



International Journal of Engineering, Business and Enterprise Applications (IJEBA)

www.iasir.net

DESIGN AND DEVELOPMENT OF SIX SIGMA IMPLEMENTATION FRAMEWORK FOR INDIAN INDUSTRIES

Ravi S. Reosekar

Faculty of Mechanical Engg, B.I.T.S., Pilani

Dr. Sanjay D. Pohekar

Faculty of Mechanical Engg, Tolani Maritime Institute

Abstract: Six Sigma has emerged as a powerful tool in quality management over the recent years and the approach is widely used across all sectors of manufacturing, service logistics and health & hospitality.

In today's competitive environment to sustain global competition means to be the best in the field at each competitive priority and to demonstrate industry best quality improvement practices like six sigma. A little work has been done in the area of framework of six sigma implementation but none of the existing frameworks was found to be suitable for the Indian scenario, and the completeness of existing Indian six sigma frameworks was also found to be lacking. Hence this paper aims to focus on the development of a new framework for providing direction and guidance for implementation of six sigma in Indian scenario.

Total 67 frameworks of six sigma implementation as proposed by various researchers, consultants, international agencies and individuals were identified through literature review. Comparative analysis of these identified frameworks was carried out and a new framework is suggested after considering domain knowledge of six sigma and through discussion with experts. Some unique elements/attributes of six sigma were identified through comparative analysis which represent/forms the pillars of six sigma.

Keywords – Six Sigma, Quality Improvement, Manufacturing Industries, Frameworks

I. INTRODUCTION

Six Sigma is a breakthrough process improvement strategy that yields dramatic reduction in defects or errors or mistakes in any process. Improved processes lead to improved customer satisfaction, increased market share, business profitability and so on. Six sigma is a powerful strategy developed to accelerate improvement in product, process and service quality by relentlessly focusing on reducing variation and eliminating waste. It is a comprehensive and flexible system for achieving, sustaining and maximizing business profitability. It is uniquely driven by close understanding of customer needs of today and tomorrow, disciplined and systematic use of data to support decisions and diligent attention to managing and improving business processes. Although Six Sigma approach to quality and process improvement have been predominantly used by manufacturing organizations, today the popularity of six sigma in the other sectors is growing exponentially, especially in banks, hospital sector, financial services, airline industry, utility services and so on. A review of the literature shows that different researchers have different views about definition of six sigma.

Andersson et al. (2006) has defined six sigma as "Improvement program for reducing variation, which focuses on continuous and breakthrough improvements"

Antony (2002) stated that "six sigma is a business performance improvement strategy that aims to reduce the number of mistakes/defects – to as low as 3.4 occasions per million opportunities."

According to Antony and Banuelas (2002), "Six sigma is a philosophy that employs a well-structured continuous improvement methodology to reduce process variability and drive out waste within the business processes using statistical tools and techniques"

Behara et al. (1995) The rating that signifies "best in class", with only 3.4 defects per million units or operations."

Bendell (2006) defined six sigma as a strategic, company-wide, approach focusing on variation reduction, projects have the potential of simultaneously reducing cost and increasing customer satisfaction.

Black and Revere (2006) mentioned six sigma as "A quality movement, a methodology, and a measurement. As a quality movement, Six Sigma is a major player in both manufacturing and service industries throughout the world. As a methodology, it is used to evaluate the capability of a process to perform defect-free, where a defect is defined as anything that results in customer dissatisfaction"

Chakrabarty and Tan (2007) defined, "A quality improvement program with a goal of reducing the number of defects to as low as 3.4 parts per million opportunities or 0.0003 per cent".

Kwak and Anbari (2006) defined six sigma as, "A business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer needs and expectations".

Six sigma within manufacturing industries has been providing significant benefits, but there is no clear consensus regarding the exact parameters for six sigma implementation in Indian or approaches for its implementation. Many organizations have followed a trial-and-error approach for its implementation. Practical and detailed guidance is required for practitioners to achieve the potential benefits from six sigma implementation. These can be resolved using the new framework of six sigma implementation to achieve best in class performance.

