Success Factors in Managing Six Sigma Projects

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Abstract

Six Sigma is a project-driven business systems improvement method. Successful implementation and growing organizational interest in the Six Sigma method have been exploding in recent years. It is rapidly becoming a major force driving the strategy of numerous successful organizations. Involvement in Six Sigma projects is becoming an important career path requirement in many organizations. Understanding the main concepts of the Six Sigma method provides important opportunities to project professionals to lead Six Sigma projects, and allows them to better support their organizations' strategic direction, and increasing needs for coaching, mentoring, and training.

It has been reported widely that Six Sigma projects are very successful, compared to the reports of dismal success rates in traditional projects and business process reengineering projects.

This paper provides a brief overview of the Six Sigma management method and its use of project management. The paper examines the main factors driving the success of Six Sigma projects. It addresses the elements of strategic selection and effective management of Six Sigma projects. It considers the organizational structure used and the roles of various participants in achieving technical, financial and customer satisfaction objectives of each Six Sigma project. It presents the methodologies used in managing Six Sigma projects for both process improvement and new development projects. It reviews the approach used for evaluating the success of these projects.

The paper summarizes extensive literature reviews and discussions with Six Sigma leaders at several organizations. It analyzes and synthesizes the lessons learned from successful management of Six Sigma projects and their potential applications in managing traditional projects. It considers further improvements to the methodologies used for managing Six Sigma projects, and addresses wider applications of promising practices to organizational change management. The paper also discusses challenges and obstacles in the application of the Six Sigma method.

The promising practices learned from the successful management of Six Sigma projects could have important applications in managing traditional projects and wider applications in managing organizational change.

Problem Statement and Research Methodology

Project failures continue at an alarming rate, despite growing understanding of determinants of success in project management, increasing maturity, and a stream of successful projects. Statistics of challenged and failed projects testify that these failures are much more common than we would like to believe (Anbari 2003, 17-18), compared to the widely reported success rate of Six Sigma projects.

Alarming Failures

The Standish Group conducted surveys and interviews to explore what causes Information Technology (IT) software development projects to be challenged or fail. These studies classified projects into three types:

- Successful: The project is completed on-time and on-budget, with all features and functions as originally specified.
- Challenged: The project is completed and operational but over-budget, over the time estimate, and offers fewer features and functions than initially specified.
- Failed: The project is canceled before completion.

The 1994 study (The Standish Group 1995) had a total sample of 365 respondents representing 8,380 projects. The results of that research showed that 16% of IT project were successful, 53% were challenged, and 31% failed. Comparisons to subsequent studies are shown in Exhibit 1 (The Standish Group 1999):

Year of Study	Successful	Challenged	Failed
1994	16%	53%	31%
1996	27%	33%	40%
1998	26%	46%	28%

Exhibit 1. Project Resolution History (Adapted from The Standish Group 1999)

The Treasury Board of Canada Secretariat (2000-2002) supported findings of The Standish Group, and indicated similarities to results of reviews of Canadian Government information technology projects. A survey of IT projects by Sauer and Cuthbertson (2002) covered various industry sectors and government in the United Kingdom and had a usable sample size of 565 projects. It showed that 5% of all projects were reported to have been abandoned prior to or during implementation, 55% of projects exceeded budget, 27% came in exactly on budget, and 8% came in below budget. Performance as a proportion of initially agreed specifications averaged above 80%.

