A Study of Six Sigma Implementation Process at an Organization in Mumbai to Develop a Model for Effective Implementation of the Six Sigma in Indian Organizations for Achieving Process Excellence

Dissertation Submitted to the
Padmashree Dr. D.Y.Patil University
Department of Business Management
Navi Mumbai

in partial fulfillment of the requirements for the award of the Degree of
MASTER OF PHILOSOPHY
IN
BUSINESS MANAGEMENT

Submitted by
Rajeshkumar Patil
(Roll No.DBM-MPHIL-0803003)
E.R.NO.086090006

Research Guide
Dr. R. Gopal
Director
Padmashree Dr. D.Y.Patil University
Department of Business Management
Navi Mumbai

Padmashree Dr. D.Y.Patil University
Department of Business Management
Navi Mumbai

MAY 2010

A Study of Six Sigma Implementation Process at an Organization in Mumbai

To Develop a Model for Effective Implementation of the Six Sigma in Indian Organizations for Achieving Process Excellence

DECLARATION

I hereby declare that the dissertation" A study of Six Sigma implementation process at an organization in Mumbai to develop a model for effective implementation of the Six Sigma in Indian organizations for achieving Process Excellence" submitted for the degree of Master of Philosophy (Business Management) at Padmashree Dr. D.Y.Patil University's Department of Business Management is my original work and the dissertation has not formed the basis for the award of any degree, associate ship, fellowship or any other similar titles.

Place: Navi Mumbai
Date:

(Rajeshkumar Patil)
Signature of the Student

CERTIFICATE

This is to certify that the dissertation titled **"A study of Six Sigma implementation process at an organization in Mumbai to develop a model for effective implementation of the Six Sigma in Indian organizations for achieving Process Excellence"** is a bona fide research work carried out by Mr. RAJESHKUMAR PATIL, student of Master of Philosophy (Business Management), at Padmashree Dr. D.Y.Patil University's Department of Business Management, during the period 2008-2010, in partial fulfillment of the requirements for the award of the Degree of 'Master of Philosophy (Business Management)' and that the dissertation has not previously formed the basis for the award of any other Degree, Diploma, Associate ship, fellowship or any other similar title.

Place: Navi Mumbai
Date:

(Dr.R.Gopal)
Signature of the Guide

Acknowledgment

I take this opportunity to express my indebtedness to the Padmashree Dr.D.Y.Patil University's Department of Business Management, which has accepted me for M. Phil. Program and provided an excellent opportunity to carry out the research project on Six Sigma. I sincerely thank Dr. R. Gopal, our esteemed Director of Department of Business Management, Padmashree Dr.D.Y.Patil University for wholeheartedly supporting the endeavor by giving me his valuable guidance for this research. I thank to Dr.Pradip Manjrekar, Professor for his support during my M.Phil.

I would also like to thank my family and colleagues, seniors of my organizations and staff members of Department of Business management for their support which helped me in completing the research work successfully.

Place: Navi Mumbai (RAJESHKUMAR PATIL)

Date: Signature of the Student

TABLE OF CONTENTS

TABLE OF CONTENTS (Contd)

TABLE OF CONTENTS (Contd)

TABLE OF CONTENTS (Contd)

List of Tables

List of Figures

LIST OF ABBREVATIONS

L&T	Larsen & Toubro Limited
C&A	Control & Automation
EBG	Electrical Business Group
EAOC	Electrical &Automation Operating
SBU	Strategic Business Unit
GB	Green Belt (Six Sigma)
BB	Black Belt
MBB	Master Black Belt
OM	Operating Manager
PM	Project Manager
LM	Line manager
CTM	Core Team Member
ODSCM	Operating Divisions Steering Committee Meeting
ELITE	EBG's Lean initiatives towards Excellence
VSM	Value Stream mapping
VA	Value Added
NVA	Non Value Added
LT	Lead Time
MED	Medical SBU
MPS	Metering Protection system SBU
ESP	Electrical Switchgear Products SBU

ESE	Electrical System & Equipments SBU
FMEA	Failure Mode Effect Analysis
QFD	Quality Function Deployment

