

Journey of Six Sigma in Indian SMEs—Literature Snapshots

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Abstract— *Six Sigma is a process improvement and defect reduction methodology employed to boost company's outturn and actualize the organizational excellence over appropriate exercising of statistical tools. As Six Sigma is a customer driven methodology, so it is necessary to prioritize the projects which provides utmost satisfaction to buyers through fulfillment of their demands and achieves more gain for the enterprise. Success of Six Sigma is leaned on project prioritization and selection. The project selection is the preceding exercise and one of the critical success factors for accomplishment of Six-Sigma mechanism. The selection criteria which specifically focuses on quality, cost and delivery, adds impacts of project. Selecting a right Six Sigma is difficult and cumbersome task but failing to do so, will likely to offset cost and efforts as well add frustration on team member. A review of the literature is expounded, accentuating scenario of Indian SMEs as well the state of Six Sigma implementations. The paper also spotlights on literature review based on critical success factors for successful implementation in disparate SMEs' scenario as well converge the significance of project selection in Six Sigma structures which is frame of intense attention through experience of former researches.*

Index Terms— **Indian Scenario, Six Sigma, Status Of Six Sigma Practice in Indian SMEs, Critical Success Factors, Project Selection and Criteria.**

I. INTRODUCTION

India is emerging as one of the key automobile components centre in Asia and is expected to play a significant role in the global automotive supply chain in the near future (www.indiainbusiness.nic). Manufacturing competence of the Indian automotive sector is much higher than that of electronics, machinery, and process industries (Dangayacha and Deshmukh, 2003). The vast range of products are manufactured in the small scale sector, the nature of the export composition makes it amply clear that products from mostly tiny or smaller enterprises (which almost singularly dominate the SSI sector) have hardly improved quality or exportability through supportive interventions towards product / process innovations, diversification and larger market access (Das K 2007). As well with the recent pronouncement of the 'landmark' MSMED Act, 2006, the Indian government has explicitly recognized the dynamic role to be played by the MSMEs in an increasingly globalised world. The clear thrust of the recent policy initiatives has been three-fold: i) enhance competitiveness through encouraging an innovative ethos amongst firms and being quality conscious; ii) increase links

with multiple stakeholders with a view to benefit from networks both nationally and globally; and iii) strive for a larger market presence beyond the domestic (Das K 2007). As well with the domestic market becoming more competitive and quality-conscious, high quality standards would be necessary for any SME even to supply to domestic OEMs or high Tier companies in a significant way, and to get out of the trap of 'low quality, low price and essentially aftermarket supplier'. Even the replacement market share will shrink for low capability firms (Chaturvedi, 2003). As a global hub for automobile components, Indian automobile components sector has a bright prospect. So, quality is vital issue for gaining competitiveness in global market. Many quality management practices and frameworks have been proposed to improve the competitiveness in the modern world. Statistical Process Control (SPC), ISO 9000, KAIZEN, Total Quality Management (TQM), Total Productive Maintenance (TPM), Benchmarking, Theory of constraints, Kaizen, Business Excellence models and many more improvement programs are adopted by large Indian corporations. But a large portion of small and medium-sized enterprises (SMEs) that make up a huge supply base of large organizations are still unable to compete even in domestic market in terms of price and quality (N. L. Hiregoudar et. al., 2011). But to remain competitive, SMEs must be capable of delivering high quality products and services on-time at a reasonable cost (Sousa-Poza, et. al., 2009). The reasons for not using proven improvement strategies may be manifold including the lack of awareness of the new improvement strategies and techniques, non committing top management, fear of huge investment, and employees' reluctance to change (N. L. Hiregoudar et. al., 2011). The following sections will focus on Six Sigma fundamentals, status of SS implementation in Indian SMEs including automotive sector. The next section criticise the success factors of the Six Sigma implementation. Further their is spotlight on CSFs consideration at disparate scenario, project selection and its criteria for Six Sigma initiative to achieve utmost gains from the business.

