International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 3, March-2014, pp: (265-279), Impact Factor: 1.252, Available online at: www.erpublications.com

Quality Improvement Tool Six Sigma: A Literature Review

Rishi Raj
Research Scholar, Department of Mechanical Engineering, UIET (MDU), Rohtak, India

Abstract: Six Sigma Methodology which was developed in 1980`s at Motorola (USA) has recently caught up with time in improving quality in large and as well as medium sized industries. Here, we are talking about the concept of six sigma & its implications in several fields. After going through the paper the reader will become fully aware of six sigma methodology as to how it optimizes the manufacturing without compromise with quality. These days apart from big industries, medium scale industries are also adapting it fast to optimize the quality. No doubt this is a revolutionary way of improving quality! Six Sigma is a systematic approach or strategic tools used by the leading organizations to achieve accuracy or good quality of the product with the maximum profit or at low cost. Six Sigma is based on the principle or methodology named as DMAIC principle contains a systematic examination of the process from starting to the finishing of the product. In the starting, we choose the product having the Part per Million (PPM) in terms of rejection is very high and need to be improved. We apply Six Sigma methodology in the terms of DMAIC principle for reducing the Part per million (PPM) of the product in terms of rejection so, In this situation, quality improvement activities have become a part of the business culture and a way of life. The very paper reflects light on the same theme.

Keywords: Six Sigma, strategy, quality, DMAIC, PPM, DPMO.

Introduction

Six Sigma is a breakthrough management strategy which is revolutionizing the world's top companies with proven results of success. Six Sigma methodology was invented at Motorola, perfected at General Electric (GE) and is now practiced by most of the organisations throughout the world. It is a comprehensive and flexible system for achieving, sustaining and maximising business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data and statistical analysis and diligent attention to managing, improving and reinventing business process (Gaddam & Amancha, 2005). Six Sigma (SS) methodology is nowadays one of the most used approaches in the Quality Management field since its benefits coming from the improvement of the process outputs quality by identifying and removing the causes of defects and variability in manufacturing and business processes (Cagnazo & taticchi). Industrial, manufacturing and service organizations are interested in improving their products and processes by decreasing the variation, because the competitive environment leaves little room for error. Variation is the enemy of quality which is defined and evaluated by the customers. We must deliver products and services at the ideal targets demanded by the customers. The traditional evaluation of quality is based on average measures of the process/product and their deviation from the target value.

However, customers judge the quality of process/product not only based on the average, but also by the variance in each transaction with the process or use of the product. Customers want consistent, reliable and predictable processes that deliver or exceed the best-in-class level of quality. This is what the Six Sigma process strives to achieve over the last twenty years, Six Sigma has been successfully implemented in many industries, from large manufacturing to small businesses, from financial services, insurance industry to healthcare systems (Kapur and Feng. 2007). Six Sigma is a disciplined, data driven approach and methodology for eliminating defects (driving towards six standard deviation between the mean and the nearest specification limit) in any process from manufacturing to process industry and from product to service. The statistical representation of Six Sigma describes quantitatively how a process is performing. Six Sigma's goal is the near elimination of defects from any process, product or service-far beyond where virtually all companies are currently operating. Six Sigma focuses all function on "processes." Every process/procedure has an expected outcome/measurement called a"mean." Every outcome/measurement has some variation. The measure of that variation is called sigma. Thus, the focus of Six Sigma methodology in manufacturing/process is to reduce variation as shown in figure 1(Kaushik, P. and Khanduja, D. 2008).

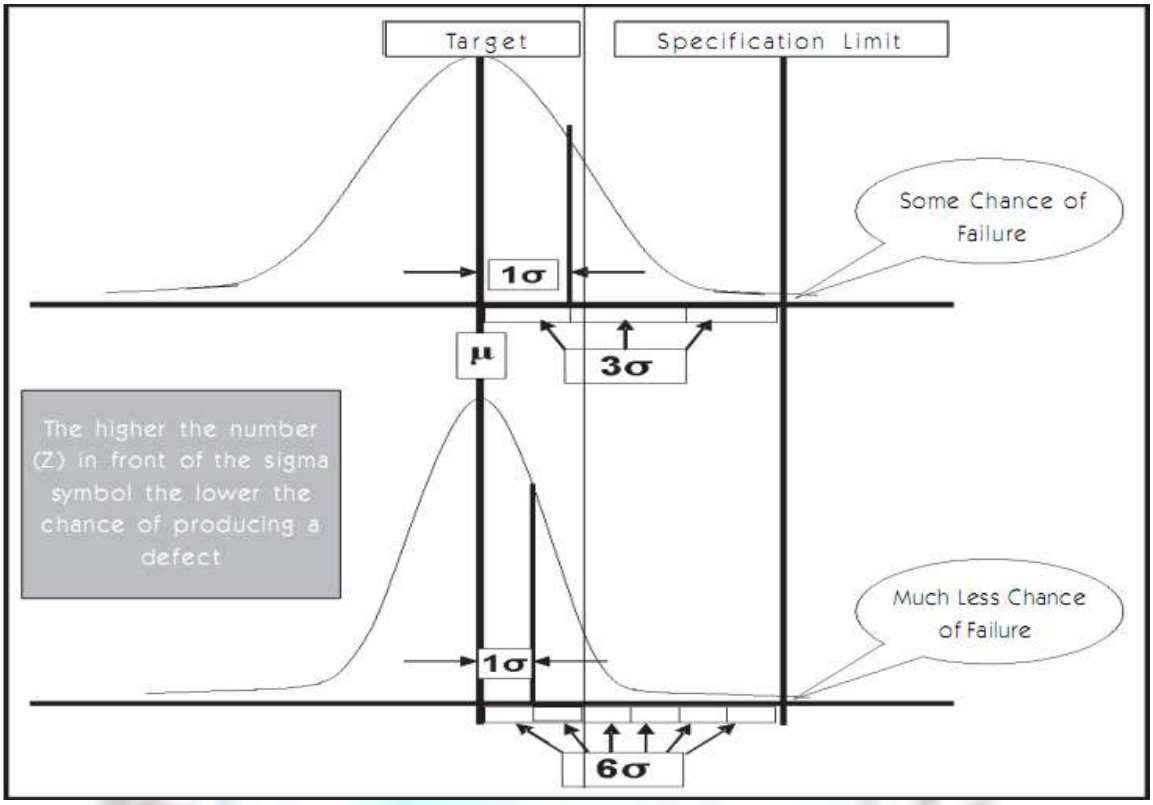

Figure 1: Reducing Variation – Reducing Defects, Source: (Kaushik, P. and Khanduja, D. 2008)

Problem of Variation and Mean value:

Six Sigma is a statistically based quality tool as it deals with the statistical problems. The nature of statistical problem is shown in figure 2 and figure 3. Figure 2 shows the problem with spread or variation. Most of the quality and management problems are due to the existence of product variation. All defects and non-conformities would have vanished if variation could have been vanished. This type of problem is mainly associated with product industries. Figure 3 shows the problem with centering or the mean value. This type of problem is mainly associated with the process industry where consumption rate is very high and to reduce the consumption rate, statisticians have to develop methodology and tools for estimating, comparing, controlling and reducing mean value (Kaushik, P. and Khanduja, D. 2008).

