QUALITY MANAGEMENT AND PRACTISES IN AUTOMOTIVE PARTS PRODUCTION

Prof. Mitreva E. PhD.[1], M.Sc. Zdravkovska L.[1], Prof. Taskov N.PhD.[1], Prof. Metodijeski D. PhD[1], Gjorshevski H.[2]
Faculty of Tourism and Business Logistics - University "Goce Delcev" - Stip, Macedonia,[1]
Faculty of Computer Science and Engineering - UKIM, Skopje, Macedonia[2]

elizabeta.mitreva@ugd.edu.mk

Abstract: *This paper comprises an analysis of an automotive industry company in order to identify whether it has an effective quality assurance system, by monitoring the manner business processes are managed (identification, documentation and control) and whether system efficiency documentation has been developed. The application of different standards/systems for: quality, environment, employee health and safety, corporative social responsibility, food products safety, etc., requires new manager proactive management style and system orientation, as well as reengineering of business processes. However, for successful operation, it is not enough to develop a system that will provide designed quality, but also the costs to implement business processes are significant. In this paper, by applying the Pareto method for detection of points where most defects occur, the Ishikawa approach which reveals the causes of errors, checklists, as well as the Quick Response Quick Control methodologies; 8D (Eight disciplines); PFMEA, the business processes for procurement of raw and repro materials was optimized. The obtained results show that the implementation of these methodologies to optimize business processes leads to the defined quality and better productivity at the lowest costs in operation.*

Keywords: OPTIMIZATION, QUALITY SYSTEM, PARETO ANALYSIS, ISHIKAWA APPROACH, QUICK RESPONSE QUICK CONTROL (QRQC), 8D METHOD, PFMEA METHOD

1. Introduction

The success of the application of the TQM (Total Quality Management) strategy depends on the managers choosing a methodology supported by a variety of methods and techniques. A lot of organizational and technical factors affect the selection and application, so depending on the design, i.e. the organizational structuring of the quality system, classification of the faultless operation methods and techniques may be proposed.

A great number of scientists [1] stress that the development of quality methods and techniques began with the emergence of the first elements of statistical theory in the field of inspection, and several different techniques and quality tools have been developed so far. They cite the example of the famous company Lucas Engineering & Systems, where three of the thirteen key principles for the development, implementation and success of the concept of a total quality management constitute methods and techniques for quality control related principles, which confirms their important role. They cite the example of the famous company Lucas Engineering & Systems, where three of the thirteen key principles for development, implementation and success of the total quality management concept is composed of principles related to the methods and techniques for quality control, which indicates their important role.

The advantage of the application of the quality control methods and techniques in companies can be traced in the following:

- raising the level of quality in all business processes of the organization;
- reduction of all types of costs;
- reduction of product price;
- creating trust with customers/users;
- increasing the knowledge of employees.

In this way, staff motivation and productivity increase, markets expand. Based on the analysis conducted in companies dealing with metalwork business activity in the UK [2], a conclusion was reached that the biggest reasons why companies do not use quality methods and techniques is ignorance and inexperience in applying such methods and techniques. They recommend overcoming these barriers by using the quality methods and techniques and their adequacy in application.

The stability and predictability of the production process can be established through statistical process control [3-5]. In addition, all variations can range in defined intervals, i.e. within toleration limits. If the process is a series of cases and conditions and a series of stages where the expected input value is expected to give the requested output with the least possible variations in such output, then we can say that the process is stable [6].

Not only education, but for [7] statistical process control, the strategy to reduce variability is also significant, as part of TQM strategy to permanently improve quality [8].

The statistical methods for quality control [5] are useful and are applied in many functions of the quality system, especially the critical areas where it is necessary to improve and optimize business processes.

Although much of the statistical methods and techniques are used in manufacturing companies, they have wide application in the servicing business activities as well [9].

They help decide which data are important and how to get the maximum information from them in order to avoid inconsistencies, analysis of current problems etc. [10].

The statistical concept of quality management is characterized by four main principles:

- the results of any process are variable, they scatter and obey some of the distribution laws;
- errors are always possible and always present;
- data is always collected and based on them, corrective action is undertaken;
- data must be presented with defined origin, the manner of their acquisition, so they can be used in the right direction.

