International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

A Review of Six Sigma Approach: Methodology, Implementation and Future Research

Meena Ahirwar[1], Dr. Devendra Verma[2]

[1]Student, Institute of Engineering and Technology DAVV
Devi Ahilya Vishwavidyalaya, Institute of Engineering & Technology, Indore, MP, India

[2]Lecturer, Institute of Engineering and Technology DAVV
Devi Ahilya Vishwavidyalaya, Institute of Engineering & Technology, Indore, MP, India

Abstract: ***Six Sigma is an approach that improves quality by analyzing data with statistics. In recent years there has been a significant increase in the use and development of the Six Sigma methodology in manufacturing industry and others. It is high time to have a review on the Six Sigma approach. This paper reviews some related literatures to describe methodology, implementation and future researches. The present paper summaries four issues within the sub-category of the initial Six Sigma concepts: basic concept, DMAIC, DFSS and deployment. Then, some sectors that benefit from the implementation of Six Sigma are listed out, and the key factors influencing the successful Six Sigma project implementation are identified. At last, some topics for future research are presented.***

Keywords: Six Sigma, methodology, implementation, future Research quality management

1. Introduction

Statistically, Six Sigma refers to a process in which the range between the mean of a process quality measurement and the nearest specification limit is at least six times the standard deviation of the process, shown as Fig. 1 and Fig. 2.

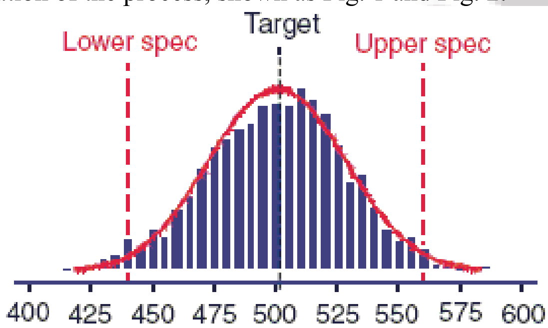


Figure 1: Illustration of centered 3 Sigma

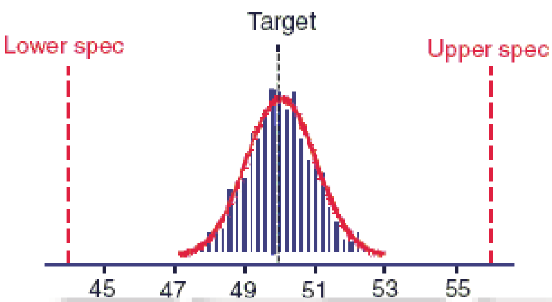


Figure 2: Illustration of Six Sigma process

The traditional quality management approaches, including Statistical Quality Control (SQC), Zero Defects and Total Quality Management (TQM), have been key players for many years, while Six Sigma is one of the more recent quality improvement initiatives to gain popularity and acceptance in many industries across the globe. Six Sigma differs from other quality programs in its top-down drive in its rigorous methodology that demands detailed analysis, fact-based decisions, and a control plan to ensure ongoing quality control of a process. Since its initiation at Motorola in the 1980s, many companies including GE, Honeywell, Sony, Caterpillar, and Johnson Controls have adopted Six Sigma and obtained substantial benefits. Six Sigma is a long-term commitment. It won't work well without full commitment from upper management. Six Sigma changes the way a company thinks by teaching fact-based decision making to all levels. In recent years, interest from the academic community has increased dramatically. However, to date only few papers can be identified as a literature review regarding Six Sigma focusing on the basic concept, implementation and future of Six Sigma [1-3]. Therefore, it is the high time to have an extensive review on the related literatures. The present paper syntheses four issues within Six Sigma basic concepts. It aims to identify the key factors influencing the successful implementation of Six Sigma projects. Finally, the areas of future research are summarized.

2. Methodology of Six Sigma

Six Sigma has been defined as the statistical unit of measurement, a Sigma that measures the capability of the process to achieve a defect free performance. Six Sigma has the ability to produce products and services with only 3.4 defects per million, which is a world-class performance. Six Sigma has also been described as a high performance data driven approach in analyzing the root causes of business problems and solving them.