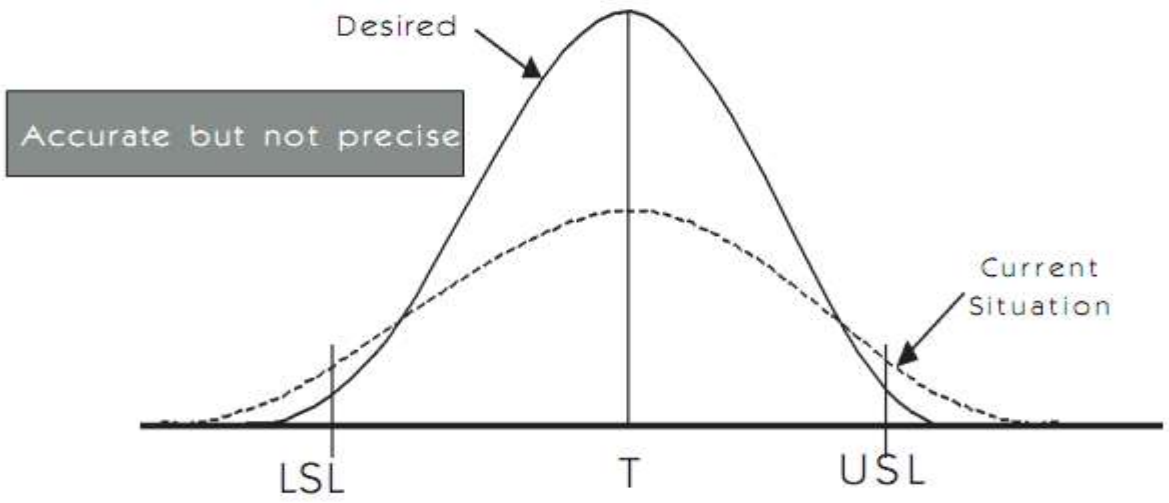

Figure 2: Problem with spread or variation, Source: (Kaushik, P. and Khanduja, D. 2008)

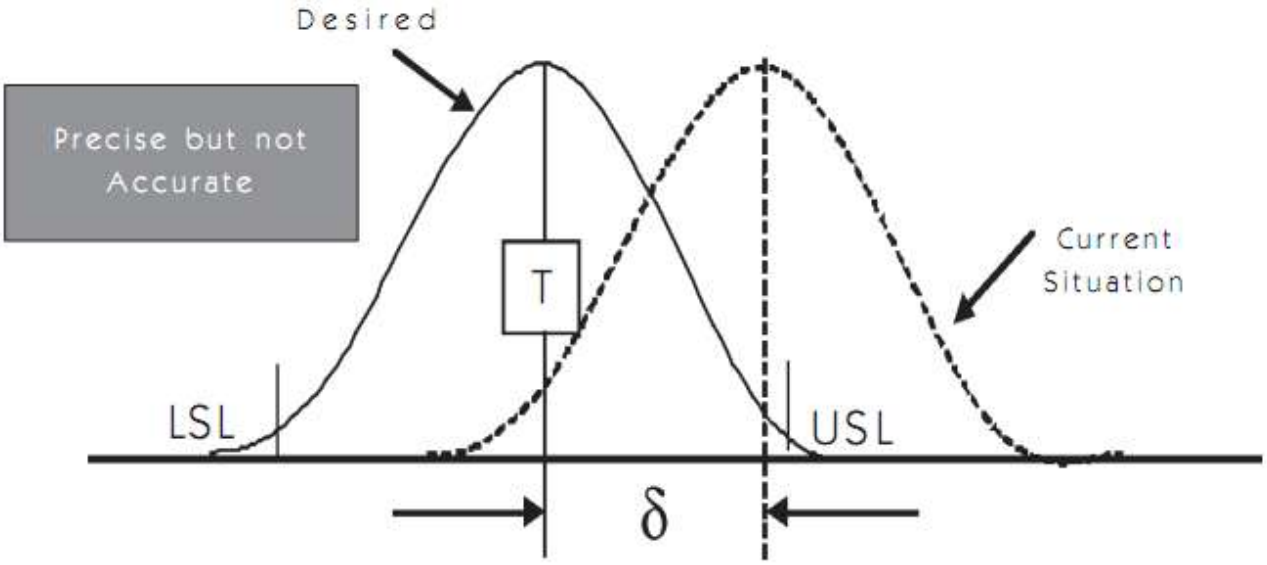

Figure 3: Problem with the Centering or the Mean value, Source: (Kaushik, P. and Khanduja, D. 2008)

Defect rate vs. Sigma level:

Six Sigma counts the number of defects per million Opportunities (DPMO) at six levels. If a company works at one sigma level it is making about 7,00,000 defects per million Opportunities (DPMO) i.e. the company is doing the right things only 30% of the time. Sigma level of two would mean that a process has the chance for 308,500 DPMO. The process at Six Sigma level allows only 3.4 DPMO (Gaddam &Amancha, 2005). This goal was far beyond normal quality levels, and required very aggressive improvement efforts. For example, Three Sigma results in a 66,810 DPMO or 93.3% process yield, while Six Sigma gives only 3.4 DPMO and 99.99966% process yield (these computations assume a 1.5 SD shift in the process mean). Figure 4 shows the relationship between DPMO and process sigma, assuming the normal distribution (Oke, S.A. 2007).

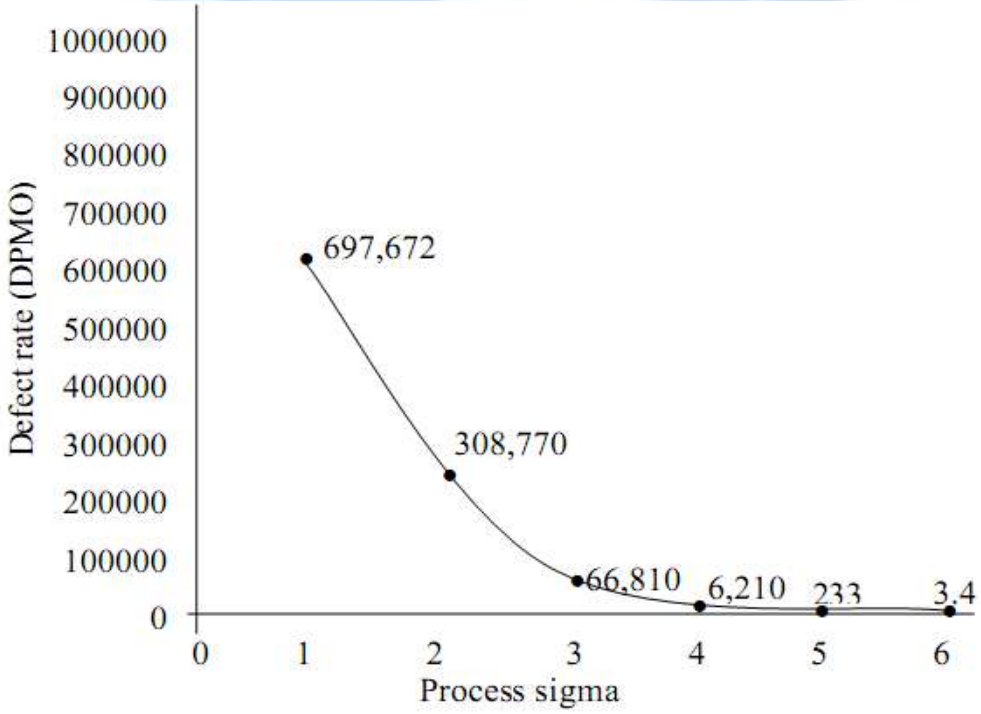

Figure 4: Defect rate (DPMO) versus process sigma level, Source: (Oke, S.A. 2007)

The numerical goal of Six Sigma is reducing defects less than 3.4 parts per million (PPM), also known as Defects Per Million Opportunities (DPMO), reducing cycle time and reducing costs dramatically which impact the bottom line. Reducing variation and mean is the essence of Six Sigma and a Six Sigma defect is defined as anything outside the customer specification. The parts per million defective with respect to various sigmas are shown in figure 4 (Kaushik, P. and Khanduja, D. 2008). Not all processes should operate at the Six Sigma level. The appropriate level will depend on the strategic importance of the process and the cost of the improvement relative to the benefit. If a process is at the two or three sigma level, it will be relatively easy and cost effective to reach the four sigma level. However, to reach five or Six Sigma will require much more effort and more sophisticated statistical tools. The effort and difficulty increases exponentially as the Process Sigma increases. Ultimately, the return on investment for the improvement effort and the strategic importance of the process will determine whether the process should be improved and the appropriate target sigma level as a goal (Panah, M.H. et. al. 2008).

Applications & Implementation of Six Sigma with Reported Benefits & Savings:

As Six Sigma was developed with the intention of reducing the "dpmo", or defects per million opportunities, the concept of "defect" has been extended from manufacturing to service. Thus there is a noticeable prevalence of Six Sigma or Lean Six Sigma to service systems, beyond the traditional domain of manufacturing systems. This is indeed one of the strengths of Lean Six Sigma: it widens the horizon of application of its tools in the real world, and as the importance of service is on the rise today, Lean Six Sigma presents itself at the right juncture (Goh, T.N. 2012).Six Sigma has been applied to a number of processes and projects in the manufacturing sector. A number of these projects are reported in Table 1. As shown in Figure 5, the application of Six Sigma in industries is wide and diverse. For example, extensive reports have been documented on Six Sigma application in healthcare. In the manufacturing sector, successful implementation of Six Sigma has been reported (see Table 1). From Figure 5, much research and many applications are needed in banking services, higher educational institutions, and food services. Although studies in the software industry are rated high, extensions of the current studies in this industry are warranted (Oke, S.A. 2007).

