Quality Improvement Procedure (QIP) based on 8D and Six Sigma Pilot Programs in Automotive Industry

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Abstract
With concentration on post-purchase support services and customer complaints, auto factories try to perform quality improvement initiatives to improve product quality and promote brand reputation. This paper proposes a quality improvement procedure based on quality management practices (8D and six sigma pilot programs), the first of which helps quality managers to promote the quality performance criteria (R/1000 or TGW/1000) and the second of which assists managers to improve the process capability performance index (CPI). The quality practices in China and South Africa are presented to illustrate the effectiveness of the proposed quality improvement procedure (QIP).
Key words: *quality improvement procedure (QIP); 8D, six sigma; pilot program; automotive industry*

1 Introduction

With more fierce competition for flourishing automotive brands, the strategic pressures facing by firms in recent atmosphere have led to increasing dependence on quality-concentrated, results-based improvements [1]. The self-brand automotive organizations are experiencing high soaring warranty cost and customer complaints, which stimulate quality pilot programs for enhancement in auto assembly factories and OEMs. Quality as one of the most strategic capabilities has been paid increasing attention by auto manufacturers and the post-sale quality activities are becoming an important feature for supporting the quality promotion [2, 3]. Cost of quality model, proposed by Juran and Feigenbaum, has been explored by lots of experts to establish the balance point between quality investment and performance received, which guides the quality managers to establish the quality improvement plan [4, 5]. There are over 15000 components in the complex assembly for vehicle products with multiple processes, and even one glitch could lead to unconformity and function failure, which could contributes to claims and brand damage [3].

It is the intention of many organizations to protect their business objectives through ensuring that customers are happy and are retained, and that the provisions of quality policies are accomplished as advocated by Oakland [6] in response to a question, *"Why a quality management system?"* Almost all the manufacturers in different levels – OEM's to tiered suppliers have some sort of a quality management system (QMS) based on either a set of defined customer requirements such as Formel-Q Capability for VW, Q1 for FORD, BIQS for General Motors or a more recognised international standard such as ISO/TS16949 developed for the automotive industry from the general application ISO9001. The adoption of a QMS in the auto industry is a strategic decision taken to ensure customer satisfaction and is in many cases a customer specific requirement, without which an organization may be prohibited from trading with its customers [7-9]. This paper proposes a quality improvement procedure with five general stages for auto factories and OEMs in China and South Africa.

2 Literature review

Due to the concentration on quality and customer perception, the statistical techniques and quality management methodologies, especially those customer-oriented methods and preventive quality plans have been adopted by practitioners [10]. The quality improvement is a continuous process and is proven to be effective to increase productivity and profitability, as well as quality cost reduction [11]. Many quality improvement initiatives have been implemented in self-brand auto factory to help quality managers to convert mistakes to success by giving life to learning from customers' feedback [12, 13].

The quality improvement activities are linked to production parameters such as productivity, capability process index (CPI), rework/scrap rate and post-sale parameters like failure frequency (R/1000), things go wrong (TGW), and customer satisfaction (CS) [4, 14]. The aim of the quality initiatives is to improve these indexes' performance. And the quality pilot programs based on different quality-oriented techniques provide an effective way to turn it into reality. Total quality management (TQM) philosophy highlights customer satisfaction with total staff involvement and continuous advancement, and it is defined as a set of specific principles for improvement. The 8D procedure, which is short for team oriented problem solving method proposed by Ford Motor Company, assists managers to deal with sudden uniformity to prevent the quality problem with all related department members involvement. The six sigma method proposed by Bill Smith in Motorola is a data-driven approach to strengthen process capability with statistical techniques [15]. Inherent to a quality management system is the requirement and expectation to continually improve on performance. By definition, quality improvement is a planned managerial activity, which involves identifying potential improvements, prioritizing potential areas for improvement, and planning the implementation of projects and improvements [16].