II. WHAT IS A FRAMEWORK?

The term framework has been used very frequently in the literature of philosophies like supply chain, TQM, six sigma. But there seems to be a lack of consensus about what really a framework is. Some authors have referred 'framework' as a prescriptive set of things to do, while others have chosen to portray the frameworks through diagrams or graphical representations. Very often, the terms model and frameworks have been used interchangeably. But it is unclear if a model is same as a framework. For the scope of our paper, it is assumed that basic guideline that a model answers 'what is' questions whereas a framework answers 'how to' questions [9]. A framework is also a set of basic assumptions or fundamental principles of intellectual origin in which discussions and actions can proceed [10].

III. REVIEW OF EXISTING FRAMEWORKS FOR SIX SIGMA IMPLEMENTATION

Over the years many authors have contributed to the literature Six sigma, but only few authors have said about models / frameworks for six sigma implementation which can help and guide the organization in achieving its desired quality objectives. A total of 67 frameworks were identified through a literature survey. Table I shows the taxonomy of six sigma frameworks.

Table I – List of 67 six sigma frameworks – Author (year)

Sr	Six Sigma Frameworks	Sr	Six Sigma Frameworks
1	Vijay Shanmugam(2007)	35	Doug Sanders and Cheryl Hild(2000)
2	Roger Hiltona, Margaret Ballab and Amrik S. Sohal(2008)	36	Venkateswarlu Pulakanam and Kevin E. Voges(2010)
3	Forrest B. Green(2006)	37	Young Hoon Kwak, Frank T. Anbari(2006)
4	Navin Shamji Dedhia(2005)	38	Archana Shukla,R. Srinivasan(2007)
5	Fu-Kwun Wang, Timon C. Du & Eldon Y. LI(2004)	39	Jaideep Motwani, Ashok Kumar and Jiju Antony(2004)
6	Kamran Moosa and Ali Sajid(2010)	40	Ricardo Banuelas & Jiju Antony(2002)
7	Ka-Yin Chau , Songbai Liu and Wai-Hung Ip(2009)	41	Taina Savolainen & Arto Haikone(2007)
8	Louise Davison & Kadim Al-Shaghana(2007)	42	Pande et al. and George(2000)
9	E. V. Guo & Tummala S. Rao(2005)		Ricardo Banuelas, Charles Tennant, Ian Tuersley and Shao
10	Rodney Mcadam & Alison Evans(2004)	43	Tang(2006)
11	Hakan Wiklund & Pia Sandvik Wiklund(2005)	44	Godecke Wessel and Peter Burcher(2004)
12	Bill Wyper & Alan Harrison(2000)	45	Chao-Ton Su,Tai-Lin Chiang,Che-Ming Chang(2006)
13	C. R. Gowen III, G. N. Stock and K. L. Mcfadden(2008)		Leila Jannesari Ladani and Diganta Das, Jerry L.
14	R. Shah, A. Chandrasekaran and K. Linderman(2008)	46	Cartwright,Robert Yenknor,Jafar Razmi(2006)
15	Ziaul Huq (2006)	47	Jiju Antony(2006)
16	Joseph A. De Feo,Zion Bar-El(2002)	48	Savolainen and Haikonen(2008)
17	SatyaS.Chakravorty(2009)	49	Geroge Elliott(2004)
18	Alessandro Brun(2011)	50	Arto Haikonen,Taina Savolainen,Pekka Jarvinen(2004)
	Xingxing Zu, Lawrence D. Fredendall, Thomas J.	51	Ayon Chakrabarty and Kay Chuan Tan(2007)
19	Douglas(2008)	52	Rhonda L. Hensley and Kathryn Dobie(2005)
	Roger G. Schroeder , Kevin Linderman, Charles Liedtke,	53	Rupa Mahanti,Jiju Antony(2009)
20	Adrian S. Choo(2008)	54	Maneesh Kumar and Jiju Antony, Alex Douglas(2009)
21	Ying-Chin Ho, Ou-Chuan Chang , Wen-Bo Wang(2008)	55	Kim M. Henderson,James R. Evans(2000)
	Leopoldo J. Gutierrez Gutierrez, F.J. Llorens-Montes and O		
22	scar F. Bustinza Sanchez(2009)	56	Mark Goldstein(2001)
	Maneesh Kumar, Jiju Antony, Frenie Jiju Antony and		
23	Christian N. Madu(2007)	57	Hemant Urdhwareshe(2004)
24	T. N. Goh(2002)	58	Coronado and Antony (2002)
25	Ricardo Banuelas, Jiju Antony, and Martin Brace(2005)	59	Burton and Sams(2005)
26	Chang-Tseh Hsieh,Binshan Lin,Bill Manduca(2007)	60	Hayes(2002)
	Grame Knowles, Linda Whicker, Javier Heraldez Femat and		
27	Francisco Del Campo Canales(2005)	61	Furterer(2004)
28	Maneesh Kumar,Jiju Antony(2008)	62	Chang(2002)
29	Jiju Antony,Darshak A. Desai(2009)	63	Park(2005)
30	Ayon Chakrabarty and Tan Kay Chuan(2009)	64	Frank T. Anbari & Young Hoon Kwak(2004)
31	Chuni Wu,Chinho Lin(2009)	65	Xingxing Zu,Lawrence D. Fredendall,Tina L. Robbins(2006)
32	Chu-Hua Kuei and Christian N. Madu(2003)	66	Wenny Chandra & T N Goh(n.d.)
33	Behnam Nakhai,Joao S. Neves(2009)	67	Daniel Alejandro Firka(n.d.)
34	Razvan Lupan and Ioan C. Bacivarof,Lasquo, Istia(2005)		