There are many examples of projects management failures outside the IT environment. More than one third of the Public-Private Partnered project in Asia from 1985-1998 had disappointing performance resulting in financial loss, cancellation, delay, and suspension of the project (Kwak 2002). The Denver International Airport was expected to be a model of efficiency and a benchmark for other airports to follow. It was completed with major delays at a cost of US $5 billion, compared to the original estimate of US $1.2 billion (Kerzner 2003, 337-382). The Channel Tunnel (Chunnel) project, undertaken to create a connection between England and France via an underground tunnel, was one of the largest privately funded construction projects ever undertaken. It was completed late at a cost of about US $15 billion, about double the original estimate, with a major claim settled for about US $2 billion (Fairweather 1994). The Iridium project was the largest telecommunications project ever undertaken to produce a satellite network that would cover the entire globe. It cost US $5 billion compared to the original budget of US $3.4 billion, involved several widely respected high technology organizations, about 6,000 engineers, technicians and managers, and 26 countries (Anbari et al. 2004). The project was a dismal commercial and financial failure, forcing Iridium LLC to file for bankruptcy (Cauley 1999), and to be ultimately sold for a mere US $25 million (Fitzgerald Communications 2000). The Superconducting Super-Collider project managed by the USA Department of Energy was a huge undertaking, from scientific, logistical, and managerial perspectives. It aimed to develop and build a high-energy subatomic particle accelerator that would generate 20 trillion volt energy beams, using a 54-mile tunnel to find answers to important questions in physics. At its peak, over 7,000 full-time employees were involved in project construction, in addition to over 1,000 scientists in the USA and another 1,000 scientists around the world. After a four-year lifespan, several escalating cost projections, and spending of about US $2 billion, the project was terminated by the USA Congress (Willard 1998).

Reported Successes of Six Sigma Projects

Benefits and savings of implementing the project-driven Six Sigma method have been widely reported. Exhibit 2 summarizes the organizations, projects, benefits, improvements, and savings achieved by implementing the Six Sigma method in the manufacturing sector, based on extensive investigation of literature on Six Sigma (Weiner 2004, De Feo and Bar-El 2002, Anthony and Banuelas 2002, Buss and Ivey 2001, and McClusky 2000).

Research Methodology

There is a stark difference between repetitive, visible failures in managing traditional projects and reported sustained successes in implementing Six Sigma projects. This paper explores the underlying root causes of this difference. It is based on extensive literature reviews, discussions with Six Sigma leaders at several organizations that have implemented the Six Sigma method, and observations of systems improvement projects. The paper carefully analyzes and synthesizes the lessons learned from successful management of

Six Sigma projects and their potential applications in managing traditional projects. It considers further improvements to the methodologies used for managing Six Sigma projects, and addresses wider applications of these promising practices to organizational change management. The paper also discusses challenges, shortcomings, obstacles and pitfalls in the application of the Six Sigma method. It charts a course for further research into this important area.

Company/Project	Metric/Measures	Benefit/Savings
Motorola (1992)	In-process defect levels	150 times reduction
Raytheon/Aircraft Integration Systems	Depot maintenance inspection time	Reduced 88% as measured in days
GE/Railcar leasing business	Turnaround time at repair shops	62% reduction
Allied Signal/Laminates plant in South Carolina	Capacity Cycle time Inventory On-time delivery	Up 50% Down 50% Down 50% Increased to near 100%
Allied Signal/Bendix IQ brake pads	Concept-to-shipment cycle time	Reduced from 18 months to 8 months
Hughes Aircraft's Missiles Systems Group/Wave soldering operations	Quality Productivity	Improved 1000% Improved 500%
General Electric	Financial	$2 billion in 1999
Motorola (1999)	Financial	$15 billion over 11 years
Dow Chemical/Rail delivery project	Financial	Savings of $2.45 million in capital expenditures
DuPont/Yerkes Plant in New York (2000)	Financial	Savings of more than $2 million
Telefonica de Espana (2001)	Financial	Savings and increases in revenue 30 million euro in the first 10 months
Texas Instruments	Financial	$ 600 million
Johnson & Johnson	Financial	$ 500 million
Honeywell	Financial	$1.2 billion

Exhibit 2. Reported Benefits and Savings from Six Sigma in the Manufacturing Sector (Data compiled from Weiner 2004, De Feo and Bar-El 2002, Anthony and Banuelas 2002, Buss and Ivey 2001, and McClusky 2000)

Brief Overview of the Six Sigma Management Method

Development and Objectives of the Six Sigma Method

Six Sigma is a project-driven method aimed at sustainable business performance improvement. It focuses on better understanding of changing customer requirements, improving processes throughout the organization, and enhancing the organization's financial performance. It is used to improve the organization's products, services and processes across various disciplines, including production, new product development, marketing, sales, finance, information systems, and administration. It is achieved through understanding the underlying processes, and reducing or eliminating defects and waste. The Six Sigma method integrates profound knowledge of systems, processes, engineering, statistics, and project management, to improve quality and delivery, reduce waste, reduce cost, develop robust products and processes, to enhance and sustain the organization's competitive advantage through continual improvement of systems in the organization.

