Can Six Sigma Enhance Quality in SSI?

Sultana[1] S K Garg[2] Pardeep Sharma[3]
[1]M.Tech. Research Scholar [2]Director [3]Assistant Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]JMIT Radaur

Abstract— At this time there is a tough competition being faced by every industry due to technological development, customer awareness and more number of competitors is producing the same products at competitive prices. The small enterprises are facing challenges from national companies as well as from the multinational organizations. In such a context, they have to adopt such methodologies and techniques that are giving them the advantage as compared to their MNCs. The Six Sigma is the perfect solution for improve the quality, efficiency and effectiveness of the organization by prompt action and logical utilization of its inventory as well as minimizing waste. The value added and non-value added items are to be traced and at last the top management must be totally committed for the implantation of Six Sigma concept to ensure quality and efficiency. The aim of this paper is review the literature Survey of Six Sigma in SME sector and effectiveness of Six Sigma in SME sector.

Key words: DMAIC, Critical to Quality (CTQ), failure mode and effect analysis (FMEA), Total Quality Management (TQM), Small Scale Industry (SSI), Small & Medium Enterprises (SMEs)

I. INTRODUCTION

Small Scale Industries (SSI) has great contribution to the Indian economy. SSI sector is deliberately placed in the industrial population of the country and in the global economy as whole. The increasing demand for high quality products and highly capable business processes by large association has left no choice for the SMEs except to consider the introduction of Six Sigma tool. To meet this new set of business needs, organizations need to install tools, which can enable them to remain competitive and grow in the increasing digital age. Over the relatively short interval of time since the discovery of Six Sigma in Motorola, its application has been primarily within large manufacturing companies and the question therefore remains how best to apply Six Sigma in another place, mainly in small and medium scale enterprises. With growing importance of supply chain management issues in the global market environment, large firms are reliant on small to medium sized enterprises (SMEs) for the provision of high quality products and services at low costs. Six Sigma has been implemented with success in many large corporations and there are very few documented evidences of its implementation in smaller organizations. Each organization will have its own strengths and difficulties, some of which may only become visible during the implementation of the Six Sigma enhancement drive. The major advantages of Six Sigma increase customer satisfaction, which is very important to any size and type of organization. As small companies are more responsive, and it is much easier to buy-in management support and commitment as opposed to large organizations. 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.

II. QUALITY CONCEPT

Quality and cost are the two key elements for the success of any manufacturing industry. Industries are implementing different quality improvement tools such as ISO9000, TQM and etc. Many different techniques and concept have developed to improve product or service quality. There are two common quality related function within a business. One is quality assurance which is the avoidance of defect, such as by the deployment of quality management system and defensive activities like failure mode and effect analysis (FMEA). The other is quality control which is the detection of defects, most commonly associated with testing which takes place within a quality management system typically referred to as verification and validation

The meaning of quality has developed over time. The various definition of quality is given below:

American society for quality (2008): "A subjective term for which each person has his or her own definition. In technical uses quality can have two meanings:

- The characteristics of a product or service which has ability to satisfy stated or implied needs.
- A product or service free of scarcity

A. Genichi Taguchi (1992), with two definitions:

- Uniformity around a target value; the idea is to lower the standard deviation in outcomes to a certain number standard deviation, with rare expectations.
- The loss of a product imposes on society after it is shipped; this definition of quality is based on a more comprehensive view of production system.

Gerald M.Weinberg (1991)" Value to some person".

III. LITERATURE SURVEY

After the discovery of Six Sigma by Motorola in the late 1980s Six Sigma has gained huge attention, especially since its implemented by high profile companies such as General Electric (GE) in the mid-1990s, Many organizations in manufacturing and services, public and private, large and small have joined the Six Sigma band wagon. But except a few, many have not yet adopted quality improvement strategy Six Sigma and other continuous process improvement techniques. Most probably this can be one of the important reasons for companies not able to gain entrance to the international market and contribute significantly to the Indian economy (Prabhushankar G.V, et. al., 2008). Wessel and Burcher (2004) identified the specific requirements for implementation of Six Sigma based on a sample of SMEs in Germany in their study. Jiju Antony

