A Literature Review of Quality Strategies and Advance Techniques in Automotive Industries

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Abstract: The automotive industry has always been an example in the field of Project Management and Leadership and, of course, as far as quality is concerned. An established methodology is followed from product development through production. This paper highlights the tools and techniques of quality management approaches used by companies in Automobile Industry in their endeavours to match global standards. In this paper, an attempt has been made to implement the some statistical process control (SPC) techniques in the industry that is offering its customers the widest and latest range of sealing solutions for various applications in the automotive industry. The power of SPC lies in the ability to examine a process and the sources of variation in that process, using tools that give weightage to objective analysis over subjective opinions and that allow the strength of each source to be determined numerically.

Keywords: Automotive, Project Management, Quality standards, Quality tools, Statistical process control.

1. Introduction

Total Quality Management, TQM, is a method by which management and employees can become involved in the continuous improvement of the production. of goods and services. It is a combination of quality and management tools aimed at increasing business and reducing losses due to wasteful practices. Some of the companies who have implemented TQM include Ford Motor Company, Motorola and Toyota Motor Company.

Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. Under SPC, a process behaves predictably to produce as much conforming product as possible with the least possible waste. While SPC has been applied most frequently to controlling manufacturing lines, it applies equally well to any process with a measurable output. Key tools in SPC are control charts and cause & effect diagrams, focused on continuous improvement. Variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer. In mass-manufacturing, the quality of the finished article was traditionally achieved through post manufacturing inspection of the product; accepting or rejecting each article (or samples from a production lot) based on how well it met its design specifications. In contrast, Statistical Process Control uses statistical tools to observe the performance of the production process in order to predict significant deviations that may later result in rejected product.

Two kinds of variation occur in all manufacturing processes: both these types of process variation cause subsequent variation in the final product. The first is known as natural or common cause of variation and consists of the variation inherent in the process as it is designed. Common cause of variation may include variations in temperature, properties of raw materials, strength of an electrical current etc. The second kind of variation is known as special cause of variation, or assignable cause of variation, and happens less frequently than the first. With sufficient investigation, a specific cause, such as abnormal raw material or incorrect set-up parameters can be found for special cause variations.

Increasing global competition over the past decade has forced automotive companies to improve quality and efficiency. Using the management tools that are relevant to the organization's needs has become a strategic issue for companies in today's competitive environment. Competition in Automotive Sector requires the manufacturers and their suppliers to innovate, improve, and increase their efficiency to meet the challenges of globalization. This force the manufacturers to maintain high quality standards in their manufacturing process under strong competitive pressure. Low Labour cost, availability of raw materials, and the emerging automobile market leads the foreign manufacturer to outsource the manufacturing of the automobile component to gain competitive advantage [1]. The relatively stable economic growth and developed infrastructure, low cost manpower, low cost manufacturing and increasing demand for vehicle provides the Indian automotive companies with opportunities to grow at a fast pace. Customer focus and continuous improvement enhances the quality innovation process in an organization. Total Quality Management implementation focuses on continuous improvement and customer focus which leads to the innovation processes in

the organization [2]. According to Kaynak, TQM and innovation together integrates organization objectives and functions which ultimately results in Customer Satisfactions [3].

Total Quality management is the management process and set of disciplines which ensures that the organization consistently meets and exceeds customer requirements. It is a combination of Quality and management tools aiming at increasing business and reducing losses due to wasteful practices. TQM is an integral part of Strategy at high level involving all employees at all levels from top to bottom and extends from supply chain to the ultimate customer [4]. According to Sultana, the Hourly Data System (HDS) and Statistical Process Control (SPC) practices to improve manufacturing performances in manufacturing companies. The focus of their work is to find out the frequencies and time duration of machine breakdowns as well as the major causes of breakdowns affecting productivity. In this research SPC is used to increase total output identifying major loss times from various machine breakdowns using HDS. The obtained result shows that any breakdown can cause a huge cost and the best approach to address any breakdown is the preventive measure [5].