A. Basic Concept

Conceptual papers also consider the overall concept, attempting to analyze the development of Six Sigma and explain its statistical foundation. Bothe presents a statistically based reason for adding a 1.5 Sigma shift before estimating process capability, proposing a new capability index, called dynamic Cpk [5]. He also suggests future study on the impact and behavior of the shift in various circumstances. Antony studies the strengths and the weaknesses of Six Sigma in detail and links Six Sigma to statistical thinking [6]. He suggests that Six Sigma has a strong statistical foundation and consequently is likely to continue to be of importance in the future. Table I summarizes Six Sigma business strategies, tools, techniques, and principles

Table 1: Strategies, Tools, Techniques And Principles [1]

Strategies and Principles	*Tools and Techniques*
Project management	Statistical process control
Data-based decision making	Process capability analysis
Knowledge discovery	Measurement system analysis
Process control planning	Design of experiments
Data collection tool & technique	Robust design
Variability reduction	Quality function deployment
Belt system	Failure mode and effects analysis
DMAIC process	Regression analysis
Change management tools	Analysis of means and variances Hypothesis testing Root cause analysis Process mapping

B. DMAIC Process

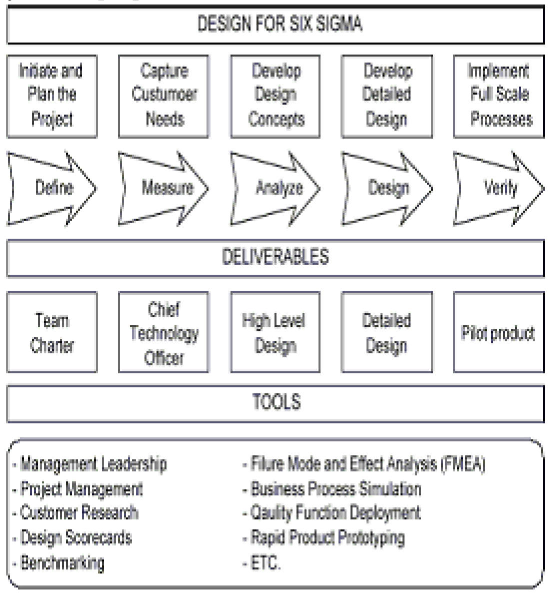
DMAIC is a closed-loop process that eliminates unproductive steps, often focuses on new measurements, and applies technology for continuous improvement. Some papers focus on explaining the DMAIC contents, with some authors discussing each phase of DMAIC in detail [7]. For example, raises teals .present self-learning training material for DMAIC, using a fictitious application [8]. This paper helps the readers to learn how to carry out a small-scale Six Sigma project, including guidance on the application of tools. It indicates a perceived need for training material and suggests that an avenue for further research is to develop training material to cover a wider range of applications and larger scale projects. Other papers concentrate on specific aspects of DMAIC, such as the project selection process in the Define phase or process control in the Control phase, explaining some key measures in Six Sigma, such as project metrics and Roll Throughput Yield (RTY). For example, Sneer emphasizes the importance of the project selection process in the Define phase for the successful implementation while Mason suggests using multivariate statistical process control in the Control phase [9-10]. These papers tend to explain the features of DMAIC rather than critically appraising or enhancing it. Future research should investigate whether aspects of DMAIC need to be modified to increase its scope, for example for the service sector or non-profit organizations. If so, research to enhance the methodology may then be needed. Table II presents the key steps of Six Sigma using DMAIC process.

Table 2: Key Steps of DMAIC Process

Steps	*Key processes*
Define	Define the requirements and expectations of the customer Define the project boundaries Define the process by mapping the business flow
Measure	Measure the process to satisfy customer's needs Develop a data collection plan Collect and compare data to determine issues and shortfalls
Analyze	Analyze the causes of defects and sources of variation Determine the variations in the process Prioritize opportunities for future improvement
Improve	Improve the process to eliminate variations Develop creative alternatives and implement enhanced plan
Control	Control process variations to meet customer requirements Develop a strategy to monitor and control the improved process Implement the improvements of systems and structures

C. DFSS Process

Design for Six Sigma (DFSS) is a systematic methodology utilizing tools, training and measurements to enable the organization to design products and processes that meet customer expectations and can be produced at Six Sigma quality levels [11].



DFSS is potentially far more effective than DMAIC as its application is in the early stage of new product/process development, thus the papers under this category aim to provide an explanation of DFSS and why it is different from DMAIC [12-15]. For example, Madera explains the DFSS methodology, its key aspects and how it enhances the design process; improving New Product Development (NPD).Antony presents DFSS using the Identify, Design, Optimize and Validate (IDOV) approach. Treichler et al. discusses the use of DFSS in the design function of major US corporations and Koch et al. explain DFSS in detail, using as an example the application of DFSS in automotive crashworthiness under an engineering design context. All of these studies of DFSS have been undertaken in a manufacturing context. Hence, there is a need for more extensive study to consider new areas of DFSS application, such as how DFSS can be applied to nonmanufacturing processes.

