Management Systems in Production Engineering

2014, No 4 (16), pp 162-167

DOI 10.12914/MSPE-04-04-2014

AN ANALYSIS OF THE CAUSES OF PRODUCT DEFECTS USING QUALITY MANAGEMENT TOOLS

Katarzyna MIDOR
Silesian University of Technology

Abstract:
To stay or strengthen its position on the market, a modern business needs to follow the principles of quality control in its actions. Especially important is the Zero Defects concept developed by Philip Crosby, which means flawless production. The concept consists in preventing the occurrence of defects and flaws in all production stages. To achieve that, we must, among other things, make use of quality management tools. This article presents an analysis of the reasons for the return of damaged or faulty goods in the automotive industry by means of quality management tools such as the Ishikawa diagram and Pareto analysis, which allow us to identify the causes of product defectiveness. Based on the results, preventive measures have been proposed. The actions presented in this article and the results of the analysis prove the effectiveness of the aforementioned quality management tools.

Key words*: quality management tools, Ishikawa's diagram, Pareto's analysis of product defectiveness*

INTRODUCTION

The modern concept of quality management is, similarly to the concept of quality, based on the consumer, which makes it necessary to run a number of operations in the company [1]. Managers use various techniques, from planning to delivering the product to the customer, in order to improve effectiveness. Many improvement tools and methods are utilised in practice and literature of quality management [2,3]. A great majority of quality management instruments relies on continuous improvement, which results from Deming's cycle. Deming's cycle suggests that one should always look for the causes of arising problems so that all elements of the production system and actions connected with them become more and more effective [4,5]. Completion of tasks and achieving the company's goals require having at one's disposal the resources which enable controlling the quality of a product in all the stages of its existence [6,7].

In everyday functioning, manufacturing companies come across various types of defects in their products. It is important that the cause of a defect be identified at the moment of its occurrence and preventive measures be taken afterwards. Using the right tools, such as Ishikawa diagram and Pareto analysis allows us to properly identify defects and then organize them in a way that enables isolating the most significant ones, which need to be eliminated first as they can generate the biggest losses for the company. These tools make it possible to identify the causes and significance of a defect [2,8].

The analysis of the causes of product defectiveness in this article will be conducted in a company operating in the automotive industry located in the Silesian Voivodeship. The said company is a part of a worldwide concern, one of the biggest manufacturers and distributors of traction control systems and emission control systems. The factory deals with the production of hydraulic shock absorbers and suspension system modules used in cars of leading brands.

USING THE PARETO-LORENZ ANALYSIS TO IDENTIFY THE MAIN CAUSES OF DAMAGED AND FAULTY GOODS' RETURN

The analysis of the causes of customers' complaints has been carried out for the period from January of 2011 to July of 2013. The analysis was started by gathering the data about the number of items sold and the number of returns in the analysed period. Unofficial returns include internal returns, ones that were detected in the company when e.g. sorting the products, and logistical returns (e.g. bad packaging). The data shows that in 2011, non-conforming products accounted for 0.19% of all goods produced; in 2012 the number was 0.6% and in 2013 – 0.05%. We observe, therefore, a downward trend, but we have to take into account that the data from 2013 was only gathered up till July. Next, the returns were divided into: returns of items under warranty, returns directly from the customer's factory (0km), internal returns and non-conforming items detected during the sorting process. The distribution of the returns by number of items is shown in Table 1. Please, note that one return can consist of more than one item.

It should also be added that the number of items sold in respective years was:

- 2011 – 3177844 items,
- 2012 – 4091531 items,
- 2013 (January – July) – 2531905 items.

Table 1
Number of returned items in the studied period

Year	Returns: No. of items					
	Under warranty	0km	After sorting	Internal returns	Official returns	Unofficial returns
2011	292	4592	351	917	36	6176
2012	12	2303	8	11	39	2295
2013 January-July	8	1196	-	-	27	1177

Source: [own study based on 9]

Table 2
The number of returned items in the studied period

Type of return	Number of returns/year		
	2011	2012	2013
Noise	35	36	16
Oil leakage	26	25	6
Badly installed component	4	3	1
Damaged component	3	4	1
Invalid component	6	3	4
Lack of a component	3	4	2
NOK parameters	6	5	3
NOK diameters	8	8	3
Illegible sticker	2	2	3
Lack of a sticker	5	2	3
Logistical returns	6	7	2
Other	4	5	2
Sum of all returns	108	104	46