Abdolshah stated that process capability indices (PCIs) are appropriate tools to measure the inherent capability of a process, but most of them do not consider the losses of a process, while in today's competitive business environment, it is becoming more and more important for companies to evaluate and minimise their losses. They presented a review of loss-based PCIs such as Cpm, Cpmk, PCIθ, Cpc, Le and L″e. They also discussed characteristics of loss-based PCIs such as reject based, asymmetric, bounded, loss based and target based. Finally, they made some recommendations for developing a new loss-based process capability index with more excellent specifications [6]. Emergence of Indian automotive industry as a global player seeks for understanding the complexity of quality practices required for running the business successfully in the international competitive environment. Today in the competitive world customers seeks for quality products and services at a low cost. In order to achieve this manufacturers have to produce those products which are economical.

Saraph (1989) proposed that empirically validated measures to integrate quality management practices helps in understanding these practices with reference to the organization quality environment and quality performance [7]. Researchers have used such measures to understand quality management practice better and to build theories and models that relate the critical factors of quality management to organizational performance to achieve business excellence. According to a study by Ferdows (1997) the reason for the firm to outsource their manufacturing processes is to provide high quality products at comparatively low prices [8]. Consumer now a days are more aware about the quality while purchasing product, it leads the companies to be more focus on developing and updating their technological capabilities [9]. Firms that adopted Quality Certifications tends to implement TQM as the next step towards their quality management journey [10].

1.1 Use of quality tools

TQM places a great deal of responsibility on all workers. If employees are to identify and correct quality problems, they need proper training. They need to understand how to assess quality by using a variety of quality control tools, how to interpret findings, and how to correct problems. These are sometimes called the seven means for quality control (cause and effect diagrams, Scatter diagram, flowcharts, Pareto chart, Histogram, Control charts, checklist).They are easy to understand and at the same time extremely useful in the quality problems identification and analysis. Sometimes, the employees use one mean, but often, the use of a combination of means is of greater help. We will further refer to three of the seven means of quality control, namely the cause and effect diagram, the checklist and the control charts. Cause-and-effect diagrams are charts that identify potential causes for particular quality problems. They are often called fishbone diagrams because they look like the bones of a fish. The “head” of the fish is the quality problem, such as damaged zippers on a garment or broken valves on a tire. The diagram is drawn so that the “spine” of the fish connects the “head” to the possible cause of the problem. These causes could be related to the machines, workers, measurement, suppliers, materials, and many other aspects of the production process. Each of these possible causes can then have smaller “bones” that address specific issues that relate to each cause. For example, a problem with machines could be due to a need for adjustment, old equipment, or tooling problems. Similarly, a problem with workers could be related to lack of training, poor supervision, or fatigue. Cause-and-effect diagrams are problem-solving tools commonly used by quality control teams. Specific causes of problems can be explored through brainstorming.

2. QUALITY MANAGEMENT PRACTICES AND TECHINIQUES IN INDIAN AUTOMOTIVE INDUSTRY

2.1 Quality Certification

India Automobile Sector requires a lot of certifications for its effective and efficient working. The ISO /TS 16949 certification is provided to the companies that emphasis on

the development of process oriented quality management system and seeks for continuous improvement in their process which results in prevention of defects, reduction in variation and elimination of waste in the supply chain. ISO 9001 certification consist of documents containing national standards of the organizations in each country. ISO 9001:2008 replaced and combined the standards of the two quality certification ISO 9002 and ISO 9003 in the year 2000. OHSAS 18000 certification assures that the organisation must meet with the international occupational health and safety management system specifications.