3 Proposed continuous quality improvement procedure in automotive industry

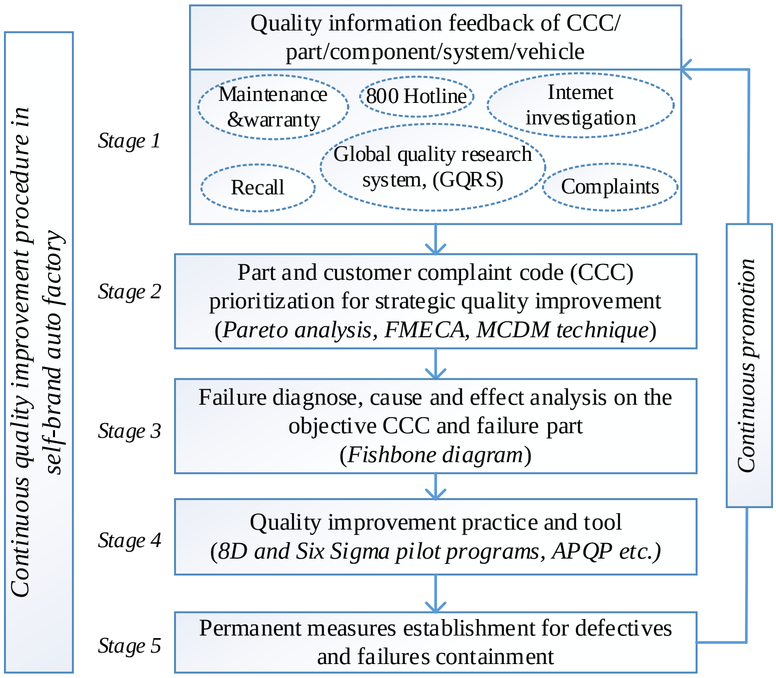
3.1 Quality performance index (QPI) in auto industry

The most prevailing criterion to represent the automobile quality is pp100 (problems per hundred vehicles), adopted by J.D. Power. The quality performance index (PP100) in initial quality survey (IQS) report is based on problem segments (9 classifications with 135 specific problem items) according to established investigation questionnaire. In automotive factories in China and South Africa, the similar criteria reflecting vehicle quality are developed, such as failure frequency per thousand vehicles (R/1000), things go wrong (TGW), and customer satisfaction (CS). In order to investigate the statistic quality information of parts and products, the vehicle has been divided into eight systems including 36 sub-systems with 308 customer complaint codes (CCCs). No matter the warranty data or claims, it contains vehicle attributes (production/sales date, vehicle identity number, supplier data) and warranty-related data (maintenance data, specific problem (CCC), maintenance cost, mileage at repair, part cost, labour code, repair actions taken) [17]. However, this kind of index is calculated and generated based on the investigated samples within objective period. As the warranty period is 36 months, the statistic period within 36 months needs to be established and we chose quality performance index in the first three service months since sales date. The quality performance indexes in this paper are R/1000@XMIS and TGW/1000@XMIS, and X means the statistic circle, the first of which reflects the product quality from maintenance and warranty data, and the second of which represents customer complaints and perception coming from global quality research system (GQRS). Generally, QPIs@3MIS is most widely used for its high conformity degree with QPIs@36MIS [18].

3.2 Continuous quality improvement procedure (CQIP) to improve QPIs

According to the international standardization organization (ISO), product quality is the totality of features and characteristics of a product that satisfies the sated or implied needs [3]. The continuous quality improvement procedure in automotive industry is proposed and it provides a general framework to deal with the unconformity and customer complaints as *Fig. 1* illustrates.

There are five stages for the CQIP in factories as *Fig. 1* shows. Firstly, the quality information and customers' feedback from multiple sources needs to be investigated and collected. The main quality information comes from global quality research system (GQRS) and maintenance database. In the second stage, the objective CCC and part should be established by Pareto analysis or MCDM technique [12] to conduct pilot program. The analysis of failure causes or complaint sources are performed based on fishbone diagram technique subsequently. In the fourth stage, the quality improvement pilot programs are performed based on quality management methods to different failure causes. As for the special factor that leads to failure of objective part/CCC/system, the 8D procedure would be implemented as a pilot program to



Terms & Abbreviations

MCDM technique: multi-criteria decision making technique;

FMECA: Failure mode effect and criticality analysis;

8D: 8D problem solving is called as team oriented problem solving with eight disciplines involving all related staff and department;

APQP: Advanced product quality planning and control plan;

CCC: Customer complaint code;

GQRS: Global quality research system.

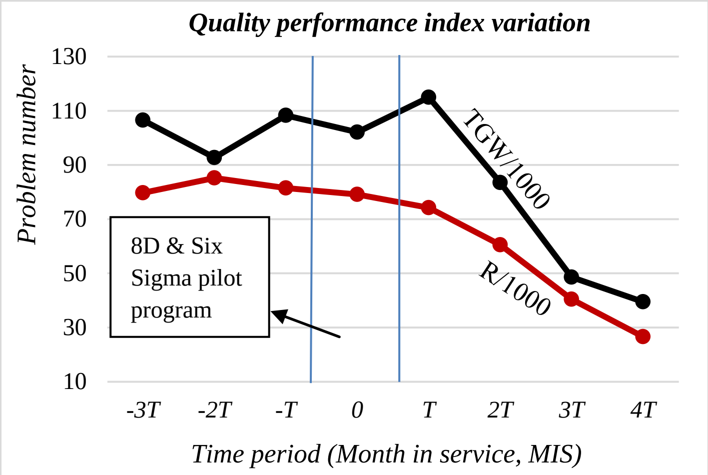
Fig.1 Continuous quality improvement procedure (CQIP) in auto factory

improve the high failure frequency for defective procurement or material. As for the less capable manufacturing procedure, typical DMAIC (Define, Measurement, Action, Implement and Check) analysis (six sigma method) is implemented to improve capability performance index of manufacturing process. If the improvement strategy shows high effectiveness, it will be established for the permanent action for the next business. The five stages of quality improvement practices are performed continuously and it has been the general procedure for quality manager to lunch their business.

