2002). *Official Journal of the European Communities,* pp. L11/4–L11/17.

Janicek, P. & Marek J. (2013). *Expertni inzenyrstvi v systemovem pojeti* (1st ed.). Praha, Czech Republic: Expert (Grada).

*Komentovane vydani navrhu norem ISO/DIS 9000:2000, ISO/DIS 9001:2000, ISO/DIS 9004:2000*. (2000). (Preklad I. Petrasova). Praha, Czech Republic: Cesky normalizacni institut.

Mrtva, M. (2015). *Rizeni kvality ve vyrobnim cyklu v souladu s jakostni politikou firmy* (Unpublished dissertation). Expert Engineering Department, Mendel University in Brno, Czech Republic.

Nenadal, J., Noskievicova, D., Petrikova, R., Plura, J. & Tosenovsky, J. (2008). *Moderni management jakosti: principy, postupy, metody* (1st ed.). Praha, Czech Republic: Management Press.

Zidkova, H. & Zvonecek, F. (2001). *Jakost—styl zivota pro treti tisicileti* (1st ed.). Plzen, Czech Republic: Zapadoceska univerzita.