International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:2, No:7, 2008

Six Sigma Process and its Impact on the Organizational Productivity

Masoud Hekmatpanah, Mohammad Sadroddin, Saeid Shahbaz, Farhad Mokhtari, Farahnaz Fadavinia

***Abstract*—**The six sigma method is a project-driven management approach to improve the organization's products, services, and processes by continually reducing defects in the organization. Understanding the key features, obstacles, and shortcomings of the six sigma method allows organizations to better support their strategic directions, and increasing needs for coaching, mentoring, and training. It also provides opportunities to better implement six sigma projects.

The purpose of this paper is the survey of six sigma process and its impact on the organizational productivity. So I have studied key concepts , problem solving process of six sigmaas well as the survey of important fields such as: DMAIC, six sigma and productivity applied programme, and other advantages of six sigma. In the end of this paper, present research conclusions. (direct and positive relation between six sigma and productivity)

***Keywords*—**Six sigma; Project management, Quality, Theory; productivity

I. Introduction

SIX Sigma has been characterized as the latest management fad to repackage old quality management principles, practices, and tools/techniques [7]. At first glance Six Sigma looks strikingly similar to prior quality management approaches. However, leading organizations with a track record in quality have adopted Six Sigma and claimed that it has transformed their organization. For example, 3M's Dental Division won the Baldrige Award and then later adopted Six Sigma to improve performance even further [16]. The financial performance of 3M since Six Sigma adoption has been very impressive [8]. Other organizations with a quality track record, such as Ford, Honeywell, and American Express, have adopted Six Sigma as a way to further enhance business performance [9].

Masoud Hekmatpanah, Faculty of Management and academic member of Azad University,Ardestan Branch, Iran Email: m1595h@yahoo.com

Mohammad Sadroddin, Member of Consulting Engineeris Pooya Sabz-e-Sepahan, Esfahan, Iran
Email: ps_sepahan@yahoo.com

Saeid Shahbaz, Member of Consulting Engineeris Pooya Sabz-e-Sepahan, Esfahan, Iran
Email: ps_sepahan@yahoo.com

Farhad Mokhtari, Member of Consulting Engineeris Pooya Sabz-e-Sepahan, Esfahan, Iran
E-Mail: unicorn2002_m@yahoo.com

Farahnaz Fadavinia, Member of Consulting Engineeris Pooya Sabz-e-Sepahan, Esfahan, Iran
E-Mail: fr. Fadavinia @gmail.com

This creates a dilemma: on the one hand, skeptics argue that Six Sigma lacks discriminate validity over prior approaches to quality management; on the other hand, quality-mature organizations adopt Six Sigma to enhance performance. Scholarly inquiry into this management approach has been limited. While many books and papers on Six Sigma have emerged in the practitioner literature, academic research on Six Sigma is just beginning to come forward. Scholarly research is needed to develop an in-depth, scientific understanding of Six Sigma and separate fact from fiction.

Motorola originally developed Six Sigma in 1987 and targeted an aggressive goal of 3.4 ppm defects. In 1994 Larry Bossidy, CEO of AlliedSignal, introduced Six Sigma as a business initiative to ''produce high-level results, improve work processes, expand all employees' skills and change the culture'' [5]. This was followed by the well-publicized implementation of Six Sigma at General Electric beginning in 1995 [18]. Currently, there are many books and articles on Six Sigma written by practitioners and consultants and only a few academic articles published in scholarly journals [13]. Reviewing the practitioner literature and these academic articles provides a starting point for defining Six Sigma. Six Sigma has been defined in the practitioner literature in a variety of ways. This disparity leads to some uncertainty and confusion. Consider some of the following definitions from the practitioner articles. Quality Progress called Six Sigma a ''high-performance, data-driven approach to analyzing the root causes of business problems and solving them'' [6]. Harry and Schroeder (2000), in their popular book on Six Sigma, described it as a ''business process that allows companies to drastically improve their bottom line by designing andmonitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction''. Hahn et al. (2000) described Six Sigma as a disciplined and statistically based approach for improving product and process quality. On the other hand, Sanders and Hild (2000) called it a management strategy that requires a culture change in the organization. Recognizing the divergence in definitions, Hahn et al. noted that Six Sigma has not been carefully defined in either the practitioner or academic literature.