2.2 Quality Control Techniques & Tools

Indian Automobile Industry has been using some general and some industry specific tools and techniques for its Total Quality Management. Kaizen refers to continuous and ongoing improvement in all activities of the organization from product development to industrial relation management to total product maintenance and ultimately to customer satisfaction. It is the result of the combination of small changes over a period of time [11]. Employee Empowerment provides incentive to employee to identify the problems and helps the management to solve the problem. It helps the staff to increase creativity, productivity, customer service and learn from their mistakes [12]. Product Design is the transformation of new ideas into a new product. It consists of three stages viz. Analysis, Concept and Synthesis. It can be classified into two category either demand pull innovation or invention push innovation. Six Sigma is the empirical and statistical technique of process improvement, developed by Motorola in the year 1986 [13]. It stands for six standard deviation from mean. It aims at maintaining the quality of product near perfection. It defines the number of defects experienced by customer per million opportunities for a defect to occur [14] which allows for only 3.4 defects per million oppurtunities for each product [15]. Automobile manufacturer's demands for zero defect quality from their suppliers. Thus it helps in achieving significant cost reduction and gain competitive advantage.

3. EXAMINATION AND CLASIFICATION OF THE QUALITY TOOLS

This report focuses on the most used tools in the sector and on those forced to be used by the manufacturer as a general rule:

1. PDCA cycle or Deming

2. Q7: the seven basic tools of quality

3. M7: the new seven tools

4. Planning techniques

5. Control techniques

6. Improvement techniques

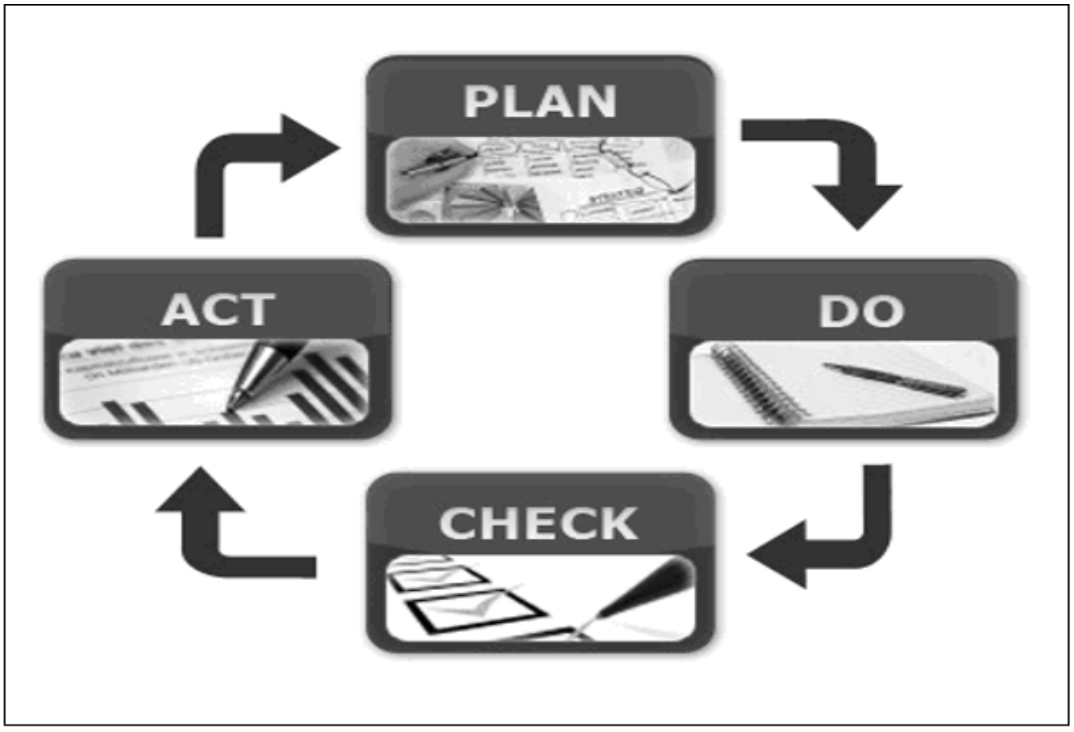

Fig. Deming cycle

3.1 The DEMING or PDCA cycle

The PDCA cycle, is used as a work philosophy and is the core principle of ISO TS. This methodology is inherent to the sector on a daily basis and it sets the steps to be followed to undertake any improvement (Fig. 1).

☐ PLAN: Assortment of problems and planning of improvement actions → To know the problem that is tried to be improved, to look for the root reason, solutions to this reason,... Here, analytical tools like Q7 are used.