II. SIX SIGMA

Process improvement is one of the most important tasks of the management in production companies. A contemporary business conditions in extremely turbulent environment with frequent technological changes require constantly adjusting of all activities with emphasis on a business and production process improvement which should be able to enable

achieving a strategic goals. Modern business practice recognizes many Process improvement techniques and Six Sigma program is one of the common used (Diana Bratić, 2011). So, Six Sigma is an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates (Linderman et. al. 2003). Anbari (2002) marked out Six Sigma is more comprehensive than prior quality initiatives such as Total Quality Management (TQM) and Continuous Quality Improvement (CQI). The Six Sigma method includes measured and reported financial results, uses additional, more advanced data analysis tools, focuses on customer concerns, and uses project management tools and methodology. Linderman, et. al., (2003) in defining Six Sigma stress up on process improvement and new product development by stating that Six Sigma is an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates. Kwak and Anbari (2006) stated the Six Sigma approach was first applied in manufacturing operations and rapidly expanded to different functional areas such as marketing, engineering, purchasing, servicing, and administrative support, once organizations realized the benefits. The Six Sigma methodology DMAIC offers a structured and disciplined process for solving business problems. Six Sigma uses tools designed to identify root causes for the defects in processes that keep an organization from providing its customers with the consistent quality of products the customers require on time and at the most reasonable cost (Zucker, 2007), where as 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 (Mader, 2002). "Six Sigma is an effective means towards operational excellence, which in turn is necessary for achieving performance improvement, financial effectiveness, customer orientation and organizational excellence." Six Sigma concept helps enterprises to formulate, integrate and realize the vision, mission and goals, and therefore to sustain and grow in the environment with growing customers' requirements and intensive competition (Marija A. P., et al., 2010).

III. STATUS OF SIX SIGMA PRACTICE IN INDIAN MANUFACTURING ENTERPRISES

Indian automotive has strong foundation in the form of TS 16949 QMS. But except a few, many have not yet adopted advanced breakthrough quality improvement strategy like Six Sigma and other continuous process improvement techniques. Presumably this can be one of the important reasons for companies not able to gain access to the

international market and contribute significantly to the Indian economy (Prabhushankar G.V, et. al., 2008). Thus, Indian SMEs are required to build their capability in respect of knowledge of global products, and global quality and technical standards. In order to enhance the quality of the output of this sector on par with world class organizations, there is a need to use continuous improvement strategies such as Six Sigma (N. L. Hiregoudar et. al., 2011). Especially large concerns have successfully tried this breakthrough improvement strategy to get solutions in many of their chronic problems. But small and medium enterprises are still ignorant regarding strengths of this improvement drive, of course there may be few exceptions. Sparing some sporadic articles and case studies in the corporate publications and magazines, the research publications illustrating wide-ranging studies regarding penetration of Six Sigma among Indian industries as a whole are not available so far (Desai, D.A. and Patel, M.B. 2009). Antony, J. (2008) provides an excellent resource for those people who believe that Six Sigma is primarily meant for large companies and also makes an attempt to remove one of the common myths of Six Sigma. The results of his study clearly indicate that Six Sigma is equally applicable to both large corporations and small companies. In fact, the results are quicker and much more visible in smaller companies than in larger corporations. Desai and Patel, (2009) pinpointed the results obtained from a cross-sectional study accomplished for the rate of response and benefits of Six Sigma implementation from different key sectors of the Indian industries. The manufacturing sector is on the top in implementing Six Sigma with 69% contribution. IT (Information Technology) industries are second to manufacturing sector in implementing Six Sigma with 15% contribution. Manufacturing and service combined and others are equal in implementing Six Sigma, both at a low contribution of mere 8%. The largest benefit drawn from Six Sigma implementation by large scale industries is "reduction in costs", whereas it is "increase in profitability" for medium scale industries. Kaushik P. et. al., (2012) focus and attempt to justify the highly useful role of quality management techniques like Six Sigma for SMEs which are normally presumed to be in the domain of large industries. Six Sigma methodology has been applied to a small unit manufacturing bicycles chains with dwindling productivity levels and found that the chain manufacturing firm can increase its profit by controlling high rejection rate of cycle chain bush. Application of Six Sigma project recommendation brought up the process sigma level to 5.46 from 1.40 by reduction in bush diameter variation in the process of bicycle chain bush manufacturing. This increase in sigma level is equivalent to monetary saving of Rs 0.288 million per annum, which is a noteworthy figure for an industry of such level. Some case studies are discussed illustrating improvement in customer delivery commitments; improving productivity and