Company/project	Metric/measures	Benefit/savings
Motorola (1992)	In-process defect levels	150 times reduction
Raytheon/aircraft integration systems	Depot maintenance inspection time	Reduced 88% as measured in days
GE/Railcar leasing business	Turnaround time at repair shops	62% reduction
Allied signal (Honeywell) laminates plant in South Carolina	Capacity / cycle time Inventory / on-time delivery	Up 50% / Down 50% Down 50% / Increased to near 100%
Allied signal (Honeywell) bendix IQ brake pads	Concept-to-shipment cycle time	Reduced from 18 months to 8 months
Hughes Aircraft's missiles systems group / wave soldering operations	Quality/productivity	Improved 1,000% / improved 500%
General Electric	Financial	$2 billion in 1999
Motorola (1999)	Financial	$15 billion over 11 years
Dow Chemical / rail delivery project	Financial	Savings of $2.45 million in capital expenditures
DuPont/Yerkes plant in New York (2000)	Financial	Savings of more than $25 million
Telefonica de Espana (2001)	Financial	Savings and increases in revenue 30 million Euro in 10 months
Texas Instruments	Financial	$600 million
Johnson and Johnson	Financial	$500 million
Honeywell	Financial	$1.2 billion

Table 1: Reported benefits and saving from Six Sigma in manufacturing sector, Source: (Oke, S.A. 2007)

Just as for manufacturing, defects found in service incur a cost to either scrap or to rework. Examples include the need to re-contact a customer to verify an order, providing an incorrect service, providing a substandard service or even over service or providing more than what is required. Service organisations such as healthcare and finance have been implementing six sigma and are registering benefits. The breadth of applications is now expanding to other services including call centers and human resource and product support services (Kaushik, C. et al. 2007).

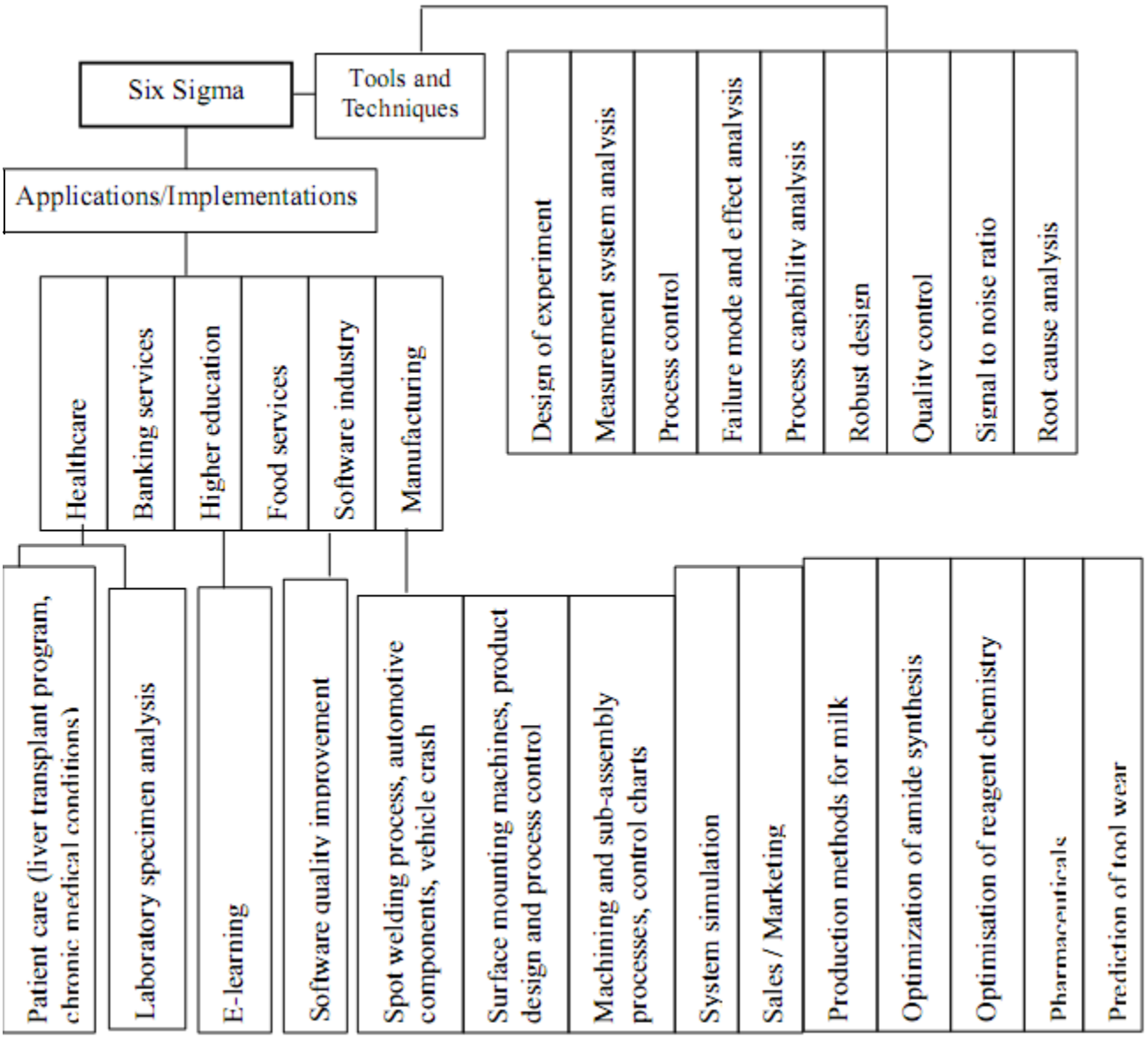

Figure 5: Example of a six sigma framework: methodology and applications/implementation, Source: (Oke, S.A. 2007).

Literature Review

Chandra. W (2002) key success factors for six sigma implementation .There are several factors that make six sigma an increasingly popular quality imitative, even more so than the past TQM, ISO, Zero Defect and so on. These factors are also determinants as to weather a six sigma program will lead to significant improvements. Goh, T.N. (2002) Six Sigma as a quality improvement framework has been gaining considerable attention in recent years. The hyperbole that often accompanied the presentation and adoption of Six Sigma in industry could lead to unrealistic expectations as to what Six Sigma is truly capable of achieving. In this paper, some strategic perspectives on the subject are presented, highlighting the potential and possible limitations of Six Sigma applications particularly in a knowledge-based environment. Without delving into the mechanics of the subject in detail, the points raised could be useful to those deliberating on the

appropriateness of Six Sigma to their respective organizations. Antony et al. (2005) in their study stated that management involvement & participation, linking Six Sigma to customers and business strategy are the most critical factors for the successful deployment of Six Sigma in a manufacturing unit. Gaddam L.R.and Amancha S. (2005) emphasized that Organisations make profits only when they fulfill customer needs. The organization should choose the projects which have direct impact on customers. When an organization define a Six Sigma project should define defects with customer dissatisfaction in mind. An effective Six Sigma deployment requires a holistic mechanism and different tools to capture the voice of the customers. Voice of the customer is important in identifying the customer needs. The author attempt to understand Six Sigma in the context of distance education. The paper explains the what, why and how of Six-Sigma which can play an important role in DE.

Brady, J.E. and Allen T.T. (2006) According to Brady and Allen "We have proposed that Six Sigma is both a method and two principles. These principles related to building and maintaining management support and to fostering usage of methods among practitioners who are not experts in statistics. Trends in the literature included an increasing academic participation and broader focus than solely on manufacturing. We found only partial consensus about the factors that make Six Sigma effective. We suggested opportunities for new research on Six Sigma including the development of more realistic project payback models, clarifying which techniques are most applicable in which situations, and possibly even for the development of new statistical methods with clear advantages for business."