4 Application of the quality improvement procedure

4.1 The application in a Chinese auto assembly factory

The application of quality improvement procedure in a Chinese auto factory is presented in this section. The CA Co. Ltd is a very famous self-brand vehicle manufacturing organization providing multiple products such as sports utility vehicles (SUV), multi-purpose vehicles (MPV), cars and vans located in Chongqing, China. Due to soaring failure frequency and increasing customer complaints of its product, the shock absorber and parking brake have been selected as the objective pilot programs by MDCM and Pareto analysis.



The quality improvement pilot programs are performed simultaneously.

Where,

T=1MIS (month in service);

R/1000: maintenance frequency within 1 MIS;

TGW/1000: Things go wrong reflecting customer complaints within 1MIS.

Fig. 2- Key QPIs variation by applying QIP

The 8D pilot program on shock absorber is performed to improve quality performance, and six sigma analysis on parking brake as a pilot program is conducted to deal with the high unconformity. The quality performance index (R/1000, TGW/1000) variation during the implementation of quality improvement practices is shown in following *Fig. 2*. From the roadmap of the key variation of QPIs, we can deduce the effectiveness of the quality pilot programs on selected objectives. The general quality improvement procedure has been applied and adopted by auto manufacturers in China to perform quality initiatives.

4.2 The application in South African automotive OEMs

The South African automotive industry is made of Original Equipment Manufacturers (OEM's) and the imported brands in an industry that has contributed on average 6.5% to the GDP between 1993 and 2013, and employed 130,000.00 people by the end of 2014 [19]. Major OEM's include BMW, NISSAN, VW, FORD, Mercedes Benz, Toyota, and General Motors. Some of the imported brands include MAHINDRA, Tata, Peugeot, Citroen, Hyundai, Kia, Honda, Subaru, Daihatsu, and Volvo. The adoption of the 8D problem solving method is wide spread in South Africa, although maturity levels and success stories are different from company to company. This section presents the application of quality improvement procedure through the implementation of problem solving measures between OEM's and Tier-1 suppliers without naming involved parties.

A case between OEM's and suppliers is chosen because it extends beyond exchange of parts in instances of customer complaints to documentation of improvement actions to ensure repeat complaints are not made. Since the publication of the tool by Ford in 1987 in a manual called the "Team Oriented Problem Solving (TOPS)", a Global 8D (G8D) has been gaining popularity in the industry and has almost become the basis by which all quality problems are addressed. Although the format used by the OEM's varies to suit individual requirements, the basic structure of the tool has not been changed and still encompasses the typical eight steps. The QIP with 8D method are followed at Bosch and have assisted the company to be A-rated by its key suppliers and many awards given for continuous quality improvements. A period between D1 and D8 is influenced by many variables, some of the major ones being team composition, technical knowledge of the problem area, management involvement, availability of information, resource provision to address the root-cause, and customer involvement.

The practices in quality improvement in South African auto factories suggest managers should focus on the following points. (i) It is often advised to involve many members in the initial stages of problem solving exercise, such as in brainstorming exercises through the use of Ishikawa techniques where all ideas are invited and respected as valid contributions towards problem solving. (ii) To successfully solve a problem, team members need to possess technical knowledge of the problem area; it is not sufficient to be skilled in problem solving methods when technical competence is lacking. (iii) Management involvement is great of significance for quality improvement. (iv) The QIP is only effective when data is available and can be converted into useful pieces of information to act as an input for the process. (v) Various stakeholders are important in QIP, and the customer is often left out as an important party for quality improvement.

5 Conclusions

Continuing improvement is needed for both kinds of quality, since competitive pressures apply to each. Customer needs are a moving target and the quality improvement activities based on post-sales information are conducted to meet the varying requirements. This paper proposed a general quality improvement procedure for auto factory including five stages. The two cases application in Chinese and South African auto factory are illustrated to verify the effectiveness of the proposed CQIP. In future study, other pilot programs based on statistic techniques and hybrid quality management methods need to be explored and developed to initiate quality improvement practices.

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