The scientists [6], based on their study in 83 Swedish companies emphasized the benefits of the use of statistical process control:

- achieving low cost of quality and reduce of losses;
- improving business processes and products;
- better understanding of the processes;
- ability to control processes;
- quality assurance.

2. Research Methods and Analysis of Results

The design and implementation of the TQM system in the automotive industry is based on several pillars, one of them being internal standardization. The Standard Operating Procedures (SOPs) are intended to define the flow of all activities for each process and based on that to define the obligations and responsibilities of each employee. The aim of these standards is to unify the quality of work of all participants in one operation or process. When creating a SOP, the knowledge of all professionals is embedded, as well as their experience and ability to rationalize the processes. Thus, on the one hand, the wealth of the company is created, while on the other hand, independence of each new employee from the experience of the old ones is built [11].

The standard operating procedure serves as an instruction that allows employees to act without requesting guidelines, and also, the

company can rely on its employees because everything is documented and their performance can easily be measured. At the same time, the standard operating procedure must be accepted and adopted by all employees, as well as by the ones preparing it or the manager in charge. After the completion of the training, the employees should declare whether they have understood and whether they accept the standard operational procedure. For instance, figure 1 shows a block diagram of the standard operating procedure for the business process - supply of raw materials by monitoring suppliers' delivery schedule depending on the demand of finished products by customers.

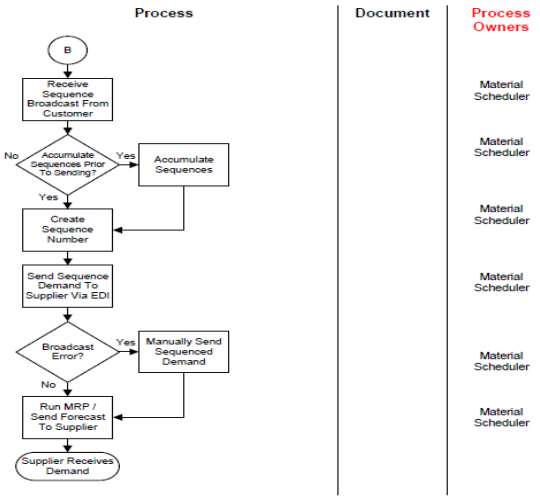


Fig. 1 *Block diagram of the standard operating procedure for the business process - supply of raw materials for production of automotive parts*

The application of internal standardization improves staff's responsibility in the implementation of business processes. The application of TQM system methodology means designing a good documented quality system that covers all business processes of the company and is the necessary basis for successful application of SPC (statistical process control) and efficient teamwork, which could not otherwise be set in case of a poor quality system.

The tendency of the company's providers is to get an exactly on time, a specification and time schedule for delivery of raw materials in order to be able to undertake all the necessary prerequisites for Just in Time.

The Pareto chart has been applied in the analysis of data regarding the frequency of problems in the process of delivery of raw materials and intermediate goods. In the last three months, the number of problems that arise in the production of circuit boards has increased, for which the Pareto chart was applied to determine the frequency of problems. The product line has a control station that records all manufactured products with defects on checklists, Figure 2.