profitability through Six Sigma at small sized Indian industries (Desai, 2008, 2006). Prabhushankar G.V, et. al., (2008) focus on results obtained by survey of Six Sigma implementations in Indian automotive components Sector. They suggested that financial constraint is the significant barrier for implementing Six Sigma. Increase in profitability and reduction in cost of poor quality are the significant benefits. 'Not a statutory requirement' and 'not insisted by customers' are the prominent reasons for not implementing Six Sigma. Prabhushankar G.V, et. al., (2009) focus and prompts the need for exclusive model of QMS which would link the standards, innovation practices and Six Sigma for enabling the automobile manufacturing sector of not only India, but also of other developing countries to achieve world class competitiveness. Sambhe R. U. et. al., (2011) pinpointed lack of financial resources; time constraint in data collection and analysis; lack of human resources found impeding in Six Sigma implementation from a survey of Indian medium scale automotive industries. They also stated Six Sigma implementation in majority to implement DMAIC methodology, where almost no practices of DFSS as well as lean manufacturing are found from their empirical study. Some researches touches on this subject by stating that Six Sigma propound many SMEs as identical benefits as larger companies and there is nothing inherent in Six Sigma that makes it unsuitable for smaller companies. So, this would allow for constructing a potent base for Six Sigma implementation in SMEs, which will lead the enterprises to yield substantial results and confront customer satisfaction.

IV. REVIEW OF CRITICAL SUCCESS FACTORS (CSFS) FOR SS IMPLEMENTATION IN SMES

The success of Six Sigma programs hinges on the sequence of many Six sigma elements/activities or a model for implementation (Chakravorty, 2009). CSFs are those factors that are critical to the success of any organization, in the sense that, if objectives associated with the factors are not achieved, the organization will fail—perhaps catastrophically (Rockart, 1979). These are essentials and play a vital role for successful Six Sigma implementations, so the prioritization of the critical success factors is very importance because it is infeasible to devote their efforts to all critical success factors. Actually, in the beginning of implementing the Six Sigma, practitioners and management team should focus their efforts on the critical success factor that has the highest priority and gradually attend to the rest of the factors which have running priority afterwards (N. Somsuk et. al., 2011). Enterprises need to identify and focus on few vital factors for process performance which could result in customer satisfaction and business gains. Critical success factors proposed from the research studies on Six Sigma implementation in SMEs from disparate locations are presented as followings review of literature. From the research finding, Chang T. L. (2002) focuses on critical