The Six Sigma method is more comprehensive than prior process improvement initiatives, such as Total Quality Management (TQM) and Continuous Quality Improvement (CQI). The Six Sigma method, uses additional, more advanced data analysis tools, uses project management methodology and tools, and includes measured financial results. TQM (or CQI) aimed to improve processes and eliminate non value-added activities, primarily through empowering individuals and teams to discuss these issues within their own area or across organizational boundaries. The tools of TQM (or CQI) were heavily oriented towards brainstorming, communications and simple data analysis. However, after several years of application, the problems that needed to be tackled next, did not lend themselves easily to simple data analysis, and required more investment in resources and time than what was viewed as appropriate involvement in TQM (or CQI) activities. Significant business results were no longer achievable through TQM (or CQI) initiatives, and organizational strategic commitment to these initiatives came to an end.

Statistical Perspective of Six Sigma

The Six Sigma management method was developed and applied by knowledgeable statisticians. Harry (1997), Hahn et al. (1999), Harry and Schroeder (2000), Montgomery (2001), Hoerl and Snee (2002), Lucas (2002) and Anbari (2002a) discussed the statistical, probabilistic, and quantitative aspects of the Six Sigma methods. From the statistical point of view, the term Six Sigma is defined by convention as having less than 3.4 defects per million opportunities (DPMO) or a success rate of 99.9997 percent, where the term sigma is used to represent the variation about the process average (Anthony and Banuelas 2002). If an organization is operating at three sigma level for quality control, this is interpreted as achieving a success rate of about 93 percent or 66,800 defects per million opportunities (DPMO). Therefore, the Six Sigma method is a very rigorous quality control concept where many organizations are still performing at the three sigma level (McClusky 2000). Six Sigma represents a very heroic target for many organizations, technologies, operations, processes, and projects (Lucas 2002).

Business Perspective of Six Sigma

In the business world, Six Sigma can be 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” (Anthony and Banuelas 2001). The Six Sigma approach was first applied at manufacturing departments and rapidly expanded to different functional areas such as marketing, engineering, purchasing, customer service, and administrative support once the 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 improvements to financial savings.

The Six Sigma management method continues to grow and thrive, from its initial development by Motorola in the mid 1980’s, to its widely advertised adoption by General Electric in 1992 (Welsh & Byrne 2001), to its subsequent adoption by many other powerful organizations including Boeing, DuPont, Kodak, 3M, Allied Signal, American Standard, Honeywell, Seagate, and many others, with very impressive results. The Six Sigma method overcomes the limitations of TQM (or CQI) by using additional, more advanced data analysis tools, applying project selection, evaluation, and relevant project management tools and techniques, and including measurements of financial results which ensure sustained commitment to the initiative by senior executives (Kwak 2003). The Six Sigma management method can be summarized as follows (Anbari 2002b):

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

Six Sigma Projects

Project-Driven Systems Improvement

The Six Sigma method is a project-driven business systems improvement method. Juran (1989) suggested that quality could be accomplished project by project and in no other way. A Six Sigma project is targeted to have a duration of three to six months. The expected financial impact per Six Sigma project is $100,000 to $500,000 with a target of $175,000 (Lucas 2002, and Hammer 2002). If a Six Sigma project exceeded the duration target, it is broken down to smaller projects. Keeping Six Sigma projects within their duration targets could be an important contributing factor to management support and resounding success compared to larger conventional projects.

Six Sigma projects are selected carefully and evaluated rigorously to ensure that they achieve their financial objectives.