Cagnazzo L. and Taticchi P.(2007) argued that Six Sigma (SS) methodology is nowadays one of the most used approaches in the Quality Management field since its benefits coming from the improvement of the process outputs quality by identifying and removing the causes of defects and variability in manufacturing and business processes. Thus, literature on the SS topic is exponentially increased during last decades; the vast number of works on the SS field represents a good opportunity for a structured literature review of the articles, in order to understand the evolutions of the concept, the fields of its application and possible evolution for further studies. The literature review has been carried out by using a chronological review of the main SS approaches developed both for large and small companies, in order to highlight particular aspects of the SS literature and some applications of the SS methodology. The evaluation of the papers found in literature is carried out through a Strengths-Weaknesses criterion. Moreover, for those treating the application of the SS methodology into both big companies both Small & Medium Enterprises (SMEs), an assessment has been carried out based on the accordance with some milestones identified as necessary for every SS system. Finally the paper argues the possible further developments of the research field.

Chakrabarty, A. and Tan, K.C. (2007) Their findings are based on analysis done both quantitatively and qualitatively. The quantitative analysis shows that articles on the topic are scattered in various types of publications and there is dominance of a few articles in terms of average citation rate. The qualitative analysis shows that application of six sigma in the service sector is concentrated in a few services. The articles provide parameters to be considered for successful implementation of six sigma and there is some unanimity among articles on these parameters. Overall the literature analysis on this topic shows that six sigma is slowly but surely finding structured and beneficial application in service industries. Feng and Kapur(2007) in their research author thoroughly discussed about the six sigma methodology for the students and new practitioners and emphasized on what six sigma is, how it is implemented & why it is used? Kaushik, C. et al. (2007) provided a review and a pilot study on six sigma application for library services with emphasis on necessary critical success factors and key performance indicators for a project to be successful. They also emphasized that the planned framework and focus on process improvement are the major strengths of six sigma. Service industries can utilise this framework, and can benefit by identifying important parameters. Oke, S.A. (2007) through an extensive literature search, it was observed that very little documentation exists in the application of Six Sigma to engineering education. In one case, it was limited to statistics education. Clearly, Six Sigma researchers have many questions to answer. Some of these are:

(i) How do we apply Six Sigma to the university training of engineers to ensure quality control in graduates?
(ii) What about the use of Six Sigma in controlling the quality of research undertaken by university lecturers?

Bergquist, B. (2008) At the beginning of 2008 three SMEs in a small town in Sweden started a network project inspired by the Six Sigma programme, and hired a full-time Black Belt to lead the improvement activities. Three months into the project, we interviewed the top management of the participating companies and the Black Belt, to pinpoint success factors as well as risks of the cooperation project. Results show that statistical methods were unused in favour of methods associated with lean manufacturing such as 5S. Accordingly, the expectations of the CEOs were related to production improvements and flow rather than quality. Both the Black Belt and the CEOs stated that management commitment was vital for the success of the partnership, but also that the visibility of this commitment could be improved. Despite this, all interviewees agreed that the project had gotten a good start and the managers had high expectations for its progress. Brun, A.(2008) With such a study, the research team aimed at accomplishing several goals: first of all, filling a specific gap in the literature; to contribute to a still young and promising research stream concerning the project selection process, and

possibly fostering further research; identifying a best practice for the selection of Six Sigma projects and thus improving the quality of the results and the credibility of the Six Sigma approach; identifying the extent to which reality differs from theory, and how one could "learn" from the other.

Douglas, A. and Middleton, S. (2008) described the two main approaches to problem-solving – the reductionist approach and the systemic approach. The reductionist approach, the dominant problem solving approach, works well for simple, well defined "hard" problems but fails to perform well on complex, ill-defined "soft" problems and when the parts of a more complex problem are all independently optimised. The holistic approach aims to understand problems holistically and addresses many of the weaknesses of the reductionist approach. This paper identifies evidence to categorize Six Sigma as a reductionist approach to problem-solving. They emphasized that Six Sigma must be open to improvement opportunities particularly if they can address the weaknesses inherent in the reductionist approach. This requires a more holistic approach such as that offered by Soft Systems Methodology.

Fan, X. (2008) Introducing Six Sigma into Green Supply Chain management is proposed in the paper by describing what organizations practicing Green Supply Chain Management can gain from Six Sigma and what Six Sigma practitioners can benefit on exploring Green Supply Chain Management. A concerted implementation of the practices will lead to environment-oriented quality management, overcoming the limitations of each practice when adopted in isolation. Possible approaches to integrating the two methodologies are presented for further research. Exploration of the integration further digs into the value of the two methods and suggestions are provided in terms of methods that would create a Green Six Sigma company. His work puts forward value propositions of methodology integration, but there is lack of a comprehensive description of phenomenon to support the practice. Fraser, N. (2008) Lean Six Sigma has had a great deal of practitioner and academic coverage over the past year or two as organisations such as the NHS has embraced the methodologies to enhance and refine their processes. However, there has also been a great deal of scepticism shown by the industry at large as to the costs and timescales for delivery of such improvements. His GE project clearly demonstrates the value of a well applied L6S method to solve a process problem within a services environment in a timely manner and create capacity in an over-stretched customer services department.

Gibbons,P.M. (2008) The paper sets out to introduce the effectiveness of the Japanese 5S system as a steady state platform for future lean and/or six sigma implementation. Using findings from six case studies of heterogeneous businesses complemented by and a taxonomic review of the contemporary 5S literature; a model of 5S deployment is suggested identifying the critical success factors to 5S implementation. Developing a conceptual framework for guiding future research; a model of lean and/or six sigma deployment is presented arguing sustainable business improvements can be achieved through the antecedent implementation of the 5S system. Grant, N. (2008) his paper outlines the operational and commercial challenges, relates how the objectives are deployed, explains the framework and roadmap adopted and justifies the grouping of potential solutions in to well-defined timeslots, adding a new dimension to the selection of the right tolls for the job. Successes, problems and the current status are discussed, in order to assist potential adopters and those who might already be mired down in the sea of options currently available. Harrison, A. (2008) "It is more important to get people to believe in why they need to do something rather than to train them in how to do it. People who truly believe in shared vision and are actively helped by their management will make Vision happen." In the author's experience, most Lean / Six Sigma trainings aim to teach people HOWs of Lean / Six Sigma. It makes bigger impact on a mind-set and will more likely get people to change their practice and behaviour when Lean / Six Sigma training demonstrates WHYs of Lean / Six Sigma. Kaushik, P. and Khanduja, D. (2008) The strategic implementation of Six Sigma in steps (DMAIC) leads to an optimisation of some selected process parameters, thus resulting in substantial saving in overall operational costs of a process industry. The study could be a paradigm initiative towards energy conservation for every energy intensive process industry. Through critical investigation of Six Sigma and its statistical tools, the study illustrates certain ground rules, which are required to be laid down before starting such an exercise with same kind of tools. Use of these ground rules will make Six Sigma more effective, more productive with less effort and less consumption.

Kaushik, P. et. al. (2008) in their study author signifies the role of six sigma in small and medium sized industries and review the implications of Six Sigma methodology over the SMEs, taking a specific case of a bicycle chain manufacturing unit. Laureani,A. (2008) his work illustrates how Six Sigma can be applied to the Human Resources (HR) practice of an organization, challenging the myth that a lack of quantitative metrics in HR makes impossible to apply the DMAIC methodology. In conclusion, we can state that implementing Six Sigma in HR is not really different from implementing it in any other part of the organization: key is the selection of the right metrics. Marsh, J. (2008) 5S sustainability model using the DMAIC approaches would provide a means of measuring the level of achievement within various functions of an organisation across each phase of the 5S program. The model would consist of an audit process designed around the 5S toolset aimed at all levels of the organisation. This would provide an insight into the culture of the organization and a general operational health-check of the 5S process in place at the company. The data from the audit would subsequently be

analysed via a specially developed model and the resulting recommendations implemented to improve the overall "buy in" of the process. It is proposed to conduct this methodology in a Lean "automated" manner reducing the need for time consuming methods for collecting, measuring and analysing the data.