success factors and pinpointed top five (5) factors as top management leadership & commitment, a well-implemented customer management system, the education and training system, a well-developed strategic planning system, equipping all with quality tool for implementing a Six Sigma QMS in SMEs. (<http://www.pqa.net>) Based on Chang's research findings, Process Quality Associates (PQA) has developed a Six Sigma implementation framework for Small and Medium Sized Enterprises (SMEs). In designing a Six Sigma framework PQA took into account certain positive characteristics inherent in this business sector which can speed up the structuring of an effective Six Sigma Quality Management System (QMS) more than in large businesses, such as flexible process flows, short decision-making chain, and high visibility of senior management, etc. On the other hand, there are factors that can be disadvantageous, such as lack of resources and expertise in change initiatives. (www.pqa.net). Pulakanam and Voges (2004), spotlighted on review of 17 empirical studies undertaken in UK, USA, Canada, India, Brazil, Singapore, and Taiwan on Six Sigma implementation covering all sectors of industries including healthcare, financial institutions, information technology as well as the SME sector. Senior management commitment, linking Six Sigma to business strategy and customers, organizational readiness and project management skills have been identified as most important CSFs in all from their studies. Antony et. al., (2005) converges on their study in UK manufacturing SMEs and suggested management involvement and participation, linking six sigma to customers and business strategy are the most critical success factors for successful deployment of Six Sigma in SMEs. M. Kumar et. al., (2009) reported implementation in UK small- and medium-sized enterprises (SMEs) They suggested strong leadership, management commitment, communication, education, and training were critical in introducing and driving any culture-change initiatives such as Six Sigma within SMEs. The survey analysis of Six Sigma implementation in Indian automobile components sector proposed training; linking Six Sigma to customers; project prioritization and selection are ranked as topped listed factors followed by project management skills and cultural change came. Management involvement and participation and understanding Six Sigma methodology stood at fourth level. Linking Six Sigma to business strategy and organizational infrastructure are also rated as significant. Linking Six Sigma to employees and suppliers were rated as not significant. This shows that companies have not linked their Six Sigma programme to its employees and suppliers (Prabhushankar et. al. 2008). Sambhe R. U. et. al., (2011) angled on SS implementation in mid-sized Indian automotive enterprises. They considered total fifteen CSFs for their study, analysis shows that top management leadership and commitment and team selection for Six Sigma project were rated as the two most critical factors for

successful implementation of Six Sigma. The next critical factor was strategic planning system; employee training & education on Six Sigma methodology and utilization of quality tools, followed by effective communication on Six Sigma program, project prioritization & selection, linking Six Sigma for rewards/ recognition to employees, organizational infrastructure, customer management system, culture of collaboration and cooperation. On the lower end, project management skills, empowerment and authority at all levels, linking Six Sigma to suppliers, linking Six Sigma to business strategy, role of information technology were rated as less critical success factors for successful implementation of Six Sigma. The selection and priority of CSFs was quite contrary in literature that can be due to change in economy, culture, enterprises size/type at disparate scenario (see Table 1). Five surveys including 3 surveys focused on SMEs have identified based on the critical success factors for The respondents rank these CSFs on a scale of 1 to 5, 1 (least important), 2 (less important), 3 (important), 4 (very important) and 5 (crucial). Table 1 is shown in Appendix. For Six Sigma implementation. These CSFs are summarized in Table 1. Management commitment, linking Six Sigma to customers and business strategy, training as well as project prioritization and selection have been more prominent factors from overall all studies of SMEs. Extent study and researches is constitutional in this direction to develop new Six Sigma framework based on analysis of CSFs to explore categorically in varied business verticals and lagging study locations of world.

V. SELECTING A PROJECT FOR SIX SIGMA

As Six Sigma is a customer driven methodology, so it is necessary to prioritize the projects which provides utmost satisfaction to buyers through fulfillment of their demands and achieves more gain for the enterprise. Success of Six Sigma is leaned on project prioritization and selection. The project selection is the preceding exercise and one of the critical success factors for accomplishment of Six-Sigma mechanism. The selection criteria which specifically focuses on quality, cost and delivery, adds impacts of project. Selecting a right Six Sigma is difficult and cumbersome task but failing to do so, will likely to offset cost and efforts as well add frustration on team member. If the project is too large or difficult, it will either fail or be cancelled before it can succeed; If the project's scope is too small, upper management may not champion and promote it; If the project's payoff is too small, it will be seen as a wasted effort (Oskar Olofsson, 2011). Project selection is the process of evaluating individual projects or groups of projects, and then choosing to implement some set of them so that the objectives of the organization will be achieved (Meredith, J. and S. Mantel, 2003). The two basic approaches suggested by Jeff Gotro, to achieve the proper project scope is to 1) create a Pareto chart for scrap by product and defect type. Focus the

