Six Sigma Approach to Quality Assurance in Global Supply Chains

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Abstract: ***Quality assurance practices in the supply chain of American automakers have evolved through decades from quality inspection and quality control to statistical process control and quality auditing .Emergence of quality auditing had been accompanied by the creation of numerous customer specific quality standards. Further,with globalization of the supply chain,quality assurance practices in global supply chains have been taking a new direction from that of inspection and quality control to six sigma continuous quality improvement .This research, present how a six sigma approach to quality management can be used successfully for continuous quality assurance and quality improvement in the global supply chain of United States auto manufacturers for achieving competitiveness in world market place.***

Keywords: six sigma, automotive

1. Introduction

In this new millennium, in a world market place, competition is no longer among companies but among global supply chains.Moreover, quality has taken precedence over all other order winning criteria and ultimately has become the order qualifier for auto assemblers as well as for auto parts and subassembly suppliers (6).Therefore, for achieving competitive advantage, quality assurance by the assemblers, as well as by each and every individual supplier has become essential. Due to this new challenge in world market place, quality assurance practices in global supply chains have been taking a new direction from that of inspection and quality control to six sigma continuous improvement approach including QS-9000/ISO-9000 registrations.(9) From the 1950's through 1960's quality assurance practices were dominated by receiving inspection ,outgoing inspections and statistical quality control of works in progress .During the 1970's and1980's they were complemented by statistical process control ,internal quality audits ,and supplier's quality audits using standards set by each customer ,Very soon numerous customer's quality standards were created all over the world ,which imposed severe stress on many suppliers of automotive parts and sub-assemblies , particularly those who wanted to supply more than one customer for expanding their customer base(8). For example ,if asupplier wanted to supply its parts to Chrysler ,Ford ,and G.M., then it had to comply with all three auto maker's individual standards such as Chrysler'sSupplier Quality Assurance standards ,Ford's Q-101 Quality systems standards ,and General Motor's NAO Target of Excellence standards (15).

In the early 1990's in order to bring harmony among all customers standards in world market places ,representatives of the Institutes of standards of various countries including U.S.A., Canada , U.K., France , Germany , Netherlands , and Switzerland ,gathered together in Geneva , Switzerland , and created a new common international standard for all quality system around the world .This common international standard is known as the ISO-9000 Series of Quality Standards"(8). Thus , in 1990s, ISO-9000 became the predominant quality standards implemented by many suppliers with the expectation of supplying multiple customers .However ,ISO-9000 was designed as a generic standard with wide flexibility that is applicable to all kinds of companies belonging to wide spectrum of industries.(3) Because of its wide flexibility, the big three automakers of the United States such as General Motors., Ford, and Chrysler, did not accept ISO-9000 as their supplier's quality standard for audit .Instead ,they jointly developed a set of more rigorous quality standards, known as QS-9000 which of course, includes all twenty elements of ISO-9000 as the core requirements plus auto industry's common requirements and each individual automakers specific requirement.(5) Thus, QS-9000 which was introduced in mid-1990s became the fundamental quality systems requirements for the supplier's of the big three auto-makers ,General Motors , Ford , and Chrysler ,and the U.S. Truck Manufactures , and others subscribing companies for quality assurance in their global supply chains. They applied QS-9000 extensively to all internal and external suppliers of raw materials ,components , subassemblies ,and service parts in their global supply chains (5) General Motors corporation mandated that all of its suppliers be registered by a third party (independent) QS-9000 Quality Systems registrar no later than December 31, 1997. For all new suppliers General Motors also started performing a potential supplier Audit since January 1, 1995 based on Quality Systems Assessment (QSA) document. By January 1,1996 third party registration to the QS-9000 Quality System requirements of all new suppliers were required by General Motor(4) Ford also required all of its suppliers to be registered to the QS-9000 Quality Systems Requirements on or before December 31,1996. However, Ford had been extending this deadline on case by case basis. Also Ford had announced that it would also allow second party audit ,instead of third party audit ,on exception basis(4) Likewise ,Chrysler corporation had laid down a demanding schedule for QS-9000 implementation by its suppliers. All of Chrysler's suppliers were asked to complete a self-assessment to QS-9000 by July 7,1995 and all production and service part suppliers to Chrysler were asked to register to QS-9000 by a third party registrar by July

31,1997.However, they had also been closely reviewing their suppliers and extending the deadline on case by case basis.(4).

Thus, quality assurance practices in global auto supply chains has changed significantly over the past decades, and has been taking a new direction in this new millennium .As compared to the earlier inspection and quality control emphasis, the current practices are becoming more quality system audit oriented requiring the registration of suppliers using ISO-9000, and QS-9000 series of quality standard (12).

2. Current Quality Assurance Practices in Automotive Supply Chain

A recent questionnaire survey conducted in 2004 among 100 tier one and tier two suppliers of American automotive assemblers revealed that.70 % of all tier one suppliers surveyed are QS9000 certified,50%of all tier 11 suppliers surveyed are either ISO-9000 or QS-9000 certified. Also, those who are not yet ISO-9000 or QS-9000 certified, they plan to certify themselves, within the next 3-5 years. 100% inspection of all incoming materials and outgoing finished products have become the common practice, and for work in process inventories SQS and SPC have been very commonly used (2).over and above all these approaches to quality assurance which assure the flow of quality parts and sub-assemblies at a substantial cost for 100% inspection ,and third party registration process ,companies should be looking in to six sigma approach to quality improvement which may significantly reduce the cost of quality by preventing process making bad parts and subassemblies by improving the product design and process capability. This survey however, revealed that the six sigma approach to quality improvement has not yet been implemented in global supply chains of U.S. automobile manufacturers. (2).