IV. NEED OF SIX SIGMA FRAMEWORK IN INDIAN SCENARIO

As companies such as Motorola, General Electric, Honeywell, Sony, Caterpillar, and Johnson Controls claimed substantial financial benefits from their investments in six sigma, the adoption of six sigma showed an upward

trend in industry [11]. However, despite the claimed benefits from TQM and six sigma implementation, there are numerous reports of problems in the process of implementing them [12],[13],[14],[15]. In order to better understand whether and how quality management approaches affect organizational performance, it is important to study the organizational contexts in which these approaches are implemented [16].

Moreover companies such as GE and Motorola have reported huge savings from their Six Sigma initiatives [18]. Critics of six sigma argue that many quality-based initiatives will fail because of the intense business competitiveness [17]. There is a need to address the issue of effective implementation of six sigma projects. We believe that developing a framework for six sigma implementation will help scholars and practitioners to gain insight into its effective implementation. It will also help organisations to effectively utilize their resources so that they can benefit. Although some frameworks like Kifayah Amar and Douglas Davis [19] do exist, they do not consider all important element which is a must for effective implementation of six sigma in a rapidly changing economy like India. Hence none of the existing frameworks can be used in their present form and there is a need to develop a new six sigma framework suitable for Indian industry. To promote the development of technological and managerial capabilities, it is necessary that industries should be provided with proper guidelines and directions, especially regarding best quality practices. These guidelines or directions are addressed in a framework or model that paves the way for Indian industries to achieve higher quality and helps them compete at the global level. But, until now no such six sigma framework has been available for Indian industry.

V. COMPARISON OF VARIOUS FRAMEWORKS OF SIX SIGMA

To develop a new framework, a better understanding of existing frameworks is required. It is necessary to understand which areas are well addressed in six sigma literature and which areas are yet to be addressed. A comparative analysis of existing frameworks of six sigma is shown in Figure 1.

First column of the fig 1 shows the various elements under different frameworks and the first row gives the names of various frameworks identified for the study. The comparison shows a matrix of numbers, which represents the order of each element as mentioned in the corresponding frameworks. Based on this comparison, it was found that only a few of the frameworks are similar and in the majority of the frameworks, the naming and number of elements differ significantly.