Black Belt project on the product/defect combination that has the largest financial impact. 2) Determine the amount of scrap and rework for each major process step. Focus the project on the process step that creates the most scrap and/or rework (www.innocentrix.com). Bertels (2003) call attention to the key characteristics differentiating successful six sigma projects from unsuccessful projects is a well-defined project based on the clear and concise description of the project objectives. But, poor project selection continues to happen even in the best-managed and best-performing organizations that can have a huge impact and undermine the success and credibility of the Six Sigma program (Noble, 2004). Six Sigma projects address three different areas of potential improvement: quality, cost and schedule. Critical characteristics in the product, process or service are identified using CTx notation: Critical-to-quality characteristics are designated CTQ; critical-to-cost, CTC; and critical-to-schedule, CTS (www.sixsigmatraining.org). The Six Sigma project selection can be either top-down or bottom-up, depending on the nature of the change required. In some cases senior management will identify a need to implement a major change spanning entire business processes (Oakland, 2003). U. Dinesh Kumar et. al., (2007) focus on six sigma projects targeted at improving the overall customer satisfaction called Big Q projects. They provides a practical approach to guide the selection of six sigma projects for implementation, especially for companies with limited resources as well converges on the sensitivity analysis to understand the uncertainties in project inputs and outputs as well suggested that Data Envelopment Analysis (DEA) tool often used for relative efficiency analysis and productivity analysis, is now successfully constructed for six sigma project selection. Maneesh Kumar et. al., (2009) proposes a hybrid methodology, which combines the analytical hierarchy process and the project desirability matrix to select a project for Six Sigma deployment through a real-life case study. The summary of discussions at QualityGurus.com focus on project selection is regarded as one of around 13 critical success factors in the six sigma literature. While not everyone deems project selection as important as for example top management commitment and team training, many do place it at or near the top in terms of importance. An interesting issue is whether project selection should be part of the "define" phase or whether it should constitute its own phase, which would mean the acronym should be PDMAIC rather than DMAIC. Either way, well-considered selection of projects in terms of clear criteria and with top management involvement is vital (www.QualityGurus.com). Good Six Sigma projects are linked to a clearly defined process and have the following four elements suggested by Jeff Gotro (www.innocentrix.com).

1. There is a gap between current and required/desired performance in a key business process.

2. Closing the gap will have a measurable and large financial impact. The cause of the problem or gap is not clearly understood.
3. There is not a predetermined solution or optimal improvement method readily apparent.
4. The performance of the process can be measured and quantified (at least once per day for initial projects).

To frame and adopt the project selection matrix, it is crucial to apprehend few sections of selection criteria suggested by disparate researchers and experts. Pande et al. (2000) assorted six sigma project selection criteria into three categories: business benefits criteria; feasibility criteria and organization impact criteria. Harry and Schroeder (2000) suggested the criteria for six sigma project selection: Defects per million opportunities (DPMO); net cost savings; COPQ; cycle time; customer satisfaction; capacity and internal performance. Greg Brue, (2006) pinpointed two important criteria for a successful accomplishment of Six Sigma project in small businesses: the effort required and the probability of success. Banuelas et. al. (2006), propose projects based on criteria such as customer satisfaction, financial benefits, top management commitment and the projects integrated with the company's strategy, from the results of the survey of UK organizations whereas Six Sigma Qualtec (2006), focus on the key elements of the project selection process and listed as: commitment of senior management to the process; project selection based on realistic, available metrics; voice of the customer/voice of the business/voice of the process; clear linkage to organizational goals; specific, detailed project plans; properly selected and prepared implementers, with key organizational support and alignment. Seyed, et. al., (2011) determine the importance of project selection criteria and prioritize them as shown in Fig.1. They consider project cost, project duration, information availability, sigma level, top management commitment, team members motivation, the probability of project success, customer satisfaction, rate of return, cost reduction as project selection criteria's for their study.