Many of the definitions of Six Sigma found in the literature are very general and do not provide elements—or factors (variables, constructs, concepts), as described them—to define the ''what'' of the theory, nor do they describe relationships among the elements to define the ''how.'' Therefore, our data collection focused on obtaining a scientific definition of Six

Sigma and then extracting both the elements of Six Sigma and their relationships.

Six Sigma

Six Sigma is a concept that was originated by Motorola Inc. in the USA in about 1985. At the time, they were facing the threat of Japanese competition in the electronics industry and needed to make drastic improvements in their quality levels [10]. Six Sigma was a way for Motorola to express its quality goal of 3.4 DPMO where a defect opportunity is a process failure that is critical to the customer). Motorola set this goal so that process variability is ±6 S.D. from the mean. They further assumed that the process was subject to disturbances that could cause the process mean to shift by as much as 1.5 S.D. off the target. Factoring a shift of 1.5 S.D. in the process mean then results in a 3.4 DPMO. This goal was far beyond normal quality levels and required very aggressive improvement efforts. For example, 3 sigma results in a 66,810 DPMO or 93.3% process yield, while Six Sigma is only 3.4 DPMO and 99.99966% process yield (these computations assume a 1.5 S.D. shift in the process mean). Fig. 1 shows the relationship between DPMO and Process Sigma assuming the normal distribution. 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.

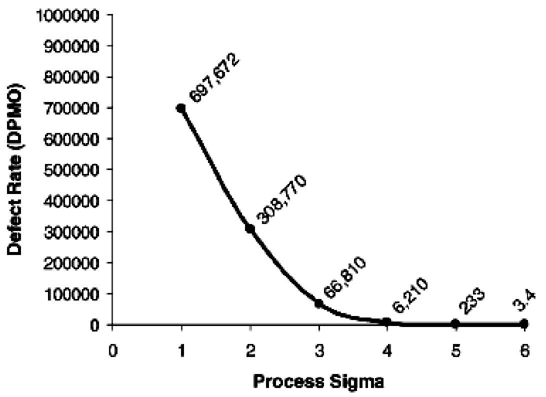

Fig. 1 Defect rate (DPMO) versus Process Sigma Level.

Fig. 2 illustrates the relationship between specific challenging goals employed in Six Sigma and performance. The effects of training and goal commitment shown in Fig. 2 are discussed below. As noted earlier, when goals become too difficult a drop-off in performance can occur. If individuals view the goal as unattainable they will often exert little effort, which decreases performance. Six Sigma sets very challenging goals, which may run the risk of being viewed as unattainable.

However, training in process improvement tools and methods mitigates the difficulty of attaining challenging improvement goals. As a result, training reduces the uncertainty involved in achieving challenging improvement goals and makes the goals more achievable. This increases the commitment of organizational members in attaining the goals since they are now viewed as more "realistic". Six Sigma organizations provide extensive training programs in process improvement methods and tools [11]. The extent of Six Sigma training reduces the uncertainty associated with improvement projects and increases the commitment of the organizational members. Fig. 2 indicates a relationship between training and goal commitment, which suggests the following proposition.

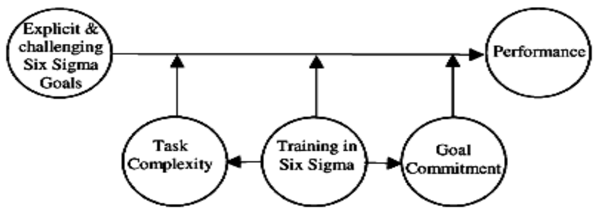

Fig. 2 Explicit Six Sigma goals and performance.