☐ DO: Realization of concrete actions to solve the problem → To put the necessary means for improvement.

☐ CHECK: Validation of results and controlling of aims → To measure the obtained results, to see if the aims are reached …

☐ ACT: Improvement of actions, of the situation, etc. → To extend the solutions to other similar problems, families of pieces…

It is based on the principle of quality management continuous improvement, one of the basis supporting the quality philosophy. It analyzes existing data and focuses on historical process capability to know the problem, that is to say, on obvious and quantified facts and problems.

3.2 : The seven basic tools of quality

They are known by "The Seven Basic Statistical Tools" because they are appropriate for people with little formal education in statistics :

☐Check sheet

☐ Flow charts

☐Cause-and-Effect Diagrams (fishbone)

☐ Control Charts

☐ Histograms

☐Pareto Charts

☐Scatter Plot

A right approach to deal with issues is to see first if the issue exists by using verified data (check sheet), quantifying its severity if it is repetitive and representative (histograms, Pareto charts) and using tools like cause and effect diagrams intending to determine the root reason of the problem.

3.3 M7: The new seven tools

This is an assortment of useful tools for decision-taking at management level. They are not new, but their popularity has increased in the engineering and manufacturing fields over the last twenty years. They are planning and management tools aimed at Management:

☐ Affinity Diagram

☐Relations Diagram

☐Tree Diagram

☐ Matrix Data Analysis

☐ Matrix Diagram

☐Process Decision Program Chart (PDPC)

☐ Arrow Diagram

3.4 Planning techniques

These tools are aimed at preventing the manufacturing of defective parts . They are applied to plan the manufacturing process, manufacturing tools, control frequency, personnel carrying out controls:

☐ Benchmarking: competence analysis; it is a systematic, continuous measurement and comparison process to determine "best" practices in order to improve an organization's performance.

☐ QFD (Quality Function Deployment): The core of this approach is a chart called house of quality. This technique identifies customer requirements and provides a discipline to ensure that those requirements are included in product design and in planning process. It reduces product development cycles, increasing quality and reducing costs.

☐ Capability Studies. They is used to know if manufacturing processes are stable and capable. This tool is closely related to statistical process control.

☐ DOE (Design of Experiments): method used for process optimization. Its implementation implies a reduction in the number of tests, so product development can be organized more economically.

☐ FMEA (Failure Mode and Effects Analysis): systematized preventive method intended to identify and evaluate the potential failure of a product/process and its effects, as well as to determine actions which could reduce the chance of the potential failure occurring.

3.5 Control techniques

The following quality techniques are widely used as control techniques:

☐ SPC (Statistical Process Control): in every production process, it is necessary to know up to which extent the products meet the pre-established requirements. The Voice of the Process (variability observed), and the "Voice of the Customer" (Specification limits) have to be compared. Therefore, Capability Studies provide indicators called capability indices (Cp, Cpk, Pp, Ppk), that inform about the level of compliance. On the other hand, process stability is to be guaranteed in order to tackle them if they are out of control. Control charts represent the Statistical Process Control (SPC) tool and notices when a process stops following the random pattern of normal behaviour.

☐ Audits: there are many types of audits, classified by internal or made by the customer. They are daily present in automotive companies, where there are several auditors that plan audits of all kinds yearly: Production, Pre-production (Internal); Run at Rate (Pre-production Customer); Quality; Product; Spic & Span (5-S philosophy); Security and Regulations.

☐Definition of indicators: Key Performance Indicators are quantifiable aspects that reflect the critical factors. There are many important indicators related to quality. They are defined during the different Project development stages, like control tool, for example "quality incident indicators of suppliers", of compliance of initial samples and prototypes, those referred to delays in deliveries, suppliers' quality systems... The main goal is to find proper indicators for particular processes and find methodology that helps to identify those indicators.

3.6 Techniques for improvement

Finally, the quality tools used as techniques for improvement are the following:

☐ Continuous improvement

☐ TPM: Total Productive Management

☐ Lean Six Sigma: methodology that firms can use to improve the output quality of a process

☐ Poka Yoke: "mistake proofing" system that helps to prevent human errors.