3. Six Sigma Approach to Quality Improvement

The term ”six sigma” originally referred to the total amount of standard deviation(+/-3=6 sigma) on both sides of the mean of a normal probability distribution curve which covers 99.95% of all representative population. However the six sigma, has emerged in 1990s as a registered trademark and service mark of Motorola, Inc as a business process improvement approach that seeks to find and eliminate causes of defects and errors, reduce cycle times and cost of operations ,improve productivity ,achieve higher asset utilization and better meet customers’ expectations(9). It is based on a simple problem solving approach entitled “DAMAIC”, which stands for Define, Measure, Analyze, Improve, and Control, which incorporates a wide range of sigma, is on improving four key initiatives: Quality, productivity. Cost and profitability .Bill Smith a reliability engineer at Motorola Inc is credited with originating the concept during the mid 1980s. This concept was subsequently implemented at Motorola, Inc. by Robert Galvin its CEO.(2).Six Sigma was also implemented at General Electric company by its former CEO Jack Welch who made it a popular approach to quality improvement initiative in mid 1990s.Since then Six Sigma has been appealing to many top business executives as compared to Total Quality Management(TQM), because of its focus on measurable bottom-line results and its disciplined fact-based approach to quality problem solving(6).

The term ”Six Sigma” has also been associated with process capability analysis where product specification and tolerances are compared to the inherent variation in the process of making the product .Six Sigma approach to process improvement focuses on reducing the variation in the production process to the point where it will be able to meet the specification and tolerance requirement of the product(23) by improving the process using process statistical tools such as process capability analysis cause and effect diagram and statistical process control..similarly, six sigma approach to product design focuses on improving the product design to meet or exceed customers’ satisfaction by using methods such as Quality Function Deployment(QFD) Taguchi’s methods of product design, and robust design.(22).

4. Six Sigma Quality Improvement Model

The six sigma quality improvement model as applied by Robert Galvin at Motorola, Inc refers to the five steps process problem solving approach known as DMAIC:(Define, measure ,Analyze, improve and control) as explained below

- **Define:** This step defines who the customers are what the customers want the process capabilities, and provides objectives for project-based improvement efforts.
- **Measure** :This step measures the quality characteristics that reflects improvement in customer satisfaction and product performance and provides the metrics of data on which the improvement efforts will be based upon
- **Analyze** : In this step data collected in previous steps are analyzed using analytical tools such as Pareto analysis process flow diagram, fish-bone diagram, statistical process control charts for identifying necessary design and process modifications for achieving customer satisfaction and performance objectives.
- **Improve:** In this step resources are located so that design and process modifications needed for improvement can be implemented.
- **Control:** In this step the process is monitored using quality management tools such as Pareto charts and statistical process control charts to ensure that the performance improvements are maintained.

5. A Model of The Six Sigma Approach to Quality Improvement

In the past decade the big three U.S. automakers implemented the QS-9000 registration requirements on their tier-1 parts suppliers for qualityassurance instead of addressing the key issues of quality, productivity cost and profitability using six sigma approach and has been continuously losing competitiveness to foreign auto makers in their own turf. It is imperative that they take a good look at six sigma approach and incorporate it into their strategic planning process. The following diagram represents a model

for six sigma approach to design and process improvement that may be implemented for continuous quality improvement by assemblers, sub-assemblers and parts suppliers in global supply chains of automotive industry.

As shown in the diagram the six sigma approach to product design focuses on the continuous improvement of product design process though Quality Function Deployment (QFD) which involves customers needs and expectation survey, preliminary design making prototypes testing of prototypes running the product through test market perfecting the design through repeated cycle of redesign and field-testing and test marketing then only finalizing the design and sending the design drawings to process planning for manufacturing of parts and assembly of finished products..Six Sigma approach to design focuses on improved design of a product which will not only meet but also exceed all customers' expectations (13).

Similarly the six sigma approach to process improvement involves process capability analysis to determine the capability of the process for making good quality parts conforming to dimension and tolerances provided in the design and drawing specifications of the product if the process is not capable of making parts to specified dimension and tolerances then the processed must be improved by replacing it with better machinery and equipment and training of the operators Thus six sigma approach to process improvement focuses on reducing variation in the production process in order to improve the quality of parts subassemblies and assemblies.

6. Conclusion

In global supply chains the assemblers of the finished products the sub-assemblers and manufacturers of parts all must work together in harmony to improve the quality the cost and just-in-time delivery of parts sub-assemblies and finished products and six sigma approach to design and process improvement has a great potential to reduce the cost of operations improve productivity achieve higher asset utilization and better meet customers' expectations in the long run In this decade the authors foresee a tremendous emphasis of six sigma approach to quality and productivity improvement in global supply chains of the automakers of all developed countries of the world.

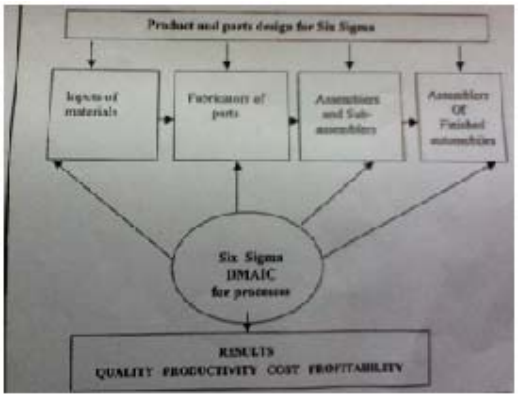

Figure 1: A model for six sigma approach to design and process improvement in automotive supply chains

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