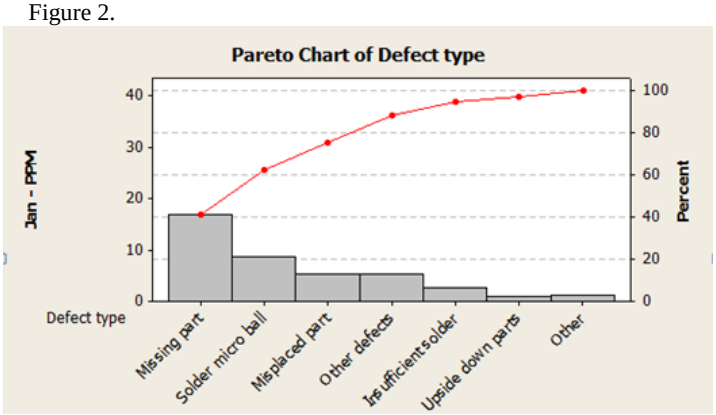
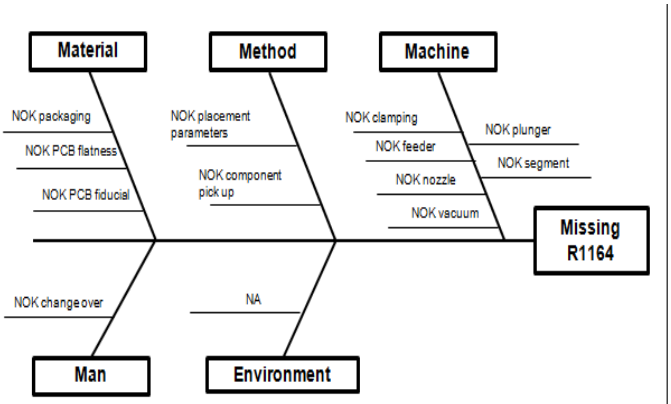


Fig. 2 *Pareto diagram to determine the frequency of defects that occur during the production of circuit boards*

Using this method, it has been found that the biggest problem arise due to lack of component. In order to determine the possible reasons for defects, the Ishikawa diagram was used, which helped establish the real causes, Figure 3. Possible causes of the problem are as follows:

- Quality of material. It shall be checked if the packaging is good, if the boards are flat and if the checkpoints are properly set;
- Applied methods. It shall be checked whether the component setting parameters are well set, as well as the components taking;
- Accuracy of machinery. It shall be checked whether all aspects of the machine associated with the setting of components are in order;
- Training of employees. It shall be checked if the human factor is the cause of the defect.



Possible root cause	What to check	Status	Comment
NOK packaging	Check component fixation in the coil	OK	
NOK PCB flatness	Check PCB flatness	NOK	NOK after 1st reflow
NOK PCB fiducial	Fiducials shape, dimensions and color	OK	
NOK placement parameters	Check component shape definition	OK	
NOK component pick up	Check pick up	OK	
NOK clamping	Check clamping mechanism visually	OK	
NOK feeder	Check feeder	OK	
NOK nozzle	Check nozzle type & conditio	OK	
NOK vacuum	Measure vacuum	OK	
NOK plunger	Check plunger condition	OK	
NOK segment	Check segment condition	OK	
NOK change over	Check all actions defined in JSU for Pick & Place	OK	

Fig. 3 *Ishikawa diagram to determine the causes of defects in the automotive industry*

The Ishikawa diagram helped determine the cause of the error, which is that the circuit board is not flat and in the process of production, it is not possible to set the required components. The source of defects is the poor quality of the incoming raw material supplied by the supplier.

The checklist is a method for assessing the stability of the process. If the analysis of the checklist shows that the process is stable, then no adjustments or changes to the parameter control process are necessary. In addition, process data may be used to predict the future performance of the process. If the diagram shows that the observed process is not under control, the analysis of the checklist can help determine the sources of variation. A process that is stable, but is outside the desired range, should be bettered. The checklist is used to measure the diameter of the electronic circuit board holes. The measurements are performed by the very machine performing these activities. The data from the machine are analyzed by the responsible process engineers and based on these data, the checklist is prepared. In case there are any deviations from the standard or if measurements show that the diameter is close to the upper or lower limit, then the source of variation is checked in order to prevent the process from getting out of control, Figure 4.

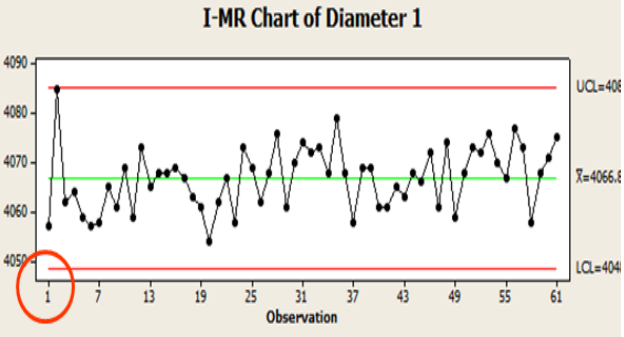


Fig. 4 *Checklist prepared as part of the analysis of the project to improve the quality of products in the automotive industry*