Six Sigma project selection and management

Cost/benefit analysis provides the basis for selection among proposed Six Sigma projects. Potential benefits include reduction in cost of poor quality as manifested by cost of rework, scrap, repairs, field service, lost customers, and reduction in cost of similar internal and external failures. Cost of Six Sigma projects includes direct and indirect payroll cost of participants in these projects, training, consulting, and the cost of implementing the solution generated by the Six Sigma project team, which may include equipment, process redesign, and information technology driven solutions (Pande et al. 2000).

Six Sigma projects require a clearly written and approved Project Charter, Scope Statement, and a basic Work Breakdown Structure (WBS). Six Sigma projects are monitored and controlled using basic project planning and control tools, including Gantt charts, milestone charts, project reporting, project closeout, and post project evaluation methods. Other tools include effective communications and team development methods. The strategy of managing the portfolio of Six Sigma projects should allow effective, agile adaptation to changes in the environment. Welsh and Byrne (2001, 390) specified that “Business success is less a function of grandiose prediction than it is a result of being able to respond rapidly to real changes as they occur. That’s why strategy has to be dynamic and anticipatory.”

Governance and Organizational Structure

Governance of Six Sigma projects is accomplished by using the “Belt” system in a strong matrix organizational structure.

The Black Belt

The Six Sigma project management structure is centered on the Black Belt. This is the Six Sigma project leader. The Black Belt works on Six Sigma projects full time, and may lead four to six projects per year. Black Belts are carefully selected and receive extensive training in Six Sigma methodology. This training concentrates on statistical methods and is presented in about four to five full weeks in addition to actual Six Sigma project involvement (Hoerl 2001). The selection of Black Belts focuses on technically oriented individuals, who are highly regarded in their discipline area, and “have the potential to realize a synergistic proficiency between their respective discipline and the Six Sigma strategies, tactics, and tools” (Harry 1997, 23.4). The Black Belt plays the role of a project manager in a strong matrix organization. Assignment as a Black Belt lasts for about two years and constitutes an important milestone in the career path of the individual assigned to that role.

Yellow Belts

Project team members who work on Six Sigma projects on a part time basis are called Yellow Belts. They receive about two to three full days of training in the fundamentals of Six Sigma methodology.

Green Belts

Specialized team members who work on Six Sigma projects on a part time basis are called Green Belts. They receive about two to three full weeks of training in Six Sigma methodology. Some organizations refer to all team members on a Six Sigma project as Green Belts and provide them with the relevant training in Six Sigma methodology.

Master Black Belts

Master Black Belts are experienced Black Belts and act as technical resources to Black Belts, Green Belts, Yellow Belts, and other team members. They play a similar role to that of a project management office, and provide mentoring, coaching, and consulting to those involved in Six Sigma projects.

Champions
Champions are the organization's strategic and tactical business leaders. They create the vision, approve Six Sigma project charters, review project progress, and ensure success of Six Sigma projects in their business units. They play a similar role to that of a project sponsor.

Exhibit 3 provides a comparison of the roles played by main participants in Six Sigma projects to the roles played by participants in traditional projects.

Six Sigma Projects	Traditional Projects
Black Belts	Project Managers
Yellow Belts	Project Team Members
Green Belts	Specialized Project Team Members
Master Black Belts	Project Management Office
Champions	Project Sponsors

Exhibit 3. Roles of Participants in Six Sigma Projects

Effective Six Sigma management requires commitment and active participation by senior executives, and leadership and communications by organizational champions. In our discussions we found the Chief Executive Officer to be involved in the overall implementation of Six Sigma.

Six Sigma Project Management Methodology

Managing process improvement projects
The following five phases constitute the generally accepted methodology for managing Six Sigma projects aimed at process improvement (Rath & Strong 2000), such as reduction of defects or increasing system availability:
Define: The objectives and scope of the process improvement project are defined. Relevant information about the process and customer are collected.
Measure: Data on the current situation and process metrics are collected.
Analyze: Collected data are analyzed to find the root cause(s) of the problem. Among other tools, this may include the "5 whys" tool which encourages deep probing by asking the question "why" five times in an effort to find the real root of the problem (Gack 2003).
Improve: Solution(s) to the problem are developed and implemented.
Control: The implemented solution(s) are evaluated and the mechanisms are implemented to hold the gains, which may include standardization.