Miguel,P.A.C. (2008) This paper has presented an empirical investigation of adopting six sigma and lean production. All the companies studied have argued that is necessary to set up an adequate organizational infrastructure when adopting six sigma and lean production. This infrastructure contributes to the dissemination of the culture for both programmes as well as providing the foundation to apply them. However, two of the three investigated companies claimed that the programmes do compete for common resources (financial and human resources). In one of them (Company B) this was 214 overcome by establishing a PMO. The consensus of the companies is that one programme can complement the other. Panah, M.H. et. al. (2008) In his work he concluded that Six sigma is a business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on outputs that are of critical importance to customers. Rajamanoharan, I.D. (2008) argued that many of the principal roles in the Six Sigma (SS) DMAIC process fit closely with International Federation of Accountants' (IFAC) four key roles for management accounting. The results showed that the SS features applicable at all phases of the DMAIC process match closely with IFAC's key roles for management accounting. At the broadest level the case studies illustrated that the role of management accounting had undergone considerable change, in parallel with the changes that were taking place in the wider business activities with the adoption of the DMAIC management process. Changes occurred mainly in the course of project prioritisation (define phase), and in project deployment (measure phase onwards). At both stages SS members focused on a set of standard criteria that link directly to IFAC's best practices of management accounting in terms of the fourteen concepts that form part of the conceptual framework for management accounting. Therefore, the results of this study provide a common understanding of the potentially useful role that IFAC's best practice of management accounting could play in the DMAIC phases.

Rowe, P. (2008) The aim of his paper is to show how DfSS was applied, using a "DCOV" methodology, to result in a quantitatively robust HPT disc design. An overview of the DCOV methodology will be given including usage of some of the key tools, such as: Quality Function Deployment (QFD), Design of Experiments, Surrogate modelling, Analytic Hierarchy Process (AHP), Monte Carlo simulation, Data Mining and parameter design. This will be followed by a review of the DCOV process for the HPT disc example. Salaheldin,S.I. (2008) his findings confirmed the belief among the respondents that in implementing quality control tools in general, and six sigma in particular, requires certain tools and techniques that are found to be unsuitable or are difficult to be implemented in the banking sector of Qatar. Surprisingly, the findings of the survey confirmed that there is hardly anydifference among the different managerial levels in perceiving and in evaluating the benefits, as well as the critical successful factors in the implementation of the quality control tools in the Qatari banking sector. The managerial implications and further research of the study are also discussed. Salah, S. and Carretero, J.A. (2008) A thorough comparison between Six Sigma and TQM was performed in their work. It was shown that TQM and Six Sigma are similar in many aspects and compatible with each other. They both share numerous values and aims and can benefit from the advantages that each can provide. More specifically, TQM can be the holistic and comprehensive umbrella that reaches to all stakeholders and Six Sigma can be the extension that provides a strong structure for achieving greater continuous process improvements. The next stage for research in this area is to study how Six Sigma and TQM can be integrated together and present a description for this integration.

Shahin, A. (2008) emphasized that his proposed model is different from existing studies, due to the fact that it not only is compatible with them in the use of SQFD as a complementary technique for the define phase in Six Sigma, but also SQFD could be benefited from Six Sigma, considering the use of the measurement system of Six Sigma in targeting and evaluation of CTQs and SPCs. It is emphasized that the integration of Six Sigma with other quality engineering techniques such as SQFD will increase the efficiency of quality management programs and it seems that the new proposed approach enables service quality designers to enhance the performance and continuous improvement aspects of their quality design and improvement programs. Shamah.R. (2008) his paper provides a model for continuous improvement quality in healthcare organizations; through applying the principles of lean thinking and 5S, which could lead to processes improvement and outcomes, reduce cost, and increase satisfaction among patients, providers and staff. However, lean thinking is providing improved quality without adding extra money. The model could support enterprises in identifying suitable actions for going lean. The applied study is on the Egyptian Healthcare organizations. Shokri, A. (2008) He intended to justify the application of some potential day-to-day technical, statistical and institutional tools and technologies within a food Service organisation to a problem solving methodology. The Simplified version of DAMIC and a good understanding of the recommended tools and technologies in food industry will help to have most effective integration in the industry. This implies some more in depth practices in this type of business.

Timans, W. (2008); In his study he focused on the following research questions:

1. Which LSS- tools and techniques are used in case study publications on projects carried out within manufacturing or engineering organizations?
2. How do experts assess the relevancy of best practice based tools and techniques and how do they group these into a LSS project structure with DMAIC-project phases?
3. To which extent is the arrangement of tools and techniques in DMAIC-project phases in accordance with the rational reconstruction of DMAIC-project phases as published by De Koning and De Mast (2006)?

Thomas, A. (2008) his paper proposes a strategic business model called Sustainable Six Sigma (S3). It will provide an overview of the S3 concept through the integration of Lean, Agility and Six Sigma into one effective approach and shows how S3 has a clear strategic hierarchy which links the strategic business requirements through the PMASEE (Plan-Measure-Analyze-Solve-Execute-Embed) cycle with the operational requirements via the DMAIC cycle. The main aim of this paper is to show how the effective implementation of the S3 approach will lead to greater opportunities for companies to achieve economic sustainability through continued growth and improved manufacturing efficiency. Yeung, S.M.C. (2008) The aim of his paper was to explore the use of "Suppliers, Inputs, Processes, Outputs and Customers" (SIPOC) in Six Sigma to monitor products and services provision for customer satisfaction. Previous researches seldom covered the application of SIPOC in marketing management to fulfill customer need, customer satisfaction, concerns of stakeholders and the community. A case of integrating SIPOC of Six Sigma into a social responsible (SR) and ethical retail shoe shop has been demonstrated in this paper. However, adopting quality concepts in marketing management is still not common, neither in academic curriculum nor in business practice. It is suggested carrying out further researches on the use of quality concepts in analyzing the relationship between consumer behavior and business performance.

Yuniato, H.A. (2008) To gain in-depth understanding of the true problem, self-learning, and better quality decision making, this study had developed frameworks for future Six Sigma suitable to the establishment of creative innovation projects, as well as future knowledge acquisition and optimum problem solving and design. Details of frameworks developed in the integration of System Dynamics, Knowledge Management and Multiple Criteria Decision Making techniques were described in his paper. The essential features of these "beyond Six Sigma" frameworks were highlighted followed by brief overviews of potential application to the maintenance problems in a manufacturing industry. Aboelmaged, M.G. (2009) A number of key findings emerged in his work: Six Sigma research is growing rapidly, covering various disciplines and domains with a great focus on Six Sigma tools and techniques; empirical research is dominant with more emphasis on case study approach; and the growing gap between manufacturing- and service-focused articles implies the return of Six Sigma to manufacturing as its initial base. Although a large volume of literature is available on Six Sigma, the topic is still under development and offers potential opportunities for further research and applications.

Chakrabarty, A. and Tan, K.C. (2009) Their findings confirmed the inclusion of critical success factors, critical-to-quality characteristics, and set of tools and techniques as observed from the literature. In the case of key performance indicators (KPI), there were different interpretations about it in the literature and also by industry practitioners. Some literature explains KPIs as performance metrics whereas some feel it as key process input or output variables, which is similar to interpretations by practitioners of Six Sigma. The responses of ''not relevant'' and ''unknown to us'' as reasons for not implementing Six Sigma show the need for understanding specific requirements of service organizations. Setijono, D. (2009) A general (basic) assumption in Six Sigma that data follow normal distribution is both an advantage and a disadvantage. The normality assumption is advantageous in the sense that it simplifies the calculation. However, normality assumption is not always realistic although it can, on the other hand, be argued that: non-normal distribution can be transformed into normal distribution; and The sum of independent random variables will be approximately normally distributed (central limit theorem).

Chakrabarty, A. and Leyer, M. (2010) They developed framework that added a new contribution to the theory of Six Sigma in financial services. Existing literature is mainly focussing on the project level or highlighting general CSFs for companies adopting Six Sigma. However, the organizational conditions needed to perform successful projects in line with the CSFs remain undefined. Thus, a gap exists between the companywide requirements and the detailed descriptions how to conduct single projects. The presented framework fills this gap by defining the organizational conditions to apply Six Sigma on a companywide level in financial service companies. Beside the theoretical contribution of this research, the framework can be used by financial services companies to evaluate their Six Sigma activities. The framework will deliver an overall picture to help identify which relevant aspects have been considered, and which are missing. Thus, the Six Sigma initiative can be made more successful.