The results of this checklist show that in one interval, the diameter of the holes is at the upper limit, which is an indication that the process may get out of control and that there is a need for corrective measures. The application of the Quick Response Quality Control (QRQC) methodology is aimed at quick resolution of the products' quality/poor quality and quality control problems. This method of quick response to quality problems was introduced in Europe and France in the automotive industry since the early 2000s. Based on facts, the QRQC technique enables quick solution of problems in the workplace involving employees who are directly performers of work. This method is used in the reality of the problem place, and thus wasting time in meetings is avoided.

The company applied the QRQC methodology as soon as the problem of the production line arose, the problem being wrong polarity of the assembled components –microprocessor. The expert team included representatives from the Department of Quality and Production who first detected the problem. The number of defective products was detected and the reasons were found. In this case, it was established that the defect occurs due to the fact that the components holders were not properly set as a result of damaging of the certain machine set. Corrective measures were taken in view of withdrawal of all machine broken parts, as well as complete control of the products, as to protect the client from receiving any defective products. The establishment of the reasons did not stop here. The 5-Way method was applied to detect the cause of problems. The activities that followed were proposing corrective measures that should be taken to avoid the same or similar problem in future. Finally, what followed was control after the application of the corrective measures.

The application of 8D (eight disciplines) methodology created by Ford to help company teams deal with quality control and safety issues at work; to find appropriate and sustainable solutions to problems; and to prevent recurrence of the problems. Although the 8D process was originally applied in manufacturing, engineering and aerospace industry, it can be useful and relevant in any industry.

The steps in the application of the Eight-D methodology in the automotive industry in Macedonia are as follows: (see Fig. 5)

- A team of competent people is formed per particular problem; in this case they are representatives of the Logistics and Quality Departments.
- The problem is described. In one component kept in the outside warehouse, an old review that is no longer used was found.
- A temporary solution is adopted. The complete discovered amount is blocked, so that it does not go into the production line.
- The root of the problem is identified. The disputable amount is not recorded anywhere, although there are separate lists of what's in the outside warehouse.
- Corrective measures are established. The Customs department which is responsible for the accuracy of the list data shall frequently check the actual situation in the outside warehouse.
- Implementation and verification of corrective measures. The corrective measures are applied in practice.
- In order to prevent the problem from recurring, the Customs Department performs frequent checks and the supplier also checks the status.
- Finally, the staff being involved in the project is congratulated and the project is finally closed.

8D Problem Analysis Report

Customer:		Date Issue Occurred:	05/10/2011
Program:		4D Due Date:	
Product:		8D Due Date:	
Issue #:		Date Issue Closed:	

1. Team Members	Champion Name	Champion Title	Champion Phone Number	Champion E-mail Address
	Additional Team Member	Title(s)	Phone Number(s)	E-mail Address(es)
2. Problem Description	Description (Describe issue in terms of what, where, when and how many)			
	Ref 1451549 with MPN: SH 3032P-02A and - Date code: 09.04.11 - Revision A qty 10 000 pcs was found in external warehouse and was not declared before			
	Impact on Customer (Identify the potential for shut down, line interruptions, yard recalls, warranty, etc...)			
	no impact on customer			
	Facilities Involved (Customer, JCI and any Suppliers)			
	Quality department and Logistics department			
3. Interim Containme	What actions were taken to immediately protect the customer and contain any suspect inventory?			
	The 10 000 pcs were blocked in jail			
	Other Product/Platform at Risk ?		Identification of certified material ?	
	Sorting Results (Time, Date, Total Number Sorted and Quantity Rejected)			
	9950 pcs were put in jail on 13/10			
	Sorted #	Defect #	Interim Containment Start Date	
	10 000	9950		
4. Root Cause	ROOT CAUSE			
	Why Made & How Verified			
	Procurment team give to Quality team the status of the pcs in external warehouse on 15/09/11, the status was not correct because Customs department did not include one shipment in the file of external warehouse inventory, it was verified when Finance department noticed one unpaid Invoice and procurement team discussed Customs department			
	Why Shipped & How Verified			
	It was shipped on 16/09/11 and was stored directly to external warehouse, it was not declared in the file of external warehouse inventory			
5. Permanent Corrective Action	ROOT CAUSE			
	Corrective Action for Why Made			
	Customs department should check more carefully the status in external warehouse			
6. Verification of Corrective Actions	Verification of Corrective Action: Has the issue been turned on and off? How? Verification through statical evidence / hypothesis testing. Verification of corrective action for each why made and why shipped is required.			
	supplier does not deliver any more the Ref 1451549 with MPN: SH 3032P-02A ; in external warehouse there is no more stock of Ref 1451549 with MPN: SH 3032P-02A ; supplier is regularly informed for the inventory in external warehouse			
	Corrective Action Owner Name	C.A. Owner Phone Number	C.A. Owner E-mail Address	Target Completion Date
	Customs department			
7. Prevention	How will this issue be avoided in the future?			
	Customs department will check the external warehouse status more often			
	Other Facilities or Platforms At Risk			
	Name	Part Number	C.A. Owner for Follow Up	Due Date
	Has the necessary documentation been updated?	Affected Document	Owner for Update	Date
8. Closure	Closure Statement			