This methodology has usually been mentioned by its initials DMAIC, and we found it to be universally used during our discussions. Harry and Schroeder (2000) suggested an additional phase called Recognize before the DMAIC phases, to "recognize functional problems that link to operational issues." They also suggested two additional phases called Standardize and Integrate after the DMAIC phases to "standardize the methods and processes that produce best-in-class performance," and to "integrate standard methods and processes into the design cycle."

Managing new development projects
The following five phases constitute the generally accepted methodology for managing Six Sigma projects aimed at new product or system development (Hayes 2003), such as developing a new industrial product or a software application, and has usually been mentioned by its initials DMADV:
Define: The objectives and scope of the new development project are defined. Relevant information about the process and customer are collected.
Measure: Data on the current situation and process metrics are collected. This may include data mining and cost of poor quality analysis.

Analyze: Collected data are analyzed to understand alternatives and tradeoffs. This may include quality function deployment (QFD) and critical-to-quality (CTQ) analysis.
Design/Build: The voice of the customer is translated into prioritized development and construction deliverables. Meaningful reviews and walkthroughs are conducted and may use measures such as Defect Containment Effectiveness. The system is developed and implemented.
Verify/Control: The implemented solution(s) are evaluated and the procedures are implemented to maintain the new system, which may include measures of success defined by the customer and the business.

Considering the above two groups of phases, it becomes apparent that the Six Sigma methodology is driven by brilliant, knowledgeable statisticians. Professionals in the project management field may find valuable opportunities to contribute to enhancing these methodologies by incorporating promising practices used in most projects most of the time, while keeping in mind the planned short duration of Six Sigma projects.

Design for Six Sigma

Design for Six Sigma (DFSS) is a systematic methodology that utilizes 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). DFSS can improve new product development and systems development processes, and reduce their risks by using tools such as quantitative tollgate reviews, and deployment of a measurement-based process to reduce or remove the subjectivity of requirements and greatly enhance subsequent development activities (Hayes 2003). DFSS aims to develop new products or services with Six Sigma criteria, capability, and performance (Tennant 2002). 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 utilizes a variety of quality oriented tools and techniques to meet customer requirements and was associated with increases in life cycle profits. Treichler et al. (2002) noted that the essence of DFSS is “predicting design quality up front and driving quality measurement and predictability improvement during the early design phases”. The DFSS process is focused on new or innovative designs that yield higher level of performance. De Feo and Bar-El (2002) summarized seven elements of DFSS:

- Drives the customer-oriented design process wit 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
- Monitors process variances to verify that customer requirements are met

DFSS has been used and proven successful at Dow Chemical (Buss and Ivey 2001), W. R. Grace, (Rajagopalan et al. 2004), Delphi Automotive (Treichler et al. 2002), NCR Corporation (McClusky 2000), General Electric (Weiner 2004), and other process oriented industries.

Reported Benefits of Implementing Six Sigma

Manufacturing Sector

The reported benefits, improvements, and savings of the Six Sigma method in the manufacturing sector were discussed earlier and summarized in Exhibit 2 by organizations and projects.

Financial Sector

In recent years, finance and credit department were pressured to reduce cash collection cycle time and variation in collection performance to remain competitive. Typical Six Sigma projects in financial institutions include improving accuracy of allocation of cash to reduce bank charges, automatic payments, improving accuracy of reporting, reducing documentary credit defects, reducing check collection defects, and reducing variation in collectors’ performance (Doran 2003).

Bank of America (BOA) has been one of the pioneers in adopting and implementing the Six Sigma method to streamline operations, attract and retain customers, and create competitiveness over credit unions. It has hundreds of Six Sigma projects in areas of cross-selling, deposits, and problem resolution. BOA reported a 10.4% increase in customer satisfaction and 24% decrease in customer problems after implementing Six Sigma (Roberts 2004). American Express applied Six Sigma principles to improve external vendor processes, and to eliminate non-received renewal credit cards. The result showed an improved sigma level of 0.3 in each case (Bolt et al. 2000). Other financial institutions including, GE Capital Corporation, JP Morgan Chase, and SunTrust Banks are using Six Sigma to focus on and improve customer requirements and satisfaction (Roberts 2004).