The 67 frameworks of six sigma, which were identified from a detailed literature review, had around 550 elements of six sigma in total. These elements/factors/constructs represent the initiatives/pillars to six sigma implementation. But the major problem is that all 550 elements cannot be adapted or followed in piecemeal fashion because some relationship or connection exists amongst these elements. Identifying and establishing the relationship can result in the development of a new structure or a framework, which will provide avenues for the organization to achieve six sigma. Hence, the objective of the comparative analyses was to develop a framework with initiatives (i.e. factors/elements/constructs) that can frame a path for achieving six sigma.

From the comparative analysis it can be found that certain elements had a frequency of 0.2 or more. That is, 20 per cent or more of frameworks were giving importance to that certain element/initiative. Hence, those elements were considered important initiatives for six sigma implementation.

Figure 1: Comparative analysis of existing six sigma frameworks

Constructs / Elements / Tools	F 1	F 2	F 3	F 4	...	...	...	F 65	F 66	F67	Fre que ncy	Percentag e
Top management commitment / Support/involvement/participation/leadership/Strong leadership and management commitment/Executive commitment /Executive engagement/Active participation of the senior executives/Proactive management /Reinforcement of Juran's tents of top management leadership, continuous education and an annual savings plan./Vision of top management/Demonstration of management commitment to quality/Role of management/Senior management commitment/Superiors' commitment/Managerial commitment and involvement					...	...	...	1	1	1	46	68.65672
Project execution and follow-up of the results/Project feasibility of the projects in a limited timeframe/Project managements skills /Project meshes with company's business strategy/Project orientation, with clear and defined goals/Project planning and management/Project prioritization and selection /Project selection, reviews and tracking/proper selection of Six Sigma projects/Project progress tracking and monitoring/Selection of projects and project management skills/Project-focused approach with a single set of problem-solving techniques such as DMAIC/Project reviews/Project selection and scoping/Project team activities					...	...	...		4	11,1 2	45	67.16418

Training and education /Good training in tools/Practical and hands on training to managers/The experts and operators training/Comprehensive training programme/Investment and training framework for trainers and mentors/Rigorous and structured training deployment plan/Education of management in the philosophy, methods,applications, and their roles/Training of experts and operators/Six sigma training/Top management education and training/Training scheme					...	...	5	39	58.20896
.....	...	...	...	...	...	...	...	...	...
.....	...	...	...	...	...	...	...	...	...
.....	...	...	...	...	...	...	...	...	...
.....	...	...	...	...	...	...	...	...	...
.....	...	...	...	...	...	...	...	...	...
Valuing and rewarding the attainment and the transfer of process/product knowledge in addition to dollars saved on projects.								1	1.492537
Verify and commit to enforcing the discipline of standard operating "should run" procedures				...	...	...		1	1.492537
Zero defects mentality		1	3	...	...	...		1	1.492537

These repetitive parameters/elements in the comparative analysis can be called “pillars”, as they become pivotal for achieving six sigma. The pillars of the framework for six sigma are shown in Table II.

Table II: Pillars of six sigma implementation framework

No.	Pillars
1	Top management commitment and leadership
2	Project selection and execution methodology
3	Training and Education
4	CRM-Customer Relationship Management
5	Effective Information / communication System
6	Quality Improvement Tools & Techniques
7	Supplier Management
8	Human Relationship Management
9	Standardization