Statistical viewpoint

Six sigma method has two major perspectives. The origin of six sigma comes from statistics and statisticians. Hoerl and Snee (2002), discuss the six sigma method from a statistical, probabilistic, and quantitative point of view. From the statistical point of view, the term six sigma is defined as having less than 3.4 defects per million opportunities or a success rate of 99.9997% where sigma is a term used to represent the variation about the process average [4]. If an organization is operating at three sigma level for quality control, this is interpreted as achieving a success rate of 93% or 66,800 defects per million opportunities. Therefore, the six sigma method is a very rigorous quality control concept where many organizations still performs at three sigma level [15].

Business viewpoint

In the business world, six sigma is defined as a 'business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer's needs and expectations [3]. 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. Particularly, the widespread applications of six sigma were possible due to the fact that organizations were able to articulate the benefits of six sigma presented in financial returns by linking process improvement with cost savings.

Six sigma process

Six sigma strategies, tools, techniques, and principles

Six sigma is a systematic, data-driven approach using the define, measure, analysis, improve, and control (DMAIC) process and utilizing design for six sigma method (DFSS) (GE 2004). The fundamental principle of six sigma is to 'take an organization to an improved level of sigma capability through the rigorous application of statistical tools and techniques'. It generally applies to problems common to production. Table 1 summarizes six sigma business strategies, tools, techniques, and principles. Six sigma strategies, tools, techniques, and principles Anbari (2002) pointed out that 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. He summarized the six sigma management method as follows:

Six Sigma = TQM (or CQI) + Stronger Customer Focus + Additional Data Analysis Tools + Financial Results + Project Management

DMAIC process

DMAIC is a closed-loop process that eliminates unproductive steps, often focuses on new measurements, and applies technology for continuous improvement. Table 2 presents the key steps of six sigma using DMAIC process.

DFSS methodology

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 [14]. The goal of DFSS is to achieve minimum defect rates, six sigma level, and maximize positive impact during the development stage of the products. It is used to develop new products or services with a six sigma criteria, capability, and performance. It utilizes variety of quality oriented tools and techniques to meet customer requirements and has shown an increase in life cycle profits. As Treichler et al. (2002) noted the essence of DFSS is 'predicting design quality up front and driving quality measurement and predictability improvement during the early design phases.' Essentially, the DFSS process is focused on new or innovative designs that yield a higher level of performance. De Feo and Bar-El (2002) summarize seven elements of DFSS as follows.

† Drives the customer-oriented design process with six sigma capability

† Predicts design quality at the outset

† Matches top–down requirements flow down with capability flow up

† Integrates cross-functional design involvement

† Drives quality measurement and predictability improvement in early design phases

† Uses process capabilities in making final decisions

Fig. 1 depicts the five step DFSS process (Table 2).

TABLE 1 SIX SIGMA STRATEGIES, PRINCIPLES TOOLS, AND TECHNIQUES (ADAPTED FROM ANTONYET AL., 2003)

Six sigma business strategies and principles	Six sigma tools and techniques
Project management	Statistical process control
Data-based decision making	Process capability analysis
Knowledge discovery	Measurement system analysis
Process control planning	Design of experiments
Data collection tools and techniques	Robust design
Variability reduction	Quality function deployment
Belt system (Master, Black, Green, Yellow)	Failure mode and effects analysis
DMAIC process	Regression analysis
Change management tools	Analysis of means and variances
	Hypothesis testing
	Root cause analysis
	Process mapping

TABLE II KEY STEPS OF SIX SIGMA USING DMAIC PROCESS (ADAPTED FROM MCCLUSKY, 2000)