Executive Summary

Six Sigma is the one of the most powerful management tool used to achieve process excellence. It has been successful in many western companies, most of them are fortune 500 companies like GE, Motorola, Ford. As Jack Welch, Ex-CEO of GE said, “Six Sigma is the most important initiative GE has ever undertaken. It is the part of the genetic code of our future leadership”, Six Sigma is now started becoming important & popular tool to remove variation & to reduce defects from product, process & service. All over world organizations are implementing process excellence initiatives like Six Sigma to improve process & product quality. History of these process initiatives shows that implementation of these initiatives is successful only in few organizations. A through analysis is required to study success & failure of implementation of these initiatives.

Many organizations in India are also implementing Six Sigma to improve Business processes. But Geographical, Cultural & Work environmental differences influences this implementation process. An implementation strategy developed for Indian work environment will increase effectiveness of Six Sigma in Indian Organizations. For this a Six Sigma Implementation model exclusively developed for Indian Organizations considering experiences of representative organizations is required. By using this model effectiveness of Six Sigma implementation in Indian Organizations will increase.

The objective of this research is to develop a model for implementation of Six Sigma in Indian organizations. In this study an emphasis is given on human

angle in context with Indian Culture and work environment because experience shows that for implementation of any new initiatives in organizations, the success of implementation depends on soft skills of people of organizations.

This is an exploratory research. The research methodology incorporated qualitative & quantitative research instruments. A comparison is done between various process excellence initiatives.

An integrated methodology using the tools, techniques and skills from lean principles and Six Sigma is necessary to optimize business process. Lean focuses on process speed, and Six Sigma focuses on process quality. This combination is very useful for Indian organizations and used while developing Implementation model in this research.

In this research following models developed.

1. **SIX SIGMA Implementation Model for Indian Industries**
2. **SIX SIGMA Project Implementation model**

Validation of the model is done by comparing internal customer satisfaction survey before and after implementing model. Extensive data is gathered for this and analyzed. A detail case study from representative organization is taken to validate Six Sigma project Implementation model.

Best of the both lean and Six Sigma methodology is used while developing these models. These models can be effectively used to reduce cycle time of business process. Customer satisfaction can be achieved along with business benefit by using these models.

Various Six Sigma tools to be used along with this model are also discussed.

The Six Sigma Implementation model used to evaluate readiness of organizations in terms of commitment of management, awareness & methodology. It also evaluates cultural aspects which is more important to Indian work environment.

The model guides for step by step implementation process. It also helps in formulating Implementation strategy and selecting tools & methodology. Creating internal resource base is most important for any organization. The pool of Back and Green belts carry on Six Sigma revolution, in an organization after consultant role is over. After developing implementation model a model for successful Six Sigma projects developed.

The implementation of Six Sigma will be more effective if Indian organizations use these models.

Chapter 1

Introduction & Objective of Research

All over the world many companies are adopting Six Sigma methodology as process excellence tool. GE, Motorola, ABB, Citi Bank, Ford are few of them. Some Asian companies are also have been implemented Six Sigma. Toshiba, Honda, Sony and Samsung are few of them.

In India many companies are implementing Six Sigma. Tata motors, Larsen & Toubro, HDFC are few of them. Globalization has opened the doors of world market to Indian organizations, which in turn forcing them to bring their products & services to world class level. For that along with various tools Six Sigma is becoming popular in India. Indian Statistical Institute is doing good work to promote Six Sigma in India.

However due to cultural, work environment & economical differences between India & western countries, different implementation strategy is required for India. To evolve this strategy & model for implementation, a through study of Indian work & organizational environment in Indian industries is required.

1.1 Objectives of this Research:

Considering specific need of Indian companies to implement Six Sigma effectively, this research is to study the problem.

The main objectives of the research are as follows:

1. To understand the need of Six Sigma in an Organization
2. To develop a model for effective implementation of Six Sigma in Indian Organization
3. To develop a model for successful Six Sigma projects in Indian Organizations

To do research on this topic a representative Indian organization is to be selected and in depth study spread in to sufficient time period should be conducted.

The study is carried out in Larsen & Toubro Limited as it is an Ideal Indian Organization.

Also