A Review of DMADV: Methodology, Customer Satisfaction and Research Area

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Abstract: - The purpose of this research note is to examine the use of six sigma Methodologies in order to increase customer satisfaction, profit maximization and future research areas mostly by using DMADV method. In the era of cut throat competition, especially in automobile sector, success of an organisation resides in its ability to respond quickly to the needs of its customers. These customer needs must be attended with minimum manufacturing costs, minimum lead time to launch the product in market and delivering better performance than the existing competitors in the market. Therefore, Indian companies in order to compete with global companies, it is very much essential to be at par, in all spheres of business aspect. Cost and Quality are two very important aspects to be globally competitive, to capture market share, to retain customers to be in business and to achieve business excellence. Integration of Six Sigma Methodology, Lean, Knowledge Management and Cost of Poor Quality is a approach for such a systematic innovation management and improvement of processes. For problem solving using six sigma methodology (DMADV) and Lean, based on the project work and investigation of lean and six sigma methodology, blank soft template is designed, developed and used for implementation of six sigma case studies as guide for step by step problem solving and for continuously updating the project status phase by phase or as per the reportable status is completed.

Keyword: - six sigma, DMADV, DMAIC, Cost of poor quality, customer satisfaction, quality, methodology

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1 INTRODUCTION

The Organizations may use right from 7 QC tools, Quality Circles, Kizens, Small Group Activities to the modest tools like Six Sigma Methodology or QC Story Approach for problem solving depending upon the nature and complexity of the problem. Where problem is chronic in nature and problem is known, however, reasons are not known, everything seems to be OK, however, defects are getting generated, and such complex problems are solved using Six Sigma Methodology.

In the present times Six Sigma Methodology and QC Story are very famous and powerful tools and are widely used in the global industries. The increase in demand of the growing customer looking for a better quality of product has compelled corporations to adopt Six Sigma in order to improve the quality for enhanced competitive advantage.

Indian Automobile Industry has already started using Six Sigma Methodology for vehicle design and process improvement to survive in the global competition. It is very important to study and investigate how Six Sigma Methodology is employed in Indian Automobile Industry for designing the product or for Process Improvement and importance of Six Sigma Methodology to reduce Cost of Quality. This motivates to take up research on this topic.

Six sigma is now a global brand and something of a revolution. The objective of this paper is to review and examine the evolution, benefits, and challenges of six sigma practices and its future as a management tool in organizations.

2 SIX SIGMA METHODOLOGIES

Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects in any process, from manufacturing to transactional and from product to service. This is accomplished through the use of two Six Sigma sub-methodologies: DMAIC and DMADV.

- The Six Sigma DMAIC (Define, Measure, Analyze, Improve, and Control) is an improvement system for existing processes for incremental improvement.
- The Six Sigma DMADV (Define, Measure, Analyze, Design, and Verify) is an improvement system used to develop new processes or products.

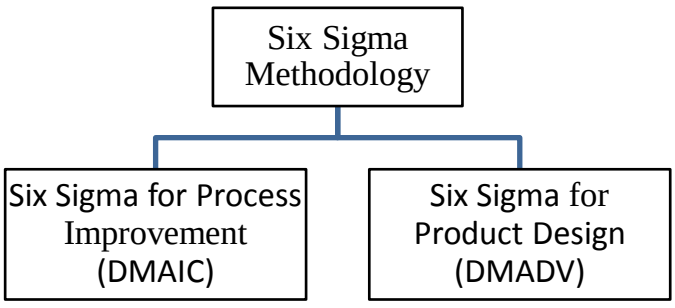

Figure 1: Six Sigma Methodology

Six Sigma is a management strategy that maximizes customer satisfaction and minimizes the defects that create customer dissatisfaction. Six sigma methodology can be used for improvement of process (called DMAIC) and also is a powerful tool for new product design or improvement in the existing product design (called DMADV). The five step DMAIC approach of Six Sigma reduces the defects in process, product or service. Flow charts, Pareto analysis, Cause & Effect diagrams are the most frequently used basic analysis and measurement tools by Six Sigma implementation teams. Investigation as regards application of Six Sigma methodology for process improvement in Indian automobile industry is done and complete framework is prepared and illustrated.