Source: [own study based on 9]

In the next stage the returns were analysed in terms of number and type of their causes. Such a compilation is shown in Table 2. The analysis of the data included in Table 2 indicates that there were 108 returns in 2011, 104 in 2012 and 46 such returns were reported in the first half of 2013. The largest number of returns in the analysed period concerned noise and oil leakage issues. The fewest returns, on the other hand, were related to a badly installed component and an illegible sticker or lack thereof. Logistical returns include defects such as: incomplete packaging, invalid packaging, invalid references, damaged packaging, wrong marking of the case. There are relatively few such returns, but they comprise the most items, hence the high number of returns directly from the factory (marked as 0km; Table 1). These returns are usually unofficial and solved by sending amended stickers/etiquettes to the customer.

In order to better visualise the most common returns, which have the biggest impact on the quality of the products, a Pareto-Lorenz analysis was carried out. The analysis was conducted based on the data contained in Table 2. The results of the calculations were presented in Table 3.

The Pareto analysis clearly indicates that returns connected with noise and oil leakage have the largest share in the overall number of returns.

THE CAUSE ANALYSIS OF NOISE AND OIL LEAKAGE ISSUES IN THE ANALYSED PRODUCT USING THE ISHIKAWA DIAGRAM

The results obtained using Pareto analysis indicate that noise and oil leakage are the most significant causes of returns. In 2011 and 2012 they accounted for 56% and in 2013 47% of all returns. This situation calls for a more thorough analysis of the causes of these defects. The first items subjected to laboratory analysis were the ones which had been rejected in the production process or returned by the customer due to noise and leakage. The laboratory analysis revealed that the cause of the aforementioned defects were various impurities, which, depending on the location, caused the defects in question. Impurities causing noise problems are usually found under the valve disc, while the ones causing oil leakage - under the gasket, causing lack of tightness.

In order to precisely determine the reasons for the occurrence of the defects being discussed, an Ishikawa diagram was developed for each defect separately. In both cases 6 groups were defined: man, environment, method, material, impurities, machine. Next, elements which might possibly cause the problem were defined for each group. A visualization of the Ishikawa diagram has been presented in Figure 1 for noise problems, and in Figure 2 for oil leakage.

Table 3
The Pareto-Lorenz analysis of the returned items in the studied period

Type of return	Number of occurrences of the defect in the studied period (January 2011-July 2013)	Percentage of the defect in the overall number of returns (%)	Cumulative percentage of the defect in the overall number of returns (%)
Noise	87	33.72	33.72
Oil leakage	57	22.09	55.81
NOK diameters	19	7.36	63.17
Logistical returns	15	5.81	68.98
NOK parameters	14	5.43	74.41
Invalid component	13	5.04	79.45
Other	11	4.26	83.71
Lack of a sticker	10	3.88	87.59
Lack of a component	9	3.48	91.07
Badly installed component	8	3.1	94.17
Damaged component	8	3.1	97.27
Illegible sticker	7	2.73	100
Sum of all returns	258		

Source: [own study based on 9]