Fig. 5 *Application of 8D methodology in the automotive industry*

Process Failure Mode Effects Analysis Methodology (PFMEA) is used by organizations, business units, or cross - functional teams to identify and assess any process weaknesses. PFMEA helps determine what the impact of a given failure will be on a certain

process and prioritizes actions in order to mitigate risk. FMEA analysis starts before the beginning of the process (or product) and is maintained and modified if necessary throughout the entire process (product) life cycle.

The steps in the application of PFMEA methodology in the automotive industry in Macedonia are as follows: (Fig. 6)

- A cross-functional team is formed out of the process holders and the personnel supporting the production and a team leader is appointed.
- The team leader defines the scope, goals and time schedule for completion of the PFMEA project.
- The team creates a detailed process map.
- The team assesses the severity, frequency and probability of detection of error for each step of the process.
- Based on the RPN value, the necessary corrective actions are identified for each step of the process.
- Corrective measures are proposed.
- The team - leader periodically checks the status of corrective actions and updates the PFMEA project.
- The team leader monitors changes in the process, changes in design, as well as other critical changes and updates of the RFMEA project.
- The team leader organizes periodical meetings to review the realization of the RFMEA project (quarterly review could be an option).

The shown PFMEA analysis (Fig. 6) has been conducted in order to identify possible errors that could occur in the production of circuit boards in the automotive industry, not after, but before they occur, and it focuses on increasing customer satisfaction. The application of PFMEA analysis is aimed at improving the quality of products and it is used as a preventive measure.

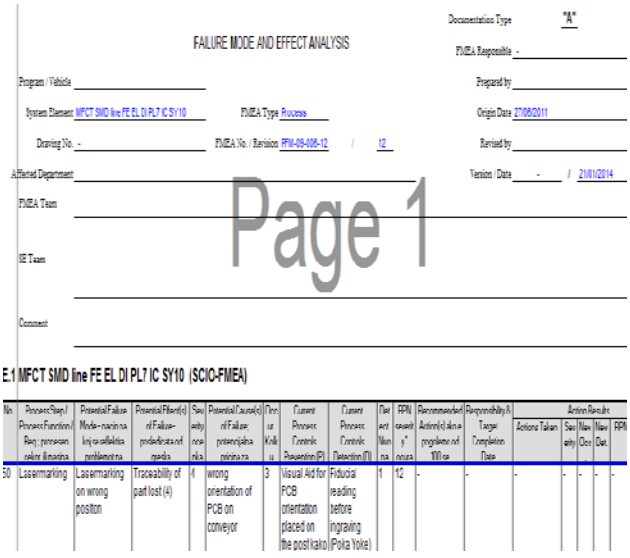


Fig. 6 *Application of PFMEA methodology in the manufacturing process of circuit boards in the automotive industry*

The shown PFMEA analysis has been conducted by the engineers in charge for launching new products before starting with serial production.