Lean and Knowledge Management are supportive to Six Sigma- DMADV methodology and Six Sigma- DMADV reduces cost of quality. Also Lean and Knowledge Management reduce cost of quality. Therefore, combination of Lean, Six Sigma-DMADV and Knowledge Management is very powerful for process improvement and reduction of cost of quality.

It is very vital and important to note that six sigma methodology can be applied for product / assembly/ sub-assembly design and it is very powerful tool which helps in launching the first time right product.

DMADV (Define opportunity, Measure performance, Analyse opportunity, Design the product and Verify the design) is the Six Sigma Methodology followed for the new product design.

3 DMADV

3.1 Define:

In this phase a serious problem is identified and a project team is formed and given the responsibility and resources for solving the problem. Identify purpose, identify and set measurable goals from the perspective of both the organization and stakeholder, develop schedule and guidelines for review, identify and assess risks.

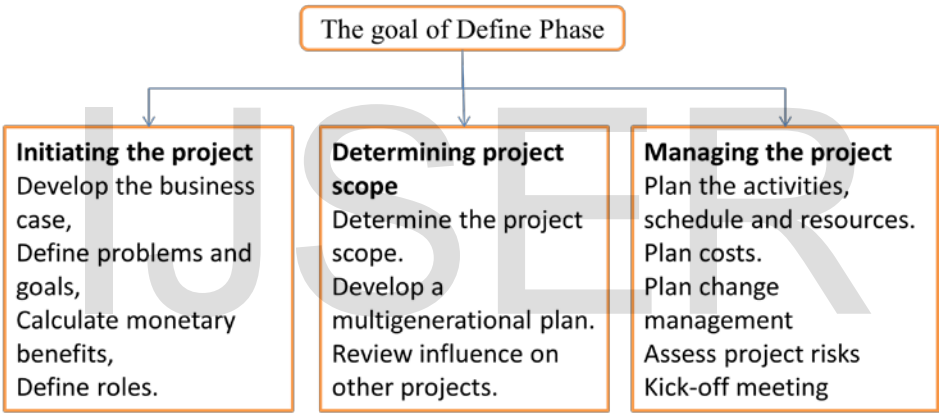

Figure 2: Goal of Define Phase

3.2.1 Define customer requirements

The challenge is to understand how our customers define and prioritize the various needs and expectations they have of your products and services. They are-

Quality: Product or service features, attributes, dimensions, characteristics related to the function of the product, reliability, availability, taste, effectiveness- Also freedom from defects.
Cost: Prices to consumer, repair costs, purchase price, financing terms, depreciation.
Delivery: Lead times, delivery times, setup times, cycle times, Delays.
Service and safety: Service requirements, after purchase reliability, parts availability, service, warranties, maintainability, product liability, product/service safety.
Corporate responsibility: Ethical business conduct, environmental impact, regulatory and legal compliance.

3.2 Measure

In this phase data is gathered and analyzed that describes with precision and accuracy- what is happening? What is current or baseline, and level of performance of the process that creates the problem. It also produces some preliminary ideas of possible causes for problem. Define requirements, define market segments, identify critical parameters for design, design scorecards to evaluate design components that are Critical to Quality (CTQ), reassess risks; assess production process capability and product capability.

This phase entails selecting product characteristics; i.e., dependent variables, mapping the respective processes, making the necessary measurement, recording the results and estimating the short- and long term process capabilities. Quality function deployment (QFD) plays a major role in selecting critical product characteristics.