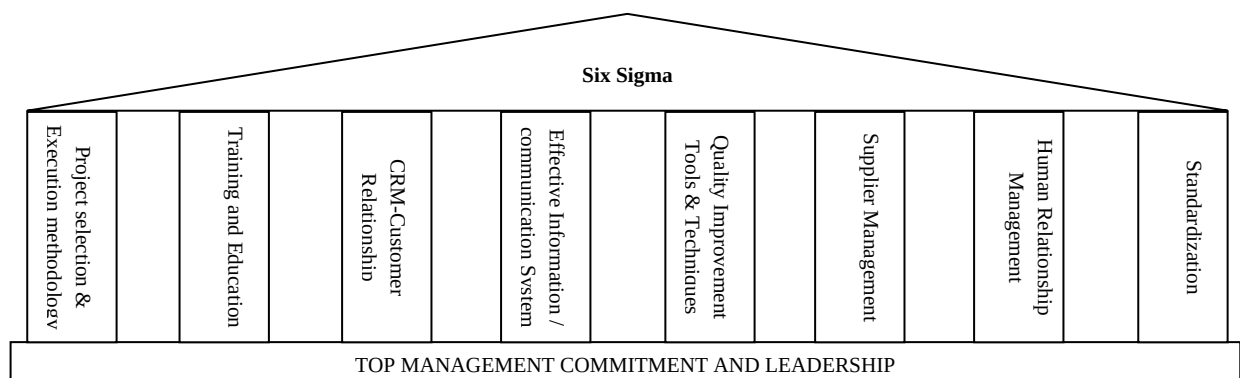
Through the comparative analysis some unique elements/attributes were identified which represent the pillars of six sigma.

VI. DEVELOPMENT OF SUB-ELEMENTS FOR THE PROPOSED FRAMEWORK OF SIX SIGMA IMPLEMENTATION

From the comparative analysis, it can be found that the unique elements/attributes that were identified can be grouped based on commonalities between them. Thus all the elements which are identified as essential for Six Sigma implementation were group under these 9 major elements, which will form the pillars of the proposed framework for six sigma implementation as shown in Figure 2.

But further refinement of the sub-elements/sub-attributes identified was needed to be done as it was felt that the above categorization of sub-elements/sub-attributes of six sigma implementation was not based on a systematic manner. Hence, few of sub-elements/attributes have been, combined, modified by using domain knowledge, expert interviews and literature review/search.

Fig 2 : A Framework of six sigma implementation



Thus, the sub-elements/sub-attributes of the proposed framework for six sigma implementation after refinement are shown in Table III.

Table III: Pillars and sub-elements of proposed Six Sigma framework

Pillars	Subelements
Top Management commitment and leadership	Strong Leadership / right project leadership Participative Mgt Six sigma vision/Objectives & mission Long term strategy development Continuous learning & development culture Appropriate resource allocation Holistic strategy for integrating system
Project selection and execution methodology	Brainstorming Benchmarking Risk management Project review teams Process capability Project Management skills Project prioritization and selection Project orientation with clear & defined goals
Training and Education	Comprehensive training programmers Rigorous and structured training deployment plan Training of experts and operators on six sigma Education of management in the philosophy, methods, applications, and their roles
Customer Relationship Management	Business strategy based on customer demand Delivery performance improvement Continuous evaluation of customer feedback Specification of value in terms of customer viewpoint Linking Six Sigma to customer Customer involvement in design process QFD-Quality function deployment VSM
Effective Information / Communication System	Knowledge capture & reuse Use of EDI(Electronic Data Interchange) to communicate between departments Electronic Commerce Use of barcoding & scanners in logistic systems Effective communication systems with customers & suppliers Internet & webservices communication between partners ERP
Quality Improvement Tools & Techniques	Centralize database for documentation SPC Tools Poka yoke FMEA Control charts Quality improvement teams Quality at the source- inspection at every stage Understanding of DMAIC methodology
Supplier Management	Long term supplier relationship Encouraging first tier suppliers with sharing profit Supplier certification Supplier feedback Supplier training & development Fewer & reliable Suppliers Supplier evaluation Supplier proximity Supplier involvement in design process
Human Relationship Management	Employee empowerment Employee involvement Multifunctional Employee Stable & long term employment Job rotation Job enrichment Fair reward & recognition Performance appraisal Suggestion schemes
Standardization	Standardize the work methods Standardize the processes Standardize the quality check methods Standardization of worksheets & templates Standardized design Standardized tools or components

VII. CONCLUSION

Various elements/construct for six sigma implementation suggested by different authors/practitioners were thoroughly studied and comparative analysis of all these 550 elements was performed to evolve with major pillars of six sigma implementation. These pillars are: Top management commitment & leadership, Project selection and execution, Training and Education, Customer Relationship Management, Effective Information/communication system, Quality Improvement Tools & Techniques, Supplier Management, Human relationship and Standardization. A framework for six sigma implementation is proposed which will guide Indian industries to implement and benefit from six sigma.