D. Six Sigma Deployment

Papers addressing Six Sigma deployment focus on people issues, with particular emphasis on the professional role of Belts and training issues. For example, some authors describe the role of BBs and the required qualifications including the suggestion of a BB training curriculum. Hoerl et al. suggest that it is a positive career move for a statistician to take up a leadership role in Six Sigma, implying that it is important for BB to have statistical skills [16]. However, care is needed in selecting the right qualities for Belts, as it is important for Six Sigma to retain an inclusive stance rather than becoming too closely aligned with specialist skills. Calcutta suggests the use of Myers-Briggs Type Indicator (MBTI) tool to assist BBs to work effectively with others [17]. It is claimed that this tool helps BBs to understand the personality types of team members and communicate more effectively, gain cooperation and overcome resistance. However, these papers are descriptive using authors' experience. Therefore further research is needed to investigate the qualities required by the Belt candidates. Further rigorous research is needed to investigate evidence for the effectiveness of the proposed training methods. Another issue regarding deployment is the successful use of teams, given that Six Sigma projects are accomplished through team efforts. It is important to focus on team success, rather than individual success, if Six Sigma projects are to be successful overall. No paper has been identified that address an individual's reaction or resistance to Six Sigma. Management involvement and support are essential to Six Sigma deployment, as is the case for many other initiatives. Haikonen et al. present a preliminary case study on the role of management in the improvement of the deployment process in Six Sigma and highlights its key finding that the level of management support is positively related to how well they understand the Six Sigma methodology [18].

3. Six Sigma Implementation

Six Sigma implementation can be divided into types of business: manufacturing and non-manufacturing, described as follows.

A. Manufacturing business

Cases of successful companies that have adopted Six Sigma are presented in many papers. The authors describe how the respective companies' implement Six Sigma, giving insights into issues of perceived best practices. Motorola was the first organization to use the term Six Sigma in the 1980s as part of its quality performance measurement and improvement program. Six Sigma has been successfully applied in other manufacturing organizations such as Boeing, DuPont, Ford Motor, Seagate, Texas Instruments, GE, etc. All of these papers are categorized as descriptive papers, giving details of business cases, but without a rigorous case study approach. As a result of Six Sigma being initiated in the USA, all the above success stones describe US companies. Very few papers have been found regarding successful implementation strategies for whole businesses in other parts of the world. Therefore, academic research outside USA could be a good area of future study to determine any comparative differences in implementation issues, such as those caused by cultural issues.

B. Non-manufacturing business

a) Healthcare sector

Healthcare services are one of the major active nonmanufacturing contexts in which Six Sigma has been adopted, with the majority of papers studying implementation issues in USA. Six Sigma principles and the healthcare sector are very well matched because of the healthcare nature of zero tolerance for mistakes and potential for reducing medical errors. Some papers explain how Six Sigma improves healthcare service quality by reducing medical errors and increasing patient safety.

b) Financial services sector

In recent years, finance and credit department are pressured to reduce cash collection cycle time and variation in collection performance to remain competitive. Typical Six Sigma projects in financial institutions include improving accuracy of allocation of cash to reduce bank charges, automatic payments, improving accuracy of reporting, reducing documentary credits defects, reducing check collection defects, and reducing variation in collector performance [19]. Bank of America is one of the pioneers in adopting and implementing Six Sigma concepts to streamline operations, attract and retain customers, and create competitiveness over credit unions. It has hundreds of Six Sigma projects in areas of cross-selling, deposits, and problem resolution. Bank of America reported a 10.4% increase in customer satisfaction and 24% decrease in customer problems after implementing Six Sigma [20].

c) Other Sectors

Still, there are other sectors in Six Sigma implementation, including Civil Engineering and Construction, Research and Development, Supply Chain Management, Human Resource Management and Train and safety.

C. Success factors in Six Sigma implementation

Some papers present the key ingredients for the effective introduction and Six Sigma implementation in manufacturing and services organizations as the following [21-22].

1) Management commitment and involvement.
2) Understanding of Six Sigma methodology, tools, and techniques.
3) Linking Six Sigma to business strategy.
4) Linking Six Sigma to customers.
5) Project selection, reviews and tracking.
6) Organizational infrastructure.
7) Cultural change.
8) Project management skills.
9) Liking Six Sigma to suppliers.
10) Training.