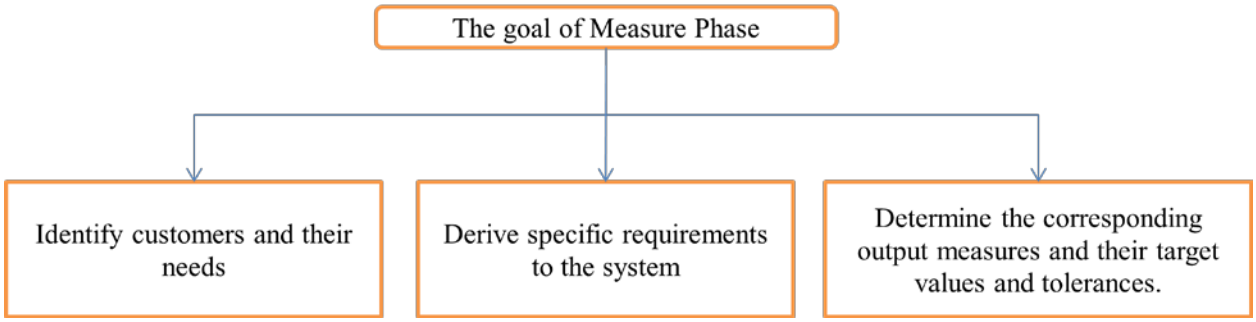

Figure 3: Goal of Measure phase

3.3 Analyze

In this phase theories are generated as to what may cause the problem and by means of testing the theories, root causes are identified. This phase is concerned with analyzing and benchmarking the key product/process performance metrics. Following this, a gap analysis is often undertaken to identify the common factors of successful performance; i.e., what factors explain best-in-class performance. In some cases, it is necessary to redefine the performance goal. In analyzing the product/process performance, various statistical and basic QC tools are used. Develop design alternatives, identify the best combination of requirements to provide value within constraints, develop conceptual designs, evaluate, select the best components and develop the best available design.

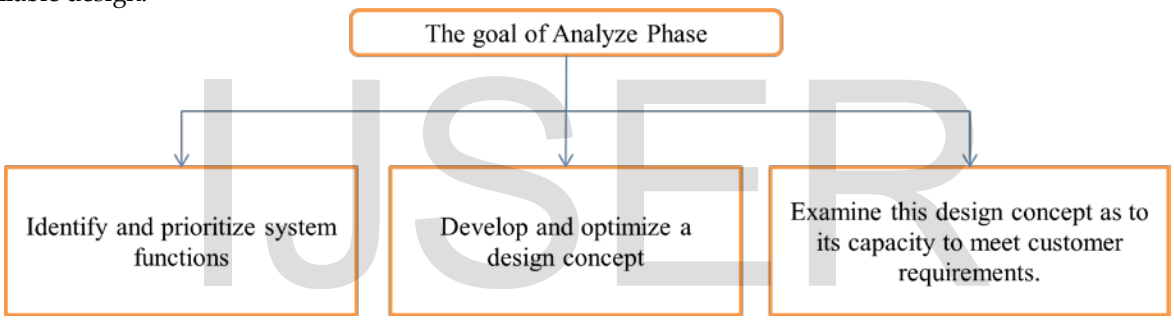

Figure 4: Goal of Analyse Phase

3.4 Design

Develop a high level design, Develop exact specifications, Develop detailed component designs, Develop related processes, Optimize design. In the Design step detailed process maps are created for the production facility layout, along with the engineering detail of the product specification. All the critical process parameters are identified; failure analysis is conducted to determine the potential risks; capability analysis is conducted to determine design robustness, and statistical analysis is used to establish tolerances for critical parameters.