REFERENCES:

- [1]. Andersson, R., Eriksson, H. and Torstensson, H., "Similarities and differences between TQM, six sigma and lean", *The TQM Magazine*, 18, 282-296 (2006)
- [2]. Antony, J., "Design for six sigma: a breakthrough business improvement strategy for achieving competitive advantage" *Work Study* 51, 6-8, (2002)
- [3]. Antony, J., Banuelas, R., Key ingredients for the effective implementation of Six Sigma program. *Measuring Business Excellence* 6, 20-27, (2002)
- [4]. Bendell, T., "A review and comparison of Six Sigma and the lean organizations", *The TQM Magazine* 18, 255-62, (2006)
- [5]. Behara, R.S., Fontenot, G.F., Gresham, A., Customer satisfaction measurement and analysis using six sigma. *International Journal of Quality & Reliability Management* 12, 9-18, (1995).
- [6]. Black, K. and Revere, L. "Six Sigma arises from the ashes of TQM with a twist", *International Journal of Health Care Quality Assurance* 19, 259-66, (2006).
- [7]. Chakrabarty, A., Tan, K.C., The current state of six sigma application in services. *Managing Service Quality* 17, 194-208, (2007).
- [8]. Kwak, Y.H., Anbari, F.T., Benefits, obstacles, and future of six sigma approach. *Technovation* 26, 708-715, (2006)
- [9]. Yusof, S.M. and Aspinwall, E., "Total quality management implementation frameworks: comparison and review", *Total Quality Management*, Vol. 11 No.3, pp. 281-294, (2000)
- [10]. Popper, K.R., "The Myth of the Framework: In Defence of Science and Rationality", London, Routledge, (1994)
- [11]. Desai, D.A., Improving customer delivery commitments the Six Sigma way: case study of an Indian small scale industry. *International Journal of Six Sigma and Competitive Advantage* 2, 23-47, (2006).
- [12]. Ahire, S.L., Ravichandran, T., "An innovation diffusion model of TQM implementation", *IEEE Transactions on Engineering Management* 48 (4), 445-464, (2001)
- [13]. Gijo, E.V., Rao, T.S., "Six Sigma implementation—hurdles and more hurdles". *Total Quality Management* 16(6), 721-725, (2005)
- [14]. Sila, I., "Examining the effects of contextual factors on TQM and performance through the lens of organizational theories: an empirical study", *Journal of Operations Management* 25, 83-109, (2007)
- [15]. Szeto, A.Y., Tsang, A.H., "Antecedents to successful implementation of Six Sigma", *International Journal of Six Sigma and Competitive Advantage* 1 (3), 307-322, (2005)
- [16]. Sousa, R., Voss, C.A., "Quality management re-visited: a reflective review and agenda for future research", *Journal of Operations Management* 20, 91-109, (2002)
- [17]. Stebbins, W.M., Shani, A., "Eclectic design for change "Creating sustainable work systems: Emerging perspectives and practice" ,213-225, London: Routledge, (2002)
- [18]. Pande, P.S., Neuman, R.P., Cavanagh, R.R., "The Six Sigma Way: How GE, Motorola, and Other Top Companies are Honing Their Performance", McGraw-Hill, New York (2000)
- [19]. Amar, K., Davis, D., "A review of six sigma implementation frameworks and related literature", In *Proceedings of the International Multi Conference of Engineering and Computer Scientist*, 91-21 March, Hong Kong, (2008)