Goh, T.N. (2010) Six Sigma aligns and integrates statistical tools for quality excellence in a manner that is at odds with a number of long-held quality improvement concepts. Six Sigma also emerged at the right time, when data processing hardware and software became prevalent at the personal level. Such theoretical and practical advantages have rendered Six Sigma a popular framework for quality improvement for more than a quarter of a century. Quality practitioners and managers may well ponder upon the implications of the paradigm shift brought about by Six Sigma; they need not necessarily follow the DMAIC roadmap in their endeavors, but certainly those traditional slogans should now be viewed as what they really are – statements which are politically correct, but on scrutiny are devoid of operational power.

Sokovic, M. et. al. (2010) DFSS methodology is a systematic and disciplined approach to product or process design including all organization functions from the early beginning, with the objective to design things right from the first time. Voice of the customer (VOC), to gather customer requirements, and Quality Function Deployment (QFD) are tools to identify customer requirements, translate them into product's technical design requirements and prioritize them according to weighted importance to meet customer basic requirements. The methodology RADAR (an integral part of EFQM Excellence model) is strategic, systematic, fact-based framework which provides tool for evaluation of organizational results, approaches, deployment, assessment and review. Kaushik, P. (2011) in this study author stated that the six sigma methodology DMAIC had been mostly successful in large industries, but there is need to implement six sigma methodology in small and medium sized enterprises. Here, six sigma has been implemented by author in a die casting manufacturing unit which has been taken as a small and medium sized industry.

Antony, J. and Kumar, M.(2012) The results of their study suggested that upper management within the organization is not getting directly involved in the actual implementation of anything that would come close to encouraging widespread use of Lean and Six Sigma. The ability to successfully implement Lean and Six Sigma cannot be something that is left with only a few people. Instead, it must be something that the entire organization takes seriously. This requires that senior management must provide the resources and training necessary to make it happen. At the same time, there must be encouragement, which can range from financial incentives to simply providing constructive feedback to employees. Goh, T.N. (2012) argued that it is worthwhile noting that Lean Six Sigma has been largely propagated outside academia and embraced by industry, which gives it a practical bent but would also mean that occasionally insufficient attention is paid to the related theoretical underpinning. The enthusiasm that is seen nowadays for personal certification is necessary but by no means sufficient to spread the effective practice of Lean Six Sigma especially in service systems. Indeed it must be said that it is only an organization with a critical mass of individuals with statistical thinking, not some certified individuals more concerned with their qualifications than customer benefits, that could bring out the true power of Lean Six Sigma.

Goh, T.N. (2012) suggested six points for Six Sigma professionals to pursue, in the interest of continued relevance of Six Sigma in the coming years. These are:

1. Shred the "greed and fear" paradigm for the adoption of Six Sigma
2. Promote the use of Six Sigma in smaller organizations
3. Beware of the certification trap which basically puts the cart before the horse
4. Align or integrate Six Sigma with other frameworks for business excellence
5. Enrich the body of knowledge of Six Sigma in professional training and applications
6. Be innovative and sensitive to changes in extending the applications of Six Sigma.

Sambhe, R.U. (2012) From review of literature, author enables to have a sound realization of six sigma implementation within the SMEs. From the reviews, empirical studies, customer's encouragement and support play vital role for initiating this Six Sigma drive in SMEs. Predominantly, Indian manufacturing enterprises are initiated implementing SS practice in large proportions as compared to service sector and out of utmost of the enterprises employing DMAIC methodology specifically rather DMADV and lean Sigma, from one study of in Indian mid-sized auto cluster. Financial and human resources are the two major constraints in Six Sigma implementation in small and medium scale enterprises. The top management commitment is most critical success factor in SS methodology implementation since it shows highest rank from most of former researches. The selection of the right project is over and above a challenge but customer satisfaction and financial benefits can have major focus as key integrants of project selection criteria's for SS implementation. The paper brings to end with, the project selection should target on needs which are assorted as per organizational explicit requirements and cost savings as well there should be no exercise on issues that fail to reduce cost.

Zhang, Q. et al. (2012) reviewed the published literature related to lean six sigma from start to date. Their methodology involved the review study of 116 papers related to Lean six sigma from well known database searches including Science Direct, EBSCO host, Emerald and Google Scholars. The paper included the results from different perspectives such as implementation of Lean six sigma, Focus Area, Focus Industry, Focus Country, Year Wise Publications and Year Wise Focus Area and Focus Industry. The review of literature found that Lean Six Sigma is mostly implemented in the Health industry. Research on LSS is on elementary stage. Lean Six sigma framework in SME organizations is needed.

Taneja, M. and Manchanda, A. (2013) attempted to justify the highly useful role of management techniques like Six Sigma for SME's, which are normally presumed to be in the domain of large industries. Product parameter variation is found to be a big problem in manufacturing industry. The education and training component is much harder for smaller companies. Moreover, small companies do not have the slack to free up top talented people to engage in training followed by execution of Six Sigma projects as they are crucial to the day-to-day operations and problem solving within the company. Being able to link compensation to Six Sigma implementation is much easier in small companies compared to a large company.

Khaidir, N.A. et al. (2014) his paper provides the research review of SS practices and process innovation and attempts to make contribution in this area through a study based in Malaysian healthcare industry. Examination of the research literature shows that there is a lack of empirical research that systematically examines the relationship between SS practices and process innovation. In order to that, the purpose of this study is to carry out structural analysis the SS practices (leadership; costumer focus; structured improvement procedure; and focus in metric) and process innovation (radical process innovation; incremental process innovation; and service process innovation) for Malaysian healthcare industry. For the future agenda, a set of questionnaire are developed. Next, analyse according to SEM techniques will used in order to get the empirical result. Facts that have been highlighted in this study hopefully can contribute to the organization and researchers to investigate more deeply the relationship between SS practices and process innovation with better awareness. Esposto, F. according to him, "Six Sigma is a revolutionary business process designed to significantly reduce organizational inefficiencies thereby increasing bottom- line profits. The concept is to eliminate defects that take time and effort to repair, not to mention make customers unhappy. It is a management philosophy that eliminates defects by emphasizing understanding, measuring and improving processes."

Six Sigma Methodology

Six Sigma is based on the principle or methodology named as DMAIC principle contains a systematic examination of the process from starting to the finishing of the product. In the starting, we choose the product having the Part per Million (PPM) in terms of rejection is very high and need to be improved. We apply Six Sigma methodology in the terms of DMAIC principle for reducing the Part per million (PPM) of the product in terms of rejection. DMAIC, refers to a data-driven quality strategy for improving processes, and is an integral part of the Six Sigma quality initiative. DMAIC is an acronym used for five interconnected phases – Define, Measure, Analyse, Improve and Control. It is a tool for ensuring total customer satisfaction, minimizing cost of poor quality, gaining extra revenues and adding a competitive edge in the fiercely competitive market.

As for reducing defects, the philosophy of all the quality approaches are the same. What differentiates Six Sigma from other quality approaches are its practical orientation, process centricity and measurement orientation, rigorous training scheme and stakeholder involvement. The tools in Six Sigma are not new but its direct linkage to business objectives and priorities makes it a powerful strategy in business. Six Sigma is used to designate standard deviation. Standard deviation is a measure of variation within a process. Sigma is a measurement used to determine the performance of a process. It tells how good or bad the quality levels of the companies are and what progress they are making on that journey. In Six Sigma process we see systematic application of statistical tools which measures the processes and analyses them to reduce variations in output (Gaddam L.R.and Amancha S. 2005).

Five Phases of Six Sigma Methodology:

The Six Sigma methodology is universally recognized and defined as comprising the following five phases: Define, Measure, Analyze, Improve and Control (DMAIC) as shown in figure 6 & see Table 2. In some organizations only four phases are used: Measure, Analyze, Improve and Control (MAIC). In this case, the Define deliverables are considered pre-work for a project or are included within the Measure phase (Esposto, F.).