et.al. (2005) described the status of Six Sigma implementation in UK SMEs and in results showed that only 16 out of 60 SMEs (i.e. about 27 percent) were actively used a Six Sigma program. Indian SMEs are required to build their potential in respect of knowledge of global products, quality and technical standards. 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. Prabhakar Kaushik *et.al.* (2008) applied Six Sigma methodology over the SMEs, and improve sigma level from 1.40 to 5.46 by reduction in bush diameter variation in the process of bicycle chain bush manufacturing unit. Pawan Jaglan *et al.* (2011) made a Six Sigma road map for SMEs. Rajeshkumar U. Sambhe (2012) review the literature survey of Six Sigma in SME sectors and also explained that 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%. Vikas Kumar and Rajiv Khanduja (2013) conducted a study in Hydraulic jack manufacturing industry for reduce the rejection rate of pump head of hydraulic jack and improve Z-bench Sigma level from 2.21 sigma to 5.64 sigma and cost saving of 0.01929 million/annum. Md. Enamul Kabir *et al.* (2013) conduct a case study in a Fan Manufacturing Company and claimed that boost up the production up to 312 and with manpower of 98 in a day and line efficiency has been improved from 64.31% to 83.60%. Mr. Deepak Bhardwaj , Mr Akhil (2014) explained that Six Sigma is a versatile strategy to achieve productivity improvement has a lot of potential for the small industries which are being continuously threatened by modern economic turbulence. Rahul Singh and Sumit Kumar (2014) were carried out a study in a SSI unit manufacturing laser machine at New Delhi (India). Initially the process capability analysis for Sigma level was 2.21. But after implementing Six Sigma, values for process capability Sigma level were found out to be 5.64. S. Suresh *et.al* (2015) carried out the study on the factors causing rejection of piston rings in the Automobile Piston Ring Manufacturing industry and reducing rejection 13.2% from 38.1% and improves the process.

IV. METHODOLOGY

If there is an existing process that is not meeting customer specifications, then using Six Sigma five phase methodology DMAIC (Define, Measure, Analyze, Improve, Control) as shown in fig 2 that process can be improved and made more effective, more efficient, or both. DMAIC can be explained as:

A. Define:

First step is to define the problem and what the customer requires. The define phase sets the expectation of the improvement of project and maintenance of focus of Six Sigma strategy on customers requirement. There are many tools used in Six Sigma methodology for defining the problem and these tools are: QFD (Quality Function Deployment), FMEA (Failure model effect analysis), Process mapping, Logic Tree, Pareto Analysis etc.

B. Measure:

This is second phase DMAIC methodology which identifies the defects in the product, gathers valid baseline information about the process and establishes improvement goals. Gauge R & R study is used to measure the accuracy of measuring tool.

C. Analysis:

The analysis phase examines the data collected in order to generate a prioritized list of source of variation. It is the key component of any defect reducing program. This is the stage at which new goals are set and route maps created for closing the gap between current and target performance level.

1) Process Capability Analysis:

Process capability is defined as "performance of a process over certain period of time while in the statistically controlled state". Process capability is the repeatability and consistency of a manufacturing process relative to the customer requirements in the terms of specification limits of a product parameter.

2) Cause and Effect Diagram:

The cause and effect diagram, also known as "fishbone diagram" because it was drawn to look like the bones of a fish, with the main fundamental categories drawn as "bones" to the spine of the fish. It categorizes many possible causes for a problem or an effect.

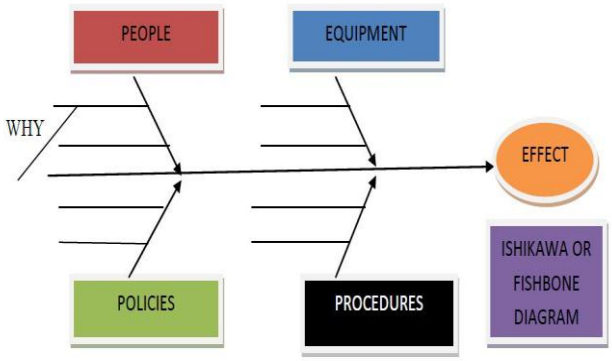

Fig. 1: Cause and Effect Diagram

3) Pareto Chart:

Pareto chart is a special bar graph; the length of which represents frequency or cost (time or money) and is arranged with the longest bars on the left and the shortest to the right. Pareto analysis is a statistical technique in decision making that is used for the selection of a limited number of tasks that produce overall effect.

D. Improve:

The most favorable solution for reducing variation or mean is determined and confirmed in the improve phase. The aim of this phase to confirm the key process variables, to analyze their effects on the critical to quality (CTQ)

1) DOE (Design of Experiments):

Design of Experiments (DOE) is a systematic method to find out the relationship between factors affecting a process and the output of that process. In other words, it is used to find cause-and-effect relationships. This information is required to control process inputs in order to optimize the output and find out the most favorable conditions.

2) Why and Why Analysis:
The 5-Why Analysis method is used to move past symptoms and understand the true root cause of a problem. It is said that only by asking "Why?" five times, successively, you can delve into a problem deeply enough to understand the ultimate root cause.

3) Action Plan:
In this phase, the improvement actions were carried out on the causes of fish bone diagram. An Action Plan was also prepared to tackle all problems.

E. Control:

The final stage of Six Sigma implementation is to hold achieve that have been obtained from the improve stage. Hence in this stage the new process considerations are documented and frozen into systems so that the gains are permanent. This phase emphasizes in determining process capability and implementing various process controls to make sure the modified process stay within acceptable limits.