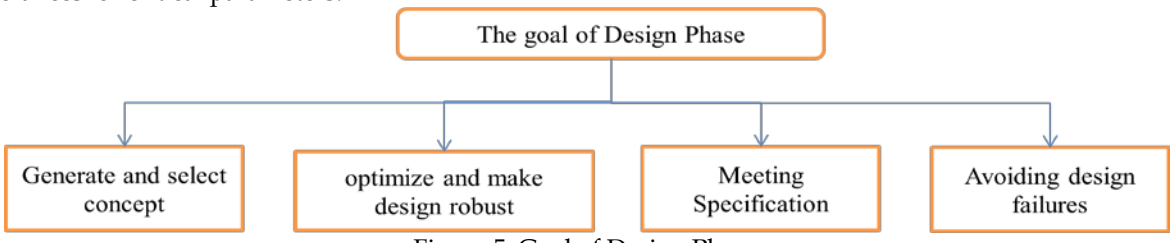

Figure 5: Goal of Design Phase

3.5 Verify

Validate that the design is acceptable to all stakeholders, complete pilot test, confirm expectations, expand deployment, document lessons learned The Verify step engages the customer in product testing through pilot tests that demonstrate the marketability of the product as well as its production readiness. Pilot tests are used to verify the details for transition to full production as well as the implementation of the control procedures for routine production after ramp-up to the full forecast volume is achieved. The control plan for the product is embedded in its assembly procedures, test procedures and acceptance

criteria. The product completes development and transitions to full production upon completion of the Verify step that is marked by an official product launch.

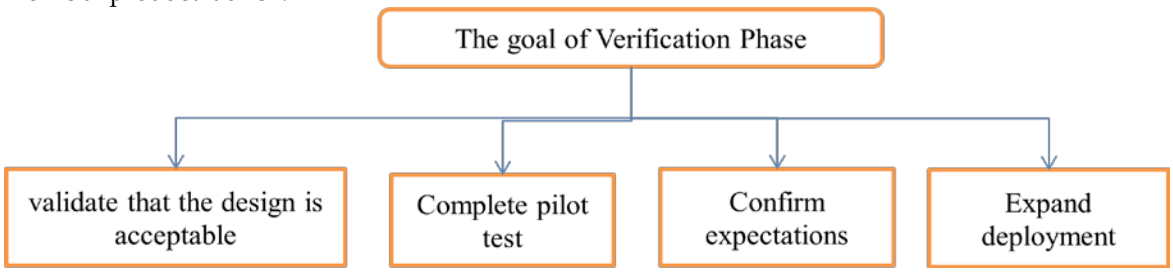

Figure 6: Goal of Verification Phase

Design Validation

The objectives of design validation are

- To validate/ conform the design actually works in the real operating environment
- May be part of initial design verification plan document or may be developed separately
- If multiple applications are foreseen for new product, plan to cover all possible applications/environments in which the product is likely to be used.

On successful validation of product and process during pilot run, final SOPs, control plans, and process documentations are prepared and commercial production run is conducted. If any further fine tuning is required as regards internal observations, customer feedback, field performance is done. Accordingly documents are reviewed and modified to incorporate the final changes if any and project is handed over to operations team.

4 SUMMARIES

Investigation of application of six sigma methodology for new product design / improvement in design in Indian automobile industry is explains details on all steps and tools used in DMADV methodology of six sigma application for product design as used in Indian automobile industries and their suppliers/ subcontractors.

DMADV helps in designing and launching first time right product with robust design features incorporating all customer requirements, more tighter tolerances and focuses on improved fit function and product performance which helps in reduction of internal and external failures costs. Thus DFSS helps in reducing cost of quality.

DMADV improves product performance, helps in designing robust and reliable product with lesser maintenance cost, lesser spare changing frequency and improves customer satisfaction, improves business profitability and increases market share of the business.

During define, measure, analyse, design, design verification phase, knowledge management done for various requirement viz. voice of customers, competitor data, benchmarking data, legal and regulatory requirements, quality function deployment for similar products, brain storming details, Kano analysis, earlier design data, identification of scope of replication or horizontal deployment supports quick problem solving by DMADV tool of six sigma methodology. Value stream mapping and application of lean tools during product design stage by taking care of minimizing number of components in the assembly, reducing weight without compromising on strength, etc lean helps in reduction of cost of quality. Lean along with six sigma is powerful tool. Lean supports six sigma and reduces cost of quality.

5 CUSTOMER SATISFACTION

Customer satisfaction is one of the watchwords for company survival in this new 21st century. Customer satisfaction can be achieved when all the customer requirements are met. Six Sigma emphasizes that the customer requirements must be fulfilled by measuring and improving processes and products.