The DMAIC methodology breaks down as follows:

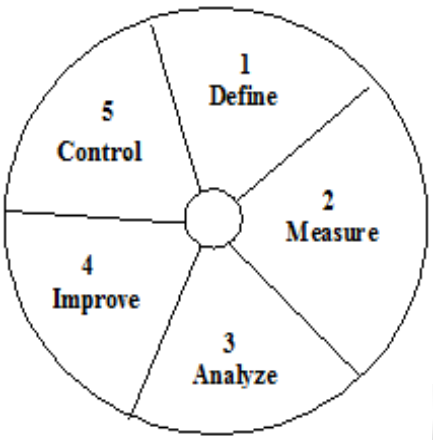

Figure 6: DMAIC Processes

Steps	Key Processes
Define	Define the requirements & expectations of the customer Define the project boundaries Define the process by mapping the business flow
Measure	Measure the process to satisfy's customer needs Develop a data collection plan Collect & compare data to determine issues & short fall
Analyze	Analyze the causes of defects and sources of variation Determine the variations in process Prioritize opportunities for future improvement
Improve	Improve the process to eliminate variations Develop creative alternatives and implemented enhanced plans
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

Table 2: DMAIC Key Processes

For solving any problem, the methodology adopted must cover all possible causes of problem. If the methodology of problem solving is not comprehensive enough, the solution obtained at completion will not be correct and problem will resurface sooner or later (Kaushik, P. and Khanduja, D. 2008). The Six Sigma methodology practitioners measure and assess process performance using DPMO and sigma. In the present study DMAIC (Define, Measure, Analyze, Improve, Control) methodology is studied to analyze processes in order to root out sources of unacceptable variation, and develop alternatives to eliminate or reduce errors and variation. Once improvements are implemented, controls are put in place to ensure sustained results. Using this DMAIC methodology has netted many organizations significant improvements in product and service quality and profitability over the last several years. The description of DMAIC is given below in the flow diagram(see figure 7) :

- Define - The problem has to be defined clearly and explicitly. It is a major step in selecting and prioritizing a project. A well-defined problem clearly sets ground rules for improvement. So in define phase, Process Map and High Level Process Map- a SIPOC (Supplier, Input, Process, Output, Customer) diagram can be drawn which will be used to document manufacturing sequence of the concerned product and to identify the scope for improvement.

- Measure - Measurement points, sources, tools and equipment, and precision and accuracy play a vital role in the project. Without measurement there is no control. Measurements are essential to collect data. So in measure phase, from the gauge R & R study, the percentage study variation for the product can be calculated to check the accuracy of micrometer.

- Analysis - The right approach in using analytical tools or methods will help to find a clearly defined solution. Data are analyzed into information to create a knowledge base and make decisions for actions. So statistical tools like Histogram, Process Capability Analysis, T-Test and Fishbone Diagram can be used to carry out the analysis. Then from the process capability analysis one can find amount of opportunities for improvement in the processes.

- Improve - Selecting the best alternative solution and implementing to remove the cause of a problem will bring the desired result. Improvements can be in the form of efficient equipment, new process, enhanced training to the employees, or new material. Improvements are actions, both corrective and preventive. So in improve phase, Design of Experiments can be done to find out the optimum conditions for the vital few factors found out after the T-Test.

- Control - After the implementation of improvement activities, monitoring becomes essential to control the processes. In control phase, X bar/R control charts can be drawn to visualize the presence of assignable causes of variation after implementing the changes in factors proposed by DOE and for ensuring that the process continues to be in a new path of optimization.

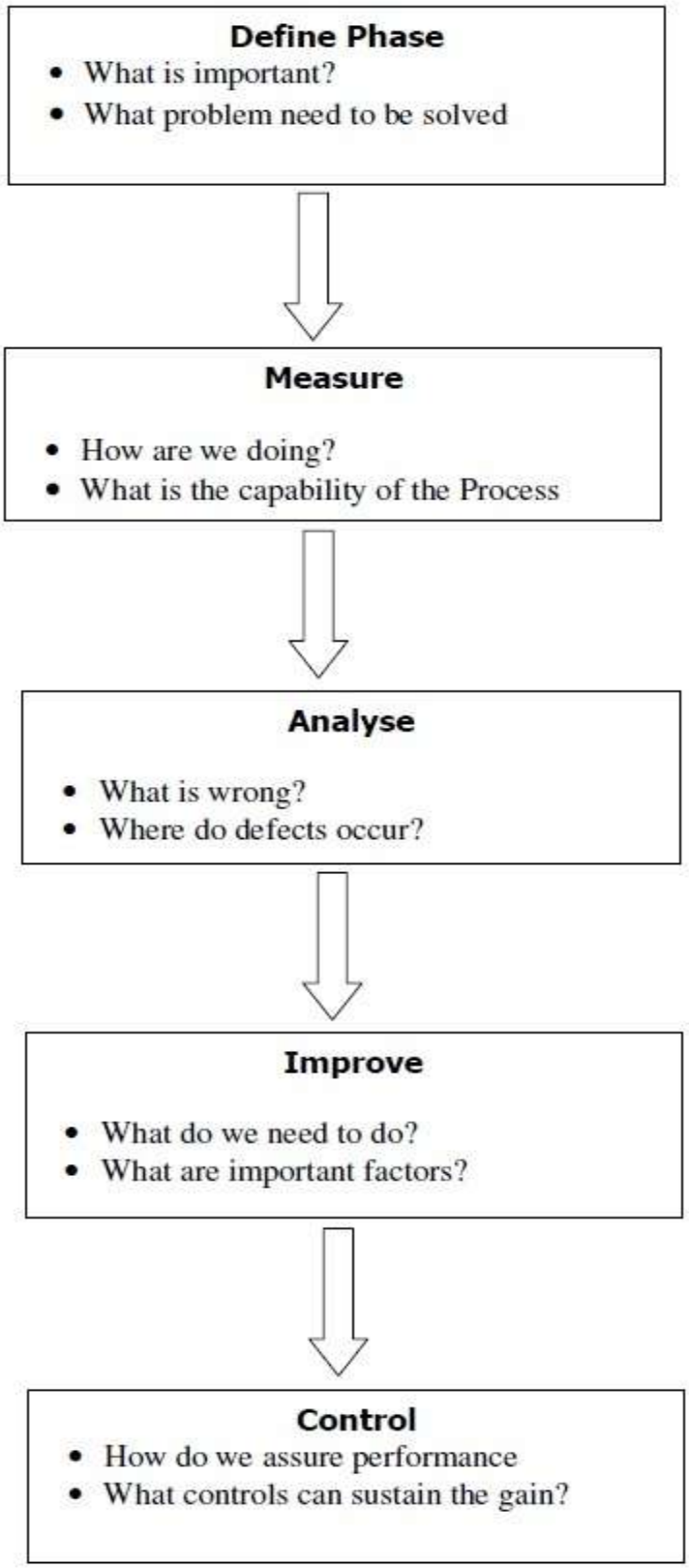

Figure 7: Flow Diagram of Six Sigma, Source: (Gaddam, L.R. and Amancha, S 2005)

Conclusions

The purpose of this paper is to provide a sound discussion on Six Sigma DMAIC methodology. This paper reviews the implications of applying Six Sigma methodology over the various fields. An Elaborate review of literature in the implications of Six Sigma techniques has provided a strong base for a research to be carried out in the said area, reducing the limitations and improving the results. The Six Sigma methodology is designed to facilitate continuous improvement and process control. Six-Sigma is a highly systematic, data-driven approach used to analyze the main cause of problems and improves the overall qualitative production of the manufacturing firm. The successful implementation of Six-Sigma depends on committed and effective leadership. Also, it is necessary to combine the right projects, the right people and the right tools in order to gain best results by applying Six Sigma methodology in any industry. The literature review has proved that applying Six Sigma technique requires mastery in skills and there is no doubt that the technique is a boom to the manufacturing industry. There is a vast scope of the technique in many areas where it has not yet been used. The future of industrial world is extremely bright when seen from point of view of quality improvement tool: Six Sigma.