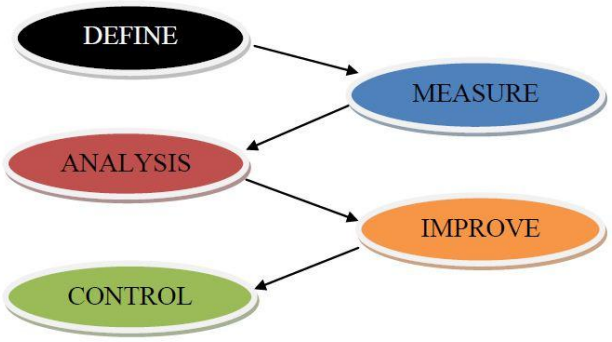

Fig 2: DMAIC Methodology

V. SIX SIGMA CASE STUDIES IN SSI

Author/ Year	Company/Sector	Results
Parsad (2002)	bulb manufacturing company	Improve Sigma quality level 3.2 to 4.5
Ricardo Banuelas (2005)	SME Manufacturing Unit	Reduce DPMO 115070 to 21311, process variability 0.256 to 0.074 in film coating process.
M. Sokovic (2005)	Cimos facility in Buzet, Croatia.	Reduce the material scrap 238 to 173 and modified design in compressor housing machine
Kulkarni P.C (2006)	Circuit Breaker assembly Manufacturing Company	Reduced gas leakage and customer complaints in circular breaker assembly
M. Kumar (2007)	Automobile Accessories manufacturing Company	Improved quality, casting density of the die-casting process by over 12% and savings of around $140 000 per year in automobile accessories
Prabhakar Kaushik (2011)	SME unit manufacturing bi-cycles at Sonipat in Haryana (India)	Improve Sigma quality level 5.46 to 1.40 in SMEs on rejection of bush
Ganguly (2012)	rolling mill	Reduce slippage, cycle time 47 days to 20, raising temp. from 510-573 or improve process in AL company
Dr. Rajeshkumar U. Sambhe (2012)	mid-sized auto ancillary unit	Reduced PPM from 18909 PPM to 2500 PPM for Lighting stalk assembly in auto auxiliary Unit
Vikas Kumar and Rajiv Khanduja (2013)	Hydraulic jack manufacturing industry	Improve sigma level 2.21 to 5.64, saving 0.01929 million per annum and reduce rejection of hydraulic pump
Pawan Jaglan *et al.* (2013)	caliper–house mountings Manufacturing Company	Sigma level improved from 5.46 to 8.16
Md. Enamul Kabir *et al.* (2013)	Fan Manufacturing Company	Boost up the production up to 312 and with manpower of 98 in a day and line efficiency has been improved from 64.31% to 83.60%.
Jogender Singh Yadava *et al* (2014)	Small Injection Moulding Unit	Improve quality, sigma level from 1.80 to 5.46, reducing latch hole diameter variation and saving 0.708 million per annum
Darshan D.Patel (2014)	Bearing manufacturing company	Reduce defect due to fine grinding from 16.6% to 1.19% and increase sigma level 2.47 to 3.76 in bearing manufacturing company
K.Srinivasan *et al.* (2014)	Small sized furnace manufacturing company	Sigma level improved from 1.34 to 2.01and saving Rs. 0.34 million.
Rahul Singh and Sumit Kumar (2014)	SSI unit manufacturing laser machine at New Delhi (India)	Sigma level Improved From 2.21 to 5.64.
U.Shrinivas Balraj and P. Anitha (2014**)**	motor and pump manufacturing company located in Maharashtra	Bearing noise is reduced from 24435 PPM to 7668 PPM, Less speed reduced from 8298 PPM to 1142 PPM Wrong assembly problems reduced from 1844 PPM to 489 PPM.
S. Suresh (2015)	Automobile Piston Ring Manufacturing industry	Rejection reduce 13.2% from 38.1% of piston ring

Table 1: Six Sigma Case Studies in SSI

VI. CONCLUSION

To maintain in the present competitive age, operational brilliance is the basic success mantra for SSI sector. For global competitiveness, many techniques, such as Quality Circles, TQM and ISO Certifications etc. are being tried but the SME sector needs a breakthrough strategy, which can lead to multiple benefits in shorter duration. From the literature survey it is clear that Six Sigma is a best quality improvement tool for the SSI sector. The multiple gains achieved by Six Sigma efforts over different quality problems in a company amply prove the usefulness of this strategy for small industries as well. Project by project application of Six Sigma in SSI sector can strengthen the understanding about this strategy along with consolidating gains from it. Integrating Six Sigma with Total Quality Management, Human Resource Functions, Lean Production, ISO 9000, ISO 9001, and the capability maturity model is one of the key areas of interest for researchers and practitioners to maximize the positive effect of the Six Sigma method.