3. Conclusion

The application of the cost optimization methodologies showed that they are very important for the management as they enable achieving the defined quality, with the smallest number of defects and loss expenses.

These methods and techniques for the faultless operation in the automotive industry enabled achieving the defined quality, protection of buyers/consumers from defective products, thereby increasing the company's competitiveness, profitability, improve quality, reduce defects and costs in operation, increase satisfaction and participation of employees in decision-making. This indicates the universal application of these methodologies in practice, regardless of industry the companies belong to. The application of these methods helps establish effective control processes to achieve the defined quality at the lowest cost of operation.

References

[1] V. Stoiljković, R. Uzunović, V. Majstorović, Q-tools, CIM College, The Faculty of Engineering Nis, 1996, www.CIMCollege.co.yu/QMS.

[2] S. A. Sohal, H. M. Abed, Z. A. Keller, Quality assurance: Status, structure and activities in manufacturing sector in the United Kingdom, Quality Forum, vol. 16, no. 1, pp. 38-49, 1990.

[3] J. M. Juran, Japanese and Western quality: A contrast in methods and results, Management Review, vol. 67, no. 11, pp. 27-45 1978.

[4] G. Taguchi, D. Clausing, Robust quality. Harvard Business Review, vol. 64, no.4, pp. 65-75, 1983.

[5] E. W. Deming, Kako izaći iz krize, PS Grmeč, Beograd, 1996, pp. 30.

[6] Stenberg, M. Deleryd, Implementation of statistical process control and process capability studies: requirements or free will?, Total Quality Management, vol. 10, no. 4 and 5, pp. 439-446, 1999.

[7] G. K. Kanji, An innovative approach to make ISO 9000 standards more effective, Total Quality Management, vol. 9, no. 1, pp. 67-78, 1998b.

[8] J. S. Oakland, Total quality management –Text with cases, 2nd edition, Butterworth Heinemann, 2000.

[9] M. Xie, T. N. Goh, Statistical techniques for quality, The TQM Magazine, vol. 11, no.4, pp. 238-241, 1999.

[10] S.L. Ahire, D.Y. Golhar, & M.A. Waller, Development and validation of TQM implementation construct, Decision Sciences, vol.27, pp. 23-56, 1996.

[11] E. Mitreva, "The superior customer's value of the new economy implemented within Macedonian companies." International Journal for Quality Research vol. 7, no. 2 pp. 215-220, 2013.

[12] S. Arsovski,"Menagement of quality ekonomic", Kragujevac, 2002.

[13] E. Mitreva, N. Taskov, V. Kitanov, O. Filiposki, & T. Boskov, The Need for Information System Design in Building a House of Quality. International Journal of Pure and Applied Sciences and Technology, vol. 16, no. 1, pp. 26-33, 2013.

[14] E. Mitreva, N. Taskov, & D. Barishic, Post-Sale Customer Support Methodology in the TQM System. Iliria International Review–2014/1, vol. 1, no.27, pp. 74-86, 2014.

[15] E. Mitreva, N. Taskov, and Z. Lazarovski, The need for the design and implementation of TQM system for the airport services TAV Airports Holding, Macedonia. In: 8th International Quality Conference, 23 May 2014, 8th IQC, Center for Quality, Faculty of Engineering, University of Kragujevac, 2014.

[16] E. Mitreva, N. Taskov, Nako and S. Crnkovic, Application of methodology for business process improvement in specialized diagnostic laboratory. Quality - Access to Success, vol. 15, no. 141, pp. 91-95, 2014.

[17] I. Mr Đekić, Z. Marković, "Sertification of management systems in automobile industrial–SWOT", week quality, Beograd, 2005.

[18] L. Al-Hakim, "Information Quality Management: Theory and applications", University of Southern Queensland, Australia, 2007.

[19] L. Carr, How Xerox sustains the cost of quality, Management Accounting, August, pp. 26-32, 1995.

[20] K. Ishikawa, What is total quality control? The Japanese way, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1985.

[21] M. D. Lascelles, G. B. Dale, The use of quality management techniques, Quality Forum, vol 16, no. 4, pp. 188-192, 1990.