☐ Improvement group. Collaborative working method between several production workers, where there is a critical figure: the improvement group facilitator (usually a quality-related person), that guides the group as regards some steps to be followed to solve a problem. That person also provides workers with knowledge and orientation on the use of quality tools.

☐ 8D Tool (8 Disciplines): it is a method used to resolve customer-related problems; customers are required to use them. The eight disciplines are followed for problem solving. The disciplines comprise several data-collection tools, determine root cause.

4. RESEARCH OBJECTIVE

The main objectives of this paper are:

i) To identify the prevalent Quality management Tools and Techniques of the Indian Automotive Industry.

ii) To identify the differences between the TQM Practices prevalent in Indian Automobile and Auto Ancillary Industry.

5. CONCLUSION

From the pilot study, it concluded that by and large Indian Automotive Industry uses similar tools and techniques for the implementation of TQM practices. There is similarity in the implementation of the practices like Kaizen, Employee Empowerment, Product Design, Statistical Process Control, Total Product Maintenance, PDSA, SMED, Six Sigma, Satisfaction Index, Autophoretic Painting, but differences were observed in the implementations of some tools and techniques like Just in time, Computer Numerical Control, laser marking, image analyzer, contour measuring, benchmarking and Poka Yoke due to the specific requirements of these segments - Automobile and Auto Ancillary. It can be concluded that despite the different principles, rules, standards etc. followed by most of the automotive companies, they aim for a common result i.e. Quality. Automobile industry by nature is consumer centric. It responds immediately to the emerging technologies and innovations, but with caution.

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7. REFERENCES

1. Phusavat, K. and Kanchana, R. (2008), Future competitiveness: viewpoints from manufacturers and service providers, Industrial Management & Data Systems, Vol. 109 No. 2, pp. 191-207.

2. Baldwin, J. R., & Johnson, J. (1996). Business strategies in more- and less-innovative firms in Canada. Research Policy, 25(5), 785-804.

3. Kaynak, H. (2003). The relationship between total quality management practices and their effects on firm performance, Journal of OperationsManagement, 21(4), 405-435.

4. David, J. what is the total quality control? The japaneese way. (New Jersey: prentice hall, 1985).

5. Sultana F., Razive, N. and Azeem, A. 2009. Implementation of statistical process control (spc), Journal of Mechanical Engineering, IEI (Bangladesh),Vol. 40 (1) .

6. Abdolshah, M., Yusuff, R. M., Hong, T. S. and Ismail, M. Y. B. 2011. Loss-based process capability indices: a review, International Journal of Productivity and Quality Management, Vol. 7, No.1, pp. 1 - 21.

7. Saraph, J. V., Benson. P. G. and Schroeder, R. G.(1989), an instrument for measuring the critical factors of quality management, Decision Sciences, 20 (4), 810-828.

8. Ferdows, K. (1997), “Making the most of foreign factories”, Harvard Business Review, Vol. 75, March, pp. 73-88

9. Sila, I., & Ebrahimpour, M. (2002). An investigation of the total quality management survey based research published between 1989 and 2000: a literature review, International Journal of Quality & ReliabilityManagement,19(7),902-970.

10. Prattana Punnakitikashem, Tritos,Michael W. McLean, (2010), "A study of quality management practices in TQM and non TQM firms", International Journal of Quality & Reliability Management, Vol. 27 Issue 9 pp. 1021 – 1035.

11. Process imporvement lean project. (2014). Retrieved 11 15, 2014, from www.kaizen.com: http://www.kaizen.com/consulting/process-improvement-lean-project.html

12. Sadgrove Kit, making TQM work, (Kogan page Ltd. 1995)

13. Adams, Cary, Praveen Gupta and Charlie vilson, six sigma deployment (New York: Routledge, 2007)

14. Tennant, Geoff, six sigma: spc and tqm in manufacturing and services. (England: Gower Publishing Limited, 2001)

15. Rajaram, S., & siva kumar, M. total quality management. (New Delhi: Biztantra. 2008).