REFERENCES

[1] Amit Kumar Singh and Dr Dinesh khanduja " Defination Quality Management in Auto Sector: A Six Sigma Preception" Procedia Material science 5(2014) 2645-2653.
[2] Darshan D. Patel, KR Gawanda (2014), "Productivity Improvement through Six Sigma Methodology in Bearing Manufacturing", International Journal for Research in Applied Science and Engineering Technology, Vol. 2, Issue III, March Edition, ISSN 2321-9653
[3] Dr. Rajesh Kumar U Sambhe "Six Sigma practice for quality improvement - A case study of Indian auto ancillary unit" IOSR Journal of Mechanical and Civil Engineering vol 4 issue 4 nov-dec 2012.
[4] Jiju Antony *et.al.* (2005), "Six-Sigma in SMEs UK Manufacturing Enterprises", International Journal of Quality & Reliability Management, Vol. 22, ISS 8, pp. 860- 874.
[5] Jogender Singh Yadava, Dr. Prabhakar Kaushik (2014), "Application of Six-Sigma in Injection Moulding Process", International Journal of R & D in Engineering, Science and Management Vol.1, pp.:8-16, ISSN 2393-865X.
[6] Kunal Ganguly (2012), "Improvement Process for Rolling Mill through the DMAIC Six Sigma Approach", International Journal for Quality Research, Vol. 6, No. 3, pp 221-231.
[7] K.Srinivasan *et.al* .(2014) "Enhancing effectiveness of Shell and Tube Heat Exchanger through Six Sigma DMAIC phases" 12th Global Congress on Manufacturing and Management, GCMM, 97; 2064-2071
[8] Md. Enamul Kabir,*et.al.* (2013), "Productivity Improvement by Using Six-Sigma", International Journal of Engineering and Technology Volume 3 No. 12, December Edition, ISSN 2049-3444.
[9] M. Sokovic, *et.al.*(2005), "Application of Six Sigma Methodology for Process Design", Journal of Materials Processing Technology, pp. 777-783.
[10] M.Kumar, *et.al.* (2007), "Implementing the Lean Sigma Framework in an Indian SME: A Case Study', Production Planning and Control, Vol.17, No.4, pp 407-423.
[11] Pawan Jaglan *et.al.* "Six Sigma: A Road Map For SMEs" International Journal of Advanced Engineering Technology, Vol. 2, Issue 4,October-December Edition, pp 461-464, E-ISSN 0976-3945
[12] Pawan Jaglan, *et.al.* (2013), "Six-Sigma for Productivity Management in Automobile Industry: A Case Study", International Conference on Advances in Mechanical and Computer Engineering, pp. 126-130.
[13] Prabhakar Kaushik,*et.al.* (2012) "A case study : Application of Six Sigma methodology in a small and medium-sized manufacturing enterprise", The TQM Journal, Vol. 24 Iss: 1, pp.4 - 16
[14] Prasad, J. (2002), "Six-Sigma in Bulb Manufacturing", Productivity Journal, Vol. 43, No. 2, pp. 192-195.
[15] Rajkumar U Sambhe "Journey of Six Sigma in Indian SMEs–Literature Snapshots" International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 2, August 2012.
[16] Rajendra M. Belokar, Jagbir Singh "Strategic Enhancement of Quality through 6σ: A Case Study" International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue6- June 2013.
[17] Rahul Singh and Amit Kumar (2014) 'Production improvement through the application of Six Sigma in small scale industry: A case study', International journal of current engineering and technology Vol. 4 No. 4.
[18] Ricardo Banuelas, Jiju Antony and Martin Brace (2005), "An Application of Six Sigma to Reduce Waste", Quality and Reliability Engineering International, Vol. 21, 553-570.
[19] R.M.Belokar, Harish Kumar Banga, Jagbir Singh, Pratik Belokar"Improvement of Quality through Six Sigma: A Case Study" International Journal of Engineering, Business and Enterprise Applications, 8(2), March-May., 2014, pp. 127-131.
[20] S. Suresh, A. L. Moe and A. B. Abu (2015) 'Defects reduction in manufacturing of automobile piston ring using Six Sigma', Journal of industrial and intelligent information Vol. 3, No. 1.
[21] U. Shrinivas Balraj, P. Anitha (2014), "Application of Six-Sigma Approach to Motor and Pump Manufacturing Industry-A Case Study", International Journal of Emerging Engineering Research and Technology, Volume 2, Issue 6, September Edition, pp 18-23, ISSN 2349-4395 (Print) & ISSN 2349-4409.
[22] Vikas Kumara, Rajiv Khanduja (2013) 'Application of Six Sigma methodology in SSI: A case study', International journal of current engineering and technology, Vol.3, No.3, August edition, ISSN 2277-4106, pp 971-976.