The identification of customer requirements is ingrained in Six Sigma and extended into the activity of translating requirements into important process and product characteristics. As customers rarely express their views on process and product characteristics directly; a method called QFD (quality function deployment) is applied for a systematic translation. Using QFD, it is possible to prioritize the importance of each characteristic based on input from the customer.

Six Sigma improvement projects are supposed to focus on improvement of customer satisfaction which eventually gives increased market share and revenue growth. As a result of revenue growth and cost reduction, the profit increases and the commitment to the methodology and further improvement projects are generated throughout the company. This kind of loop is called “Six Sigma loop of improvement projects,” and was suggested by Magnusson, et. al. (2001).

6 FUTURE SCOPE OF WORK

Investigation as regards application of six sigma methodology to Indian automobile industry for reducing cost of quality is done for manufacturing processes. However as stated above, Six Sigma Methodology is industry independent and it is applicable to all business process. Viz. Purchasing, marketing, financial marketing, finance etc. Future work may be taken up as follows.

- **Application of six sigma for non manufacturing processes in Indian automobile industry.**

This includes various functions viz. purchase, finance, marketing, stores, maintenance etc. These functions are though non-manufacturing, make a lot of impact as regards business is concerned. Six Sigma project may be taken up to improve on time delivery performance by marketing or it may be taken up to ensure no stock out situations by purchase or for inventory control and optimization by stores. Finance may take up the project for minimising cost of borrowing.

- **Application of six sigma to Indian engineering industry viz. non automobile companies.**

This includes manufacturing industry segment which is non automobiles viz. Electronic goods manufacturing, house hold appliances manufacturing, ship building, air craft building, etc. This is very big industry segment and both six sigma approaches (DMAIC and DMADV) can be used for process improvement and new product development.

- **Application of six sigma in hospitality industry, Application of six sigma in small scale industry.**

This includes small units with restricted turn over. This segment is catered for Six Sigma application to some extent if they are suppliers or subcontractors for automobile industry as a part of supplier quality improvement programme. However, a lot of scope exists to study six sigma applications and its role in reduction of cost of quality for the segment.

7 RESULTS AND DISCUSSIONS

- Six sigma is a methodical approach and philosophy widely used by automobile industry for improvement in existing process. Through analysis of data problems are identified as chronic or sporadic. Sporadic problems are handled through abnormality handling route. & QC tools, Quality Circles, Kaizens, Why –Why analysis, 8D format may be used or it could be based on experience. Problems are addressed.
  Chronic problems (viz. recurring internal rejections, repetitive re-work, repetitive customer complaints, field failures, customer returns, in-house defect generation, supplier quality problems of repetitive nature, etc.) are solved by using structured problem solving tools viz. six sigma methodology or Q.C. Story approach.
- For problem solving using six sigma methodology (DMAIC) and Lean, based on the project work and investigation of lean and six sigma methodology, blank soft template is designed and developed as guide for step by step problem solving and for continuously updating the project status phase by phase or as per the reportable status is completed. This will also help in reviewing the status of the project any time and keep the track of events.
- Though in this project main focus we have kept on Indian automobile industry, we may remember that domain for Six Sigma Methodology is all business process and it is industry independent.

8 CONCLUSION

Six sigma is methodology and a powerful quality improvement and design improvement tool. It can be used for existing process improvement. Six Sigma can be used for improvement in existing product design or in the process of a new product development. Six sigma methodology is problem solving tool and used to solve chronic problems where in problem is known, however reason/s for problem are not known. Six sigma methodologies are used by Indian automobile industry for supplier quality improvement. Six sigma methodologies helps in defect reduction, process improvement, inventory reduction, productivity improvement, reduction in customer complaints, reduction in field returns, reduction in field failures, reduction in warranty costs, and etc leading reduction in Cost of Poor Quality. Six sigma methodology and Knowledge Management are closely associated and supportive to each other. Six Sigma is an "Industry Independent" methodology and has been successfully applied across:

- Manufacturing industry including Automotives, Aerospace, Health Equipment, FMCG, Electronic goods, Continuous process industries, Textiles, etc.
- Service industry including Telecom, Banking and Financial Services, Health care, Hotels, IT, ITES, Airlines, Cargo movement, Support Services, HR services, Marketing Services, etc.
- R&D organizations or in R&D functions of various organizations.