4. Future Research of Six Sigma and Conclusion

Given that Six Sigma methodology has been around in industry for over a decade, it now seems unimportant to determine whether Six Sigma is better than other approaches. It is more important to learn how to enhance the Six Sigma methodology and improve implementation issues for the growing number of firms that are choosing to adopt it as a means of process improvement. The primary focus should be on improving overall management performance, not just pinpointing and counting defects. Researchers and practitioners are trying to integrate Six Sigma with other existing innovative management practices that have been around to make Six Sigma method even more attractive to different organizations that might have not started or fully implemented the Six Sigma method. One area of future research is how these Six Sigma practices are adopted in different organizational contexts is needed, since different organizations have different maturity levels of QM implementation and the strengths and weakness of their existing QM systems vary. Another area suggested for future research is the investigation of how Six Sigma works with other improvement methods such as lean manufacturing. Successful implementation and growing organizational interest in six sigma method have been exploding in the last few years. However, there is still the need for more empirical research into the Six Sigma phenomenon, using rigorous research methods to validate the many uncorroborated Six Sigma claims and to test new theories or models that have been proposed to strengthen the methodology. Yet, the research territory to date has been only found within the North America region with only a few studies in Europe and Asia. Given the globalization of many companies, including those using Six

Sigma, study in other parts of the world is needed to gain insights into cultural issues that may affect the theory and practice of Six Sigma. Effective Six Sigma principles and practices are more likely to succeed by refining the organizational culture continuously.

References

[1] Young Hoon Kwak, Frank T. Anbari, “Benefits, obstacles, and future of six sigma approach,” Technovation. Vol. 26, pp.708-715, 2006.
[2] P. Nonthaleerak, L. C. Hendry, “Six Sigma: literature review and key future research areas,” Int. J. Six Sigma and Competitive Advantage. Vol. 2, pp. 105-129, 2006.
[3] James E. Brady, Theodore T. Allen, “Six Sigma Literature: A Review and Agenda for Future Research,” Quality and Reliability Engineering International. Vol. 22, pp. 335-367, 2006.
[4] Tennant G., Six Sigma: SPC and TQM in Manufacturing and Services. Hampshire: Gower Publishing Company, 2001.
[5] Bothe D., “Statistical reason for the 1.5s shift,” Quality Engineering. Vol. 14(3), pp.479-488, 2001.
[6] Antony J., “Some pros and cons of Six Sigma: an acdemic perspective,” The TQM Magazine. Vol. 16(4), pp.303-306.
[7] Snee R. D., “Six Sigma: the evolution of 100 years of business improvement methodology,” Int. J. Six Sigma and Competitive Advantage. Vol. 1, pp.4-20, 2004.
[8] Rasis D., Gitlow H. S. and Poppvich E., “Paper organizers international: a fictitious Six Sigma Green Belt case study,” Quality Engineering. Vol. 15(2), pp.38-47, 2003.
[9] Snee R. D., “Make the view worth the climb,” Quality Press. Vol. 34, pp.58-61, 2001.
[10] Mason Y., “Interpretive features of T2 chart in multivatiates SPC,” Quality Progress. Vol.33(4), pp. 84-90, 2000.
[11] Mader D.M., “Design for Six Sigma,” Quality Progress. Vol. 35, pp.82- 86, July, 2002.
[12] Antony J., “Design for Six Sigma: a breakthrough business improvement strategy for achieving competitive advantage,” Work Study. Vol. 51(1), pp. 6–8, 2002.
[13] Mader D.M., “DFSS and your current design process,” Quality Progress. Vol. 36, pp.88-89, July, 2003.
[14] Treichler D., Carmichael R., Kusmanoff A., et al, “Design for Six Sigma: 15 lessons learned,” Quality Progress. Vol. 35(1), pp.33-42, 2002.
[15] Koch P. N., Yang R. J. and Gu L., “Design for Six Sigma through robust optimization,” Structural and Multidisplinary Optimization, Vol. 26, pp.235-248, 2004.
[16] Hoerl R. W.,Rodebaugh W. and Snee R. D., “Six Sigma and statistidal leadership,” Annual Quality Congress Proceedings. Milwaukee: pp. 385- 389, 2004.
[17] Caulcutt R., “Black Belt types,” Quality and Reliablity Engineering International. Vol. 20, pp. 427-432, 2004.
[18] Haikonen A., Savolainen T. and Javinen P., “Exploring Six Sigma and CI capability development: preliminary case study findings on management role,” J. Manufacturing Technology Management. Vol.15(4), pp.369-398, 2004.
[19] Doran, C., “Using six sigma in the credit department,” Credit Management. pp. 32-34, 2003.
[20] Roberts, C.M., “Six sigma signals,” Credit Union Magazine. Vol. 70 (1),pp. 40-43, 2004.
[21] Antony, J., Banuelas, R., “Key ingredients for the effective implementation of six sigma program,” Measuring Business Excellence. Vol. 6(4), pp.20-27, 2002.
[22] Banuelas Coronado, R., Antony, J., “Critical success factors for the successful implementation of six sigma projects in organizations,”The TQM Magazine. Vol. 14 (2), pp. 92–99, 2002.978