Healthcare Sector

Six Sigma principles and the healthcare sector are very well matched because of the healthcare nature of very low or zero tolerance to mistakes and potentials for reducing medical errors. Some of the successfully implemented Six Sigma projects include improving timely and accurate claims reimbursement (Lazarus and Butler 2001), streamlining the process of healthcare delivery (Ettinger 2001), and reducing the inventory of surgical equipment and related costs (Revere and Black 2003).

The radiology film library at the University of Texas M. D. Anderson Cancer Center also adopted the Six Sigma method and improved service activities greatly (Benedetto 2003). Also in the same institution's outpatient exam lab, patient preparation times were reduced from 45 minutes to less than 5 minutes in many cases and there was a 45 percent increase in examinations with no additional machines or shifts (Elsberry 2000).

Engineering and Construction Sector

In 2002, Bechtel Corporation, one of the largest engineering and construction companies in the world reported a savings of $200 million with an investment of $30 million in its Six Sigma program to identify and prevent rework and defects in everything from design to construction to on-time delivery of employee payroll (Eckhouse 2003). As examples, Six Sigma was implemented to streamline the process of neutralizing chemical agents, and at a national telecommunications project to help optimize the management of cost and schedules (Moreton 2003).

Research and Development Sector

The objectives of implementing Six Sigma in Research and Development (R&D) organizations are to reduce cost, increase speed to market, and improve R&D processes. To measure the effectiveness of Six Sigma, organizations need to focus on data-driven reviews, improved project success rate, and integration of R&D into regular work processes. One survey noted that as of 2003 only 37% of the respondents had formally implemented Six Sigma principles in their R&D organization (Johnson and Swisher 2003). Rajagopalan et al. (2003) reported that the development and manufacturing of new prototypes at W. R. Grace (Refining Industry) was cut to 8-9 months from 11-12 months by implementing the DFSS process.

Key Factors for Successful Six Sigma Method and Projects

Key Factors of Successful Six Sigma Method Implementation

Anthony and Banuelas (2002) and Banuelas Coronado and Anthony (2002) presented the key ingredients for the effective introduction and implementation of Six Sigma program in UK manufacturing and services organizations as:

- Management commitment and involvement
- Understanding of Six Sigma methodology, tool, and techniques
- Linking Six Sigma to business strategy
- Linking Six Sigma to customers
- Project selection, reviews and tracking
- Organizational infrastructure
- Cultural change
- Project management skills

- Liking Six Sigma to suppliers
- Training
- Linking Six Sigma to human resources (Wyper and Harrison 2000)

Johnson and Swisher (2003) provided useful implementation tips for successful Six Sigma applications:
- Sustained and visible management commitment
- Continuing Education and training of managers and participants
- Set clear expectations and select project leaders carefully for leadership skills
- Pick and select strategically important projects

Starbird (2002) argued that the Six Sigma process is part of a management system to achieve business excellence in the organizations and presented keys to Six Sigma success:
- Start process management: Identify core processes, customer needs, and measures
- Drive performance through reporting: Leaders must maintain and report opportunity lists, status of active projects/resources, and results from finished projects
- Integrate championing of active projects: Select and charter projects and require updates during existing staff meetings

Summary of Findings on Success Factors in Six Sigma Projects

Based on literature reviews and discussions with Six Sigma leaders, the authors identified the following key factors for successful Six Sigma implementation and projects:

Management Commitment, Organizational Involvement, and Project Governance

Six Sigma requires top management commitment and contribution of required resources and effort. A good example is the commitment of GE's former Chief Executive Officer (CEO) Jack Welch (Henderson and Evans 2000). He was charismatic and influential enough to restructure the business and change the attitudes of employees throughout the company toward Six Sigma (Hendricks and Kelbaugh 1998). In our discussions we found the CEO to be generally involved in the overall implementation of Six Sigma. Organizational infrastructure needs to be established with well trained individuals ready for action. Implementation of Six Sigma projects means commitment of resources, time, money, and effort by the entire organization, based on clear mandates from senior executives. We generally found the Six Sigma organizational structure to be integrated a strong matrix within the overall structure of the organization. This appears to allow Six Sigma projects to be undertaken as part of normal business activities rather than as a separate initiative super-imposed on the organization.