Priorities with respect to: Goal: project selection



Inconsistency=0.06 with 0 missing judgments

Fig. 1 Ranking Criteria (Source: Seyed, M. K. Et. Al., 2011)

So, the selection of project should be based on requirement of customers and benefits to be expected by the enterprise. The considerable potency of Six Sigma lies with project selection and commensurable time span allowed for the team members to illustrate and focus on problem thoroughly.

VI. CONCLUSION

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.

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Table 1. Ranking Of Critical Success Factors from Disparate Studies

Critical Success factors	Mean (Rank)				
	Chang T.L. (2002)** (www.pqa.net)	Antony (2004) UK service organizations	Antony et. al., (2005) UK Manufacturing SMEs*	Prabhushankar et. al., (2008), Indian automotive (Large Size +SMEs)	Sambhe R. U. et. al., (2011) Indian Mid-sized automotive
Total factor under consideration	10	13	11	11	15
Management involvement and participation	5.99(1) ***95.9% (1)	4.22 (4) [Executive leadership and senior management commitment]	(1)	4.00 (6)	4.6 (1)
A well-implemented customer management system	5.92 (2) *** 74.0% (2)	4.4 (2) [Customer Focus }	(2) [Linking six sigma to customers]	4.67 (1)	3.07 (9)
The education and training system	5.64 (3) ***71.2% (3)	3.1 (10)	(6) [Training]	4.67 (1) (Training)	4.03 (4) [Employee training & education on Six Sigma methodology and utilization of quality tools]
A well-organized information and analysis system	5.58 (4) *** 30.1% (8)				1.8 (15) [Role of Information Technology]
A well-implemented process management system	5.57 (5) *** 34.2% (7)				
A well-developed strategic planning system	5.53 (6) ***61.6% (4)				4.43 (3)
A well-developed supplier management system	5.50 (7) *** 39.7% (6)		(10) [Linking six sigma to suppliers]	2.67 (11) [Linking Six-Sigma to suppliers]	2.1 (13) [Linking Six Sigma to suppliers]
Equipping all with quality tools	5.46 (8) *** 61.6% (4)				
A well-developed human resource management system	5.22 (9) *** 17.8% (9)	2.96 (12) [Incentive program]	(11) Linking Six-Sigma to employees	3.17(10) [Linking Six-Sigma to employees]	3.6 (7) [Linking Six Sigma for rewards/ recognition to Employees]
A well-developed competitive benchmarking system	4.95 (10) *** 13.7% (10)				

Team selection for Six Sigma project					4.57 (2)
Effective communication on Six Sigma Program					3.7 (5)
Organizational infrastructure / readiness		4.15 (5)	(4)	3.33 (9)	3.33 (8)
Culture of collaboration and cooperation		3.7 (7) [Management of cultural change]	(8) [Cultural change]	3.83 (5) [Cultural change]	2.97 (10)
Empowerment and authority at all levels					2.6 (12)
Linking six sigma to business strategy		4.55 (1)	(3)	3.67 (8)	2.03 (14)
Understanding Six Sigma methodology		3.15 (9)	(5)	4.00 (6)	4.03 (4) [Employee training & education on Six Sigma methodology and utilization of quality tools]
Project prioritisation and selection		4.05 (6)	(7)	4.67 (1)	3.67 (6)
Project tracking and reviews		3.02 (11)			
Company-wide commitment		2.85 (13)			
Integration of Six Sigma with financial accountability		3.5 (8)			
Project management skills		4.4 (2) [Project management skills]	(8) [Project management skills]	4.33 (4) [Project management skills]	2.77 (11) [Project Management Skills]

*Figures read from chart

** The respondents rank these CSFs on a scale of 1 to 7, 1: strongly disagree to “7: strongly agree”.

*** % of SMEs placing CSFs in top 5 (Rank in brackets)