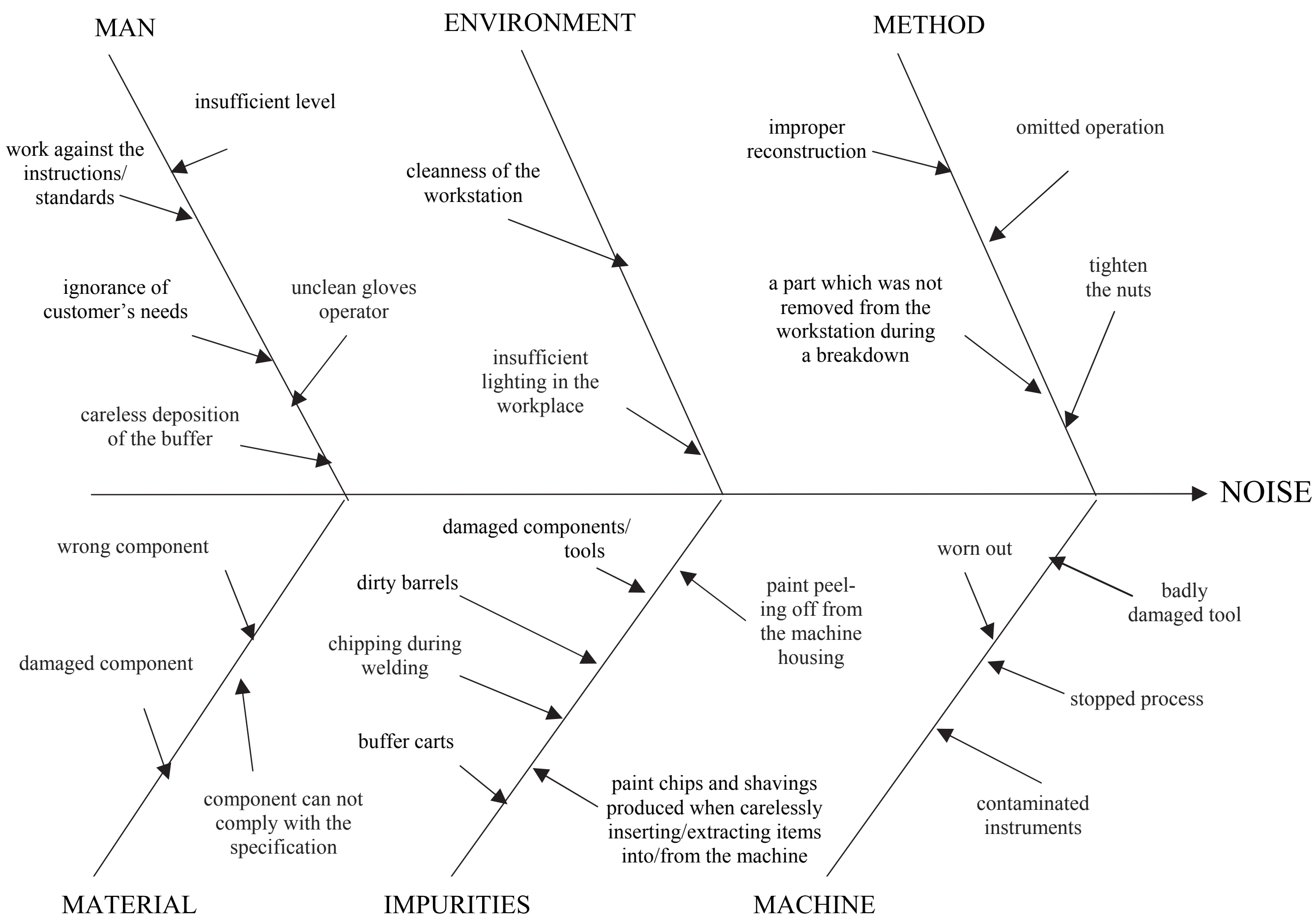

Fig. 1 Ishikawa diagram for the defect: noise

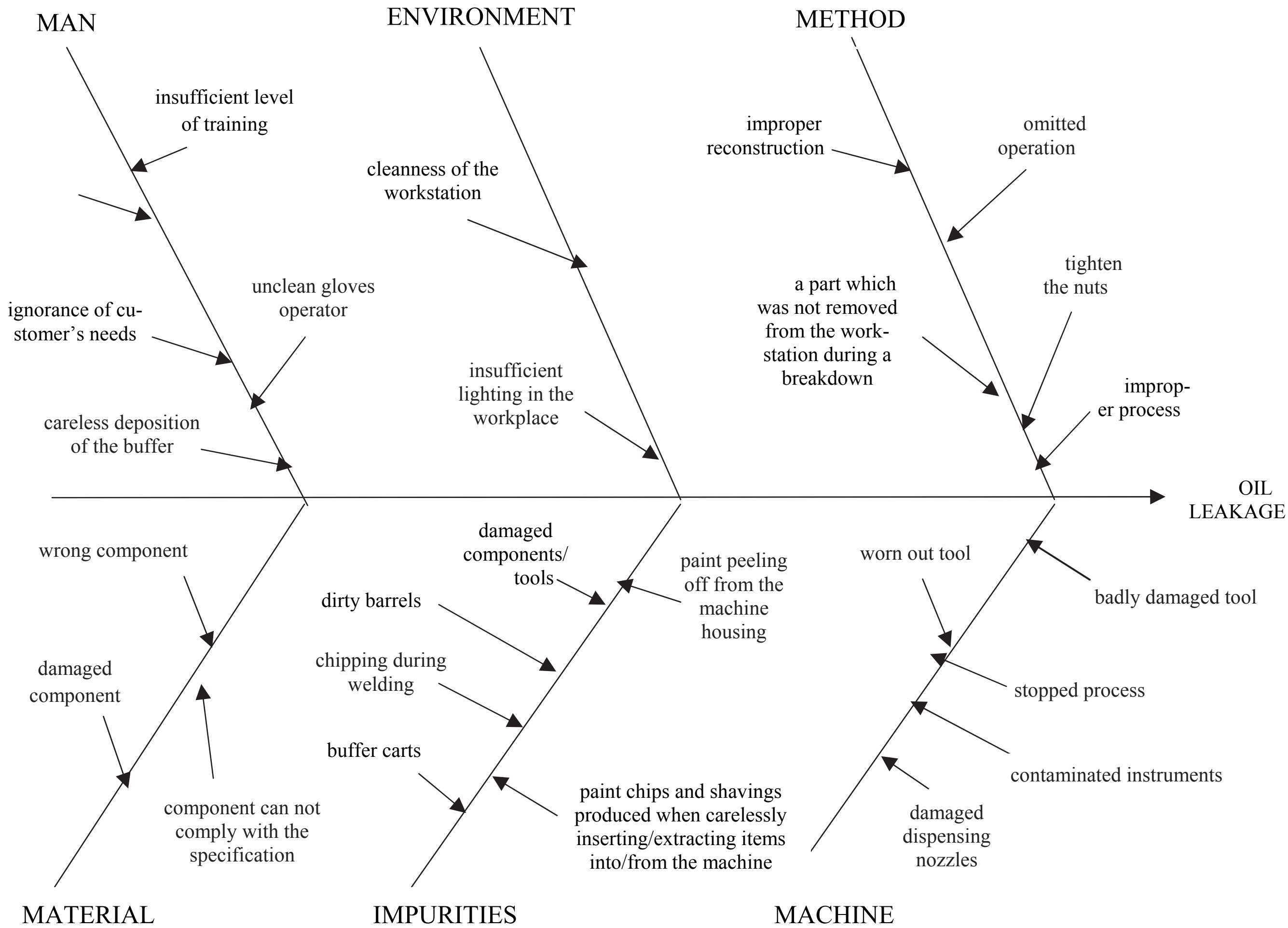

Fig. 2 Ishikawa diagram for the defect: oil leakage

Table 4
The Pareto-Lorenz analysis for the noise defect

Group	Number of occurrences in the studied period	Percentage of the group I n the sum of all groups (%)	Cumulative percentage of the group in the sum of all groups (%)
Impurities	52	59.77	59.77
Machine	9	10.35	70.12
Method	8	9.19	79.31
Material	8	9.19	88.5
Man	5	5.75	94.25
Environment	5	5.75	100
Sum:	87	100	

Source: [own study based on 9]

In the „man" group have been identified such causes as: work against the instructions/standards, insufficient level of training, ignorance of customer's needs. The main cause in the "environment" group is the cleanness of the workstation while in the group "method" the identified causes include: improper reconstruction and a part which was not removed from the workstation during a breakdown. For the "oil leakage" defect, an additional cause – improper process parameters - has been observed. With both defects, the largest number of causes has been identified in the "impurities" group, such as: damaged components/tools, paint chips and shavings produced when carelessly inserting/extracting items into/from the machine; paint chips coming from the metal base/receptacle/cover of the machine; dirty barrels and buffer carts. Pareto analysis was used for the analysed defects to single out the group which had the biggest impact on the examined issues. The results of the analysis for the noise defect are presented in Table 4 and for the oil leakage defect - in Table 5. The analysis has been carried out on a sample of 87 returns due to the noise defect and 57 returns due to oil leakage.

The Pareto analysis indicated that the type of impurity had the biggest impact on the occurrence of a defect, so further action was taken in order to determine what type of impurities posed the biggest threat. The company monitored the impurities in returned or discarded items since January 2013.The analysis was carried out on a sample of 166 items, in which 271 various impurities were detected. The data was subjected to Pareto analysis, the results of which have been presented in Table 6.