Project Selection, Planning, and Implementation Methodology

Six Sigma projects have to be carefully selected, planned, and reviewed, to maximize the benefits of implementation. The project has to be feasible, organizationally and financially beneficial, and customer oriented. There has to be a clear set of measures and metrics to incorporate customer requirements. Each project has to be reviewed periodically to evaluate the status of the project as well as the performance of Six Sigma tools and techniques being implemented. Each project should be well documented to track the various project constrains. There should be a lessons learned mechanism to capture the key learning issues of previous projects. Using common methodologies for the implementation of Six Sigma projects (DMAIC and DMADV) simplifies the application and learning and allows lessons learned to be communicated effectively across projects, organizational units, and as appropriate in the profession.

Six Sigma Project Management and Control

A Six Sigma project is targeted to have a duration of three to six months. If the planned duration of a Six Sigma project exceeded the duration target, it is broken down to smaller projects. Keeping Six Sigma projects within these duration targets could be an important contributing factor to management support and resounding success of Six Sigma projects compared to larger conventional projects. During our discussions we found that project scope is generally well defined. We also found that scheduling, control, and progress reporting are accomplished using basic scheduling tools such as milestones and Gantt charts.

The expected financial impact per Six Sigma project is $100,000 to $500,000. During our discussions we found that some organizations have approved Six Sigma projects with benefits below $100,000. We also found that it is common to reject proposed Six Sigma projects if they could not present compelling benefits to justify organizational resources required to accomplish them successfully.

During our discussions we found it possible to define all projects in an organization as Six Sigma projects and to subject them to the rigors of the Six Sigma method. This includes building a new facility, implementing a new production system, or developing a new software application system. This is achieved by asking the question "why" several times. Ultimately, such proposed projects could be found to have the objective of improving a business system and are evaluated and planned using the Six Sigma method. Otherwise, they are likely to be rejected.

Encouraging and Accepting Cultural Change

People facing organizational change and cultural challenges due to implementation of Six Sigma must first understand the nature and aim of the change. This requires having a clear communication plan and channels, motivating individuals to overcome resistance, and educating senior managers, employees, and customers on the benefits of Six Sigma. Communicating the results of Six Sigma projects including successes, obstacles, and challenges was found to help future projects adopt the most promising practices and avoid making similar mistakes. The lessons learned function could be performed by the Master Black Belts who help transfer the learning among Six Sigma projects. This area has important implications in managing organizational change initiatives, in general.

Continuous Education and Training

Education and training give a clear vision to people to better understand the fundamentals, tools, and techniques of the Six Sigma approach. Training is part of the communications techniques used to make sure that managers and employees apply complex Six Sigma tools effectively. The ranking of expertise identified by the Six Sigma Belt system (Master, Black, Green, Yellow) ensures that establishment and execution of Six Sigma projects are accomplished seamlessly (Hoerl 2001). The training curriculum is customized and needs to be provided by identifying key roles and responsibilities of individuals implementing Six Sigma projects (Anthony and Banuelas 2002). Organizations need to continuously learn and adapt the latest methods and techniques outside the Six Sigma domain that might be useful in complementing the Six Sigma approach. During our discussions we found similarities in the overall duration of training, subject coverage, and requirement for involvement in actual Six Sigma projects. However, there were slight variations in the duration of training of Six Sigma project participants.

Obstacles and Challenges of Six Sigma Method

Issues of Strategy

One of the main criticisms of the Six Sigma method is that it has nothing new and simply provides repackaged traditional principles and techniques related to quality (Catherwood 2002). Hammer and Goding (2001) indicated that Six Sigma principles have been the target of criticism and controversy in the quality community characterizing it as "Total Quality Management on Steroid." Stamatis (2000) argued that Six Sigma had "little to offer that isn't already available through other approaches." Organizations must realize that Six Sigma is not the universal answer to all business issues, and that it may not be the most important management strategy requiring a sense of urgency of understanding and implementation. To ensure the long-term prosperity and sustainability of the Six Sigma method, organizations need to analyze and accept the strengths and weaknesses of the approach and to properly utilize Six Sigma concepts and tools.