References

[1]. Aboelmaged, M.G. (2009), "Six sigma quality: a structured review and implications for future research", International Journal of Quality & Reliability Management, Vol. 27 No. 3, pp. 268-397.
[2]. Antony, J. And Kumar, M.(2012), "Lean and six sigma methodologies in NHS Scotland: An empirical study and directions for future research", Quality Innovation Prosperity XVI/2-2012, ISSN No. 1338-984X, pp. 19-34.
[3]. Arendt, M. (2009), "Innovation and design for six sigma", Economics and Organization of Enterprise, Vol. 4 No. 2, pp. 22-32.
[4]. Bergquist, B. (2008), "Networking to Boost SME Lean Six Sigma Potential", 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 488-500.
[5]. Brady, J.E. and Allen T.T. (2006), "Six sigma literature: A review and agenda for future research" link: BradyAllenSSLitRev2206. pp. 2-49.
[6]. Brun, A.(2008), "Six sigma project identification and selection: A benchmark Among Italian and US companies", 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 74-123.
[7]. Cagnazzo L. and Taticchi P.(2007), "SIX SIGMA: a literature review analysis", ISSN: 1790-5117.
[8]. Cagnazzo, L. and Taticchi, P. (2008), "Six sigma: a literature review analysis" , Recent advances in E- activities, information security and privacy, ISBN: 978-960-474-143-4, pp. 29-34.
[9]. Chakrabarty, A. and Leyer, M. (2010), "Developing a six sigma framework-Perspectives from financial service companies", Managing Service Quality.
[10]. Chakrabarty, A. and Tan, K.C. (2007), "Current state of six sigma application in services", Managing Service Quality, Vol. 17 No. 2, pp. 194-208.
[11]. Chakrabarty, A. and Tan, K.C. (2009), "An exploratory qualitative and quantitative analysis of six sigma in service organizations in Singapore", Management Research News, Vol. 32 No. 7, pp. 614-632.
[12]. Chandra.W. (2002), "Introducing six sigma a framework for quality management", Bandung, 12 October 2002.
[13]. Dahlgaard, J.J. and Park, S.M.D. (2006), "Lean production, six sigma quality, TQM and company culture", The TQM Magazine, Vol. 18 No. 3, pp. 263-281.
[14]. Douglas, A. and Middleton, S. (2008), "Enhancing the six sigma problem-solving methodology Using the soft systems methodology" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 472-487.
[15]. Esposto, F., "Six sigma basics", USC Consulting group, link: six-sigma-basics41.pdf.
[16]. Fan, X. (2008), "The Integration of six sigma and Green supply Chain management" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 554-572.
[17]. Fraser, N. (2008), "Lean six sigma applied to a customer facing operations Process In financial services" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 422-446.
[18]. Feng. Q. and Kapur K. C.(2007), "An introduction to SIX SIGMA for students and new quality practitioners", International journal of SIX SIGMA and competitive advantage.
[19]. Gaddam, L.R. and Amancha, S. (2005), "Six sigma in distance education: A Roadmap for breakthrough", ICDE International Conference, New Delhi.
[20]. Gibbons, P.M. (2008), "Implementing 5s for lean six sigma deployment" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 162-197.
[21]. Goh, T.N. (2002), "A strategic assessment of six sigma", Quality and Reliability Engineering international, Vol. 18(DOI: 10.1002/qre.491), pp. 403-410.
[22]. Goh, T.N. (2010), " Paradigm shifts in modern approach to quality excellence", Current Issues of Bussiness and Law, Vol.5 No. 2, pp. 320-327.
[23]. Goh, T.N. (2012), "Some practical issues in the application of lean six sigma to service systems", Nang Yan Business Journal , Vol.1.1 No. 4, pp. 21-26.
[24]. Goh, T.N. (2012), "Six sigma at a crossroads", Current Issues of Business and Law, Vol. 7 No. 1, pp. 17-26.
[25]. Grant, N. (2008), "Process Improvement at HM Naval Base- Clyde Giving Lean six sigma their place in a critical operation" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 501-553.

[26]. Harrison, A. (2008), "What makes lean/six sigma succeed: Experiential Improvement Strategy (model): A case study" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 447-471.
[27]. Kaushik, C. et al. (2007), "Six sigma application for library services", DESIDOC Bulletin of information Technology, Vol. 27 No. 5, pp. 35-39.
[28]. Kaushik, P. and Khanduja, D. (2008), "DMAIC Methodology: The Enigma of Six Sigma",SCMS Journal of Indian Management, Vol. 5 No.1, pp. 9-18.
[29]. Kaushik, P. et al. (2008) "A case study Application of Six Sigma methodology in a small and medium-sized manufacturing enterprise" , The TQM Journal, Vol. 24 No. 1, 2012 pp. 4-16.
[30]. Kaushik, P. (2011), "Relevance of six sigma line of attack in SME's : a case study of die manufacturing unit" , Journal of Engineering & Technology, Vol. 1No. 2, pp.107-112.
[31]. Kevin Linderman, Roger G. Schroeder, Adrian S. Choo, 2003 Six Sigma: a goal-theoretic perspective.
[32]. Khaidir, N.A. et al. (2014), "Investigation of six sigma practices and process innovation for Malaysian healthcare industry", International Journal of Innovation and Applied Studies, Vol. 5 No. 2, pp. 131-138.
[33]. Laureani,A. (2008), "Lean six sigma in Human Resources: A case study of Transactional service" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 338-350.
[34]. Marsh, J. (2008), "Development of a 5s sustainability model for use with lean And/or Six sigma projects", 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 302-320.
[35]. Miguel,P.A.C. (2008), "Exploring case studies on the adoption of six sigma and lean Production" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 198-218.
[36]. Moyers, H. et al. (2004), "Choosing a quality/performance improvement methodology", Shaw Resources (www.shawresources.com).
[37]. Oke, S.A. (2007), "Six Sigma: A literature review", South African Journal of industrial Engineering, Vol. 18 No. 2, pp. 109-129.
[38]. Panah, M.H. et. al. (2008), "Six sigma process and its impact on the organizational productivity", World Academy of Science, Engineering and Technology, Vol. 2 No. 7, pp. 337-341.
[39]. Rajamanoharan, I.D. (2008), "Expected Role of management accounting within the six Sigma methodology: case evidence" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 33-73.
[40]. Rowe, P. (2008), "Application of Design for six sigma processes to the design of an Aero Gas Turbine" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 380-421.
[41]. Salaheldin,S.I. (2008), "The implementation of six sigma in the banking sector in Qatar" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 219-256.
[42]. Salah, S. and Carretero, J.A. (2008), "Six Sigma and Total Quality Management (TQM): Similarities, Differences and relationship" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 257-278.
[43]. Sambhe, R.U. (2012), "Journey of Six Sigma in Indian SMEs–Literature Snapshots", International Journal of Engineering and Innovative Technology (IJEIT), Vol. 2 No. 2, pp. 29-37.
[44]. Setijono, D. (2009), "Normal approximation through data replication when estimating DPMO, DPMO, left-side and right-side Sigma levels from non-normal data", International Journal of Quality & Reliability Management, Vol. 27 No. 3, pp. 318-332.
[45]. Shahin, A.(2008), "Integration of six sigma and service quality Function Deployment – with a case study in the Hospitality Industry", 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 1-22.
[46]. Shamah.R. (2008), "Lean thinking of Improving perceived Healthcare Quality" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 124-161.
[47]. Shokri, A. (2008), "Adoption of daily required technologies and tools in a food service Organisation to promote an effective simplified six sigma based Methodology" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 573-605.
[48]. Sokovic, M. et. al. (2010), "Quality improvement methodology- PDCA cycle, radar matrix, DMAIC, DFSS", Journal of Achievements in Materials and Manufacturing Engineering, Vol. 43 No. 1, pp.476-483.
[49]. Taneja, M. and Manchanda, A. (2013), "Six sigma an approach to improve productivity in manufacturing industry", International Journal of Engineering Trends and Technology(IJETT), Vol. 5 No. 6, pp. 281-286.
[50]. Thomas, A. (2008), "Proposing a sustainable six sigma model" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6,pp. 279-301.
[51]. Timans, W. (2008), " Lean six sigma, an expert-based study on tool & Techniques in a manufacturing context", ISBN: 978-0-947649-32-6, pp. 23-32.
[52]. Yeung, S.M.C. (2008), "Using six sigma – SIPOC for customer satisfaction" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 351-379.
[53]. Yuniato, H.A. (2008), "Beyond six sigma: A holistic quality maintenance system EmbodyingSystems thinking, systems engineering Knowledge-based" , 3rd International Conference On Six Sigma, ISBN: 978-0-947649-32-6, pp. 321-337.
[54]. Zhang, Q. et al. (2012), "Lean six sigma: A literature review", Interdisciplinary Journal of Contemporary research in business, Vol. 3 No. 10, pp. 599-605.