Table 5
The Pareto-Lorenz analysis for the oil leakage defect

Group	Number of occurrences in the studied period	Percentage of the group in the sum of all groups (%)	Cumulative percentage of the group in the sum of all groups (%)
Impurities	29	50.88	50.88
Machine	10	17.54	68.42
Method	8	14.04	82.46
Material	5	8.77	91.23
Man	3	5.26	96.49
Environment	2	3.51	100
Sum:	57	100	

Source: [own study based on 9]

Table 6
The Pareto-Lorenz analysis of the type of impurities

Type of impurity	Number of occurrences	Number of occurrences (%)	Cumulative percentage of impurities (%)
Paint chips	123	45	45
Metal particles	101	37	82
Other	25	9	91
Fibre	11	4	95
Paper	7	3	98
Foil	4	2	100
Sum:	271	100	

Source: [own study based on 9]

Analysing the data from the table we can see that the impurities present in the factory are: paint chips, metal particles, fibre, paper, foil and other, including hair, nail polish, etc. Paint chips and metal particles are the most common impurities. Paint chips can appear due to careless insertion of items into the machine (bumping the item against the socket of the machine or the positioning pin) and improper placement of the item inside the machine (the proper position is: vertically to the socket. Metal particles are generated when internal components are carelessly inserted into the external tube, during the process of clamping the valve and as shavings produced when tightening the nuts.

PROPOSAL OF PREVENTIVE MEASURES AGAINST THE DEFECTS OF NOISE AND OIL LEAKAGE CAUSED BY IMPURITIES

Taking into account the results of the analyses conducted using quality management tools such as the Ishikawa diagram and Pareto analysis, measures were taken in order to eliminate the causes of defects in the analysed product. The research conducted has clearly indicated that impurities which get into the product during the assembly process are the major cause of returns. Therefore, the following improvements have been proposed:

- polyurethane cover of the machine,
- polyurethane sockets of the machine,
- polyurethane upper tools of the machine,
- polyurethane tests,
- plastic packaging for all components has been introduced,
- updated 5S instructions,
- training has been conducted in order to raise the staff's awareness regarding cleanness of the workspace.

The proposed actions have been implemented in the factory and resulted in a significant decrease in the number of returns connected with the noise and oil leakage defects.

REFERENCES:

[1] J. Łunarski. *Zarządzanie jakością. Standardy i zasady*. Warszawa: Wydawnictwo Naukowo-Techniczne, 2008.

[2] B. Skotnicka-Zasadzień, W. Biały. „Analiza możliwości wykorzystania narzędzia Pareto-Lorenza do oceny awaryjności urządzeń górniczych." Maintenance and Reliability - *Eksploatacja i Niezawodnosc* no. 3, pp. 51-55, 2011.

[3] M. Zasadzień. "The analysis of work performance ability of maintenance workers as exemplified of an enterprise of automobile industry." *Scientific Journals Maritime University of Szczecin*, no. 24, pp. 119-124, 2011.

[4] R. Kraszewski. *Nowoczesne koncepcje zarządzania jakością*. Toruń, 2006.

[5] M. Molenda. "Rating of quality management in selected industrial companies." *Scientific Journals Maritime University of Szczecin,* no. 27, pp. 105-111, 2011.

[6] A. Hamrol, W. Mantura. *Zarządzanie jakością. Teoria i praktyka.* Warszawa - Poznań: Państwowe Wydawnictwo Naukowe, 1999.

[7] W. Prussak. *Zarządzanie jakością. Wybrane elementy.* Poznań: Wydawnictwo Politechniki Poznańskiej, 2006.

[8] M. J. Ligarski. "Problem identification method in certified quality management systems." *Quality & Quantity*, no. 46, p. 315-321, 2012.

[9] E. Puszer. „Wykorzystanie narzędzi zarządzania jakością w zakresie analizy niezgodności wyrobu w przedsiębiorstwie przemysłowym". M.A. thesis, Silesian University of Technology, Poland, 2014.

dr inż. Katarzyna Midor
Silesian University of Technology
Faculty of Organisation and Management
Institute of Production Engineering
ul. Roosevelta 26, 41-800 Zabrze, POLAND
e-mail: katarzyna.midor@polsl.pl

Artykuł w polskiej wersji językowej dostępny na stronie internetowej czasopisma.

The article in Polish language version available on the website of the journal