Issues of Organizational Culture

Quality concept needs to be embedded into the process of design not just monitoring quality at the manufacturing level (McClusky 2000). The more important aspect is the change in organizational culture that puts quality into planning. Addressing the problems and issues that are easy to correct and claiming that Six Sigma method is a big success is simply deceiving. Organizations without a complete understanding of real obstacles of Six Sigma projects or a comprehensive change management plan will no doubt fail. Senior management's strong commitment, support, and leadership are essential in dealing with any cultural issues or differences related to Six Sigma implementation. If the commitment and support of utilizing required resources in Six Sigma projects do not exist, the organization should not consider embarking on such project.

Issues of Training

Training is a key success factor for Six Sigma projects and should be part of the overall approach of Six Sigma implementation. The Six Sigma Belt program should start at the top and be applied to the entire organization. The curriculum of the Belt program should reflect the organization's needs and requirements, and has to be customized to incorporate economic and organizational benefits. Training should cover both qualitative and quantitative measures and metrics, leadership, and appropriate project management practices and skills. It is important to note that formal training is part of the development plan of various Belt level experts. People need to be better informed of the latest method, tools, and techniques of Six Sigma, and to be able to communicate effectively with actual data and meaningful analysis.

Future of the Six Sigma Method

The Six Sigma method is likely to remain as one of the key initiatives to improve the management process than just being remembered as one of the fads (Johnson and Swisher 2003). The primary focus should be on improving overall performance of management, not just pinpointing and counting defects. Researchers and practitioners are also trying to integrate Six Sigma with other existing and innovative management practices to make the Six Sigma method even more attractive to different organizations that might have not started or fully implemented the Six Sigma method. Integrating and comparing principles and characteristics of Six Sigma with Total Quality Management (Revere and Black 2003, Hammer and Goding 2001), Human Resource Functions (Wyper and Harrison 2000), Lean Production (Antony et al. 2003), ISO 9000 (Catherwood 2002), ISO 9001 (Dalgleish 2003), and the Capability Maturity Model (Murugappan and Keeni 2003) are all part of the quality community effort to maximize the positive effects of the Six Sigma method. Harry (in Dusharme 2004) indicated that some aspects of the Six Sigma method, particularly the Design of Experiments, had become institutionalized. "In other words, we did what we set out to do: got it implemented and institutionalized. For the formal training courses, it was waning. But from an institutional point of view, it was growing." Harry specified that he did not see the Six Sigma method as having fallen short of its promises, but saw "mistakes within the industry of Six Sigma itself, within the quality profession. An example is lean Sigma. It's just an attempt for consulting firms in a waning market in the current economic times to throw something new to the customers."

Conclusions and Directions for Future Research

Successful implementation and organizational interest in the Six Sigma method have been exploding in the past few years. The statistical aspects of Six Sigma must complement business perspectives and challenges to the successful implementation of Six Sigma projects. The Six Sigma approach has been applied to increase the overall performance of different business sectors. However, integrating the data-driven, structured Six Sigma processes into organizations has room for improvement. Organizational cultural change requires time and commitment before it is fully adopted by the organization. Effective Six Sigma principles and practices will succeed through continuous refinement of the organizational culture.

Factors influencing the success of Six Sigma projects include management commitment, organizational involvement, project governance, project selection, planning, implementation methodology, project management and control, cultural change, and continuous training. Understanding the key features, obstacles, and shortcomings of the Six Sigma method provides opportunities for practitioners to better implement their projects. The promising practices learned from the successful management of Six Sigma projects could have important applications in managing traditional projects and wider applications in managing organizational change.

Future research could productively address success factors of Six Sigma projects through detailed interviews and surveys of leaders and participants in such projects. It could address the application of these success factors in traditional projects and in managing organizational change in general.

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