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REFERENCES

[1] Garima Chaudhary, (2014), Six Sigma Concepts: a Complete Revolution, International Journal of Emerging Research in Management &Technology, Volume-3, Issue-2, PP 82 – 86.
[2] peter mutua mutia, stephen morangi nyambegera, (2014), six sigma approach for quality improvement and its future in kenyan organizations: a research agenda, International journal of science commerce and humanities, Volume no 2 no 1, 125-136.
[3] Vipin s. Patil, Sunil r. Andhale, izhak d. Paul, (2013), A review of DFSS: methodology, implementation and future research, International journal of innovations in engineering and technology (ijiet), Vol. 2, 369 to 375.
[4] Nurul fadly habidin, sha?ri mohd yusof, (2013), Critical success factors of lean Six sigma for the Malaysian Automotive industry, International journal of lean six sigma, Vol. 4 no. 1, 60- 82.
[5] Nurul Fadly Habidin, Sha'ri Mohd Yusof, Che Mohd Zulkifli Che Omar, Syed Ismail Syed Mohamad, Sharul Effendy Janudin, Baharudin Omar, (2012), Lean Six Sigma Initiative: Business Engineering Practices and Performance in Malaysian Automotive Industry, IOSR Journal of Engineering (IOSRJEN) ISSN: 2250-3021 Volume 2, Issue 7(July 2012), PP 13-18
[6] Nabeel Mandahawi, Rami H. Fouad, Suleiman Obeidat, (2012), An Application of Customized Lean Six Sigma to Enhance Productivity at a Paper Manufacturing Company, Volume 6, Number 1, Feb. 2012 ISSN 1995-6665 Pages 103 – 109
[7] Lou Magritzer, PE, Jichao Xu, (2012), Six Sigma and the Cost of (Poor) Quality, Vol. 3 Iss: 2 pp. 159 – 182
[8] Subhash s. Tirumalai, (2012), Role of design for six sigma (dfss) in designing and Building test rigs for Commercial aircraft, Quest global services.
[9] Yang, Ching-chow, (2010),Six sigma and total quality management, Intech.
[10] Sameer Kumar, Kenneth F. Bauer, (2010), Exploring the Use of Lean Thinking and Six Sigma in Public Housing Authorities, University of St. Thomas
[11] B. Tjahjono, P. Ball, V.I. Vitanov, C. Scorzafave, J. Nogueira, J. Calleja, M. Minguet, L. Narasimha, A. Rivas, A. Srivastava, S. Srivastava, Yadav, (2010), Six Sigma: a literature review, Vol. 1 Iss: 3 pp. 216 – 233
[12] Mohamed Gamal Aboelmaged, (2009), Six Sigma quality: a structured review and implications for future research.
[13] Raymond vella, sekhar chattopadhyay john p.t. Mo, (2009),Six sigma driven enterprise model transformation, International journal of engineering business management, Vol. 1, no. 1, 1 – 8.
[14] Jim franklin, (2009),A case study for DFSS, Six sigma experts.
[15] Rafat a. Samman, ian graham, (2007),The six sigma project management Strategy, Belfast, uk, association of researchers In construction management, 587-596.
[16] M. Soković, D. Pavletić, E. Krulčić, (2006), Six Sigma process improvements in automotive parts production, Journal of Achievements in Materials and Manufacturing Engineering, VOLUME 19, ISSUE 1, November 2006.
[17] Role of design for six sigma in total product development, (2006), Six sigma academy international , llc, new York.
[18] frank t. Anbari, young hoon kwak, (2004), success factors in managing six sigma projects, Project management institute research conference, london, uk, 1 to 14.
[19] Charles huber, glenn h. Mazur, (2003),QFD and design for six sigma, 14th symposium on QFD.
[20] Gregory H. Watson, (2003), The Elements of Design for Six Sigma, GOAL/QPC Press, 01 to 16.