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

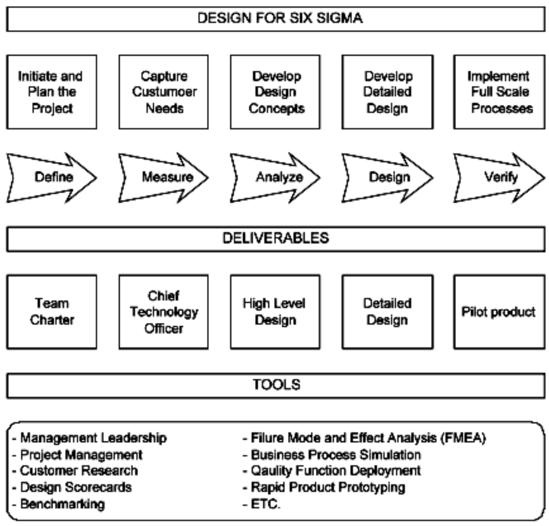

Fig. 1 Five Step DFSS process

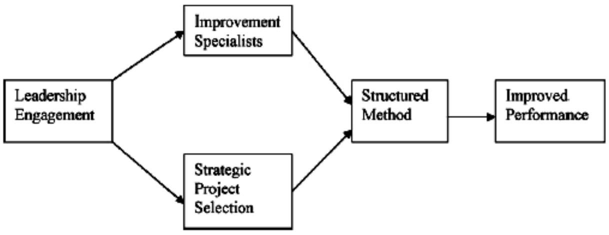

Fig. 2 Proposed mediation model for Six Sigma.

These Six Sigma elements can be arranged in a framework by the proposed mediation model in Fig. 2. We have shown leadership as a driver of three other elements, and it is an exogenous variable, as is commonly proposed in the literature. Leadership should lead to strategic project selection and the use of improvement specialists. These two elements in turn enable the use of the structured method for process improvement. Finally, the structured method leads directly to improved organization performance. From Fig. 2, specific hypotheses can be empirically tested using structural equation modeling or path models.

Six sigma and Productivity

This 2-day in-house training programme introduces the key concepts. application and implementation of Six Sigma.

The programme is designed for quality service managers and administrative/professional staff, who are seeking to learn and apply six sigma language and concept at their respective workplaces.

1) Training Objectives :

At the end of the programme, participants will learn:

(a) How six sigma can perfect processes and drive down costs;

(b) How to apply six sigma methodology for improving an existing process to six sigma level;

(c) How to apply six sigma framework on an improvement project;

(d) Six Sigma tools & techniques

(e) How to analyse data using simple six sigma tools.

2) Learning Outcomes:

The programme will be taught by staff of Office of Quality Management. Methodologies used include action learning: experiential learning, case studies, experience sharing and group discussions. The training sessions are intended to be hands-on and practice-oriented.

3) Over View of Six sigma:

a) What is Six Sigma?
b) Concept of Six Sigma
c) Core Principles and benefits of Six Sigma
d) Setting Business Metrics
e) Cost of Poor Quality

4) Six sigma Methodology:

a) The DMAIIC Roadmap
b) Define
c) Measure
d) Analyse
e) Improve
I) Implement
g) Control

5) Project Selection and Intitation:

a) Projection Selection
b) Team Formation / Facilitation
c) Project Charter

6) Deployment of Six sigma:

a) Leadership
b) Quality Service Culture
c) Roles and Responsibilities

7) Debrief and Programme Review:

All participants will be asked to utilise the DMAIIC method to analyse problem in their organizational units. A programme review will be held at the end of the programme to gauge the effectiveness of the training programme.

8) Duration/ Date

The programrne will be conducted twice a year. Each run will be held over 2 days, fron 9.00 am to 5.00 pm.

9)Programme Schedule

Time	Day 1	Day 2
0900 - 1030	• introduction • Programme outline & objectives	• Day 1 – Recap • Deployment of Six Sigma (Roles & Responsibilities)
1030 - 1100	Tea Break	
1030 - 1230	• Overview of Six Sigma	• Six sigma tools & Techniques • Group Exercise discussion
1230 - 1330	Lunch Break	
1330 - 1500	• Six sigma Methodology • Group Exercise	• Six sigma tools & Techniques • Group Exercise
1500 - 1530	Tea Break	
1530 - 1700	• Projection Selection & Initiation • Project Charter • Deployment of Six Sigma (Quality Service Culture)	• Sustaining Six Sigma • Debrief and review

- Conclusions

1- 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.

2- The four phase improvement process; measure, analyze, improve, control (MAIC).

3- Six sigma has both management and and technical components.

4- Six sigma is designed to dramatically upgrade a organizations performance, improving quality and productivity.

5- The programme of six sigma and productivity is designed for quality service managers and administrativity/ professional staff, who are seeking to learn and apply six sigma lanuage and concept at their respective work places and increasing their productivity.

6- direct and positive relation is between six sigma and productivity.

7- It works and it can be important to both the success of your organization and your career. Six Sigma is arguably the most important business and industry initiative that has involved statistical thinking and methods.

8- "good things don't come easy". This is certainly the case for Six Sigma.

REFERENCES

[1] Aldred, K., 1998. Baldrige Award recognizes four U.S. companies. IIE Solutions 30 (3), 8.
[2] Anbari, F.T., 2002. Six Sigma Method and Its Applications in Project Management, Proceedings of the Project Management Institute Annual Seminars and Symposium [CD], San Antonio, Texas. Oct 3–10. Project Management Institute, Newtown Square, PA.
[3] Antony, J., Banuelas, R., 2001. A strategy for survival. Manufacturing Engineer 80 (3), 119–121.
[4] Antony, J., Banuelas, R., 2002. Key ingredients for the effective implementation of six sigma program. Measuring Business Excellence 6 (4), 20–27.
[5] ASQ, 2002. The Honeywell edge. Six Sigma Forum Magazine 1 (2), 14–17.
[6] Blakeslee Jr., J.A., 1999. Implementing the Six Sigma solution. Quality Progress 32 (7), 77–85.
[7] Clifford, L., 2001. Why you can safely ignore Six Sigma. Fortune 143 (2), 140.
[8] Fiedler, T., 2004. Mopping up profits: With 3M sitting on solid earnings, CEO James McNerney handled his fourth annual meeting like a contented company veteran. Star Tribune, Metro ed., May 12, Minneapolis, MN.
[9] Hahn, G.J., Doganaksoy, N., Hoerl, R., 2000. The evolution of Six Sigma. Quality Engineering 12 (3), 317–326.
[10] Harry, M.J., Schroeder, R., 2000. Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations, Doubleday, NY.
[11] Hoerl, R.W., 2001. Six Sigma Black Belts: what do they need to know? Journal of Quality Technology 33 (4), 391–435.
[12] Hoerl, R.W., Snee, R.D., 2002. Statistical Thinking: Improving Business Performance. Duxbury Press/Thompson Learning, San Jose.
[13] Linderman, K., Schroeder, R.G., Zaheer, S., Choo, A.S., 2003. Six Sigma: a goal-theoretic perspective. Journal of Operations Management 21 (2), 193–203.
[14] 14] Mader, D.M., 2002. Design for six sigma. Quality Progress July, 82–86.
[15] McClusky, R., 2000. The Rise, fall, and revival of six sigma. Measuring Business Excellence 4 (2), 6–17.
[16] McClenahen, J.S., 2004. New world leader. Industry Week 253 (1),36–39.
[17] Sanders, D., Hild, C.R., 2000. Six Sigma on business processes: common organizational issues. Quality Engineering 12 (4), 603–610.
[18] Slater, R., 1999. JackWelch and the GEWay: Management Insights and Leadership Secrets of the Legendary CEO. McGraw-Hill, NY.
[19] Treichler, D., Carmichael, R., Kusmanoff, A., Lewis, J., Berthiez, G., 2002. Design for six sigma: 15 lessons learned. Quality Progress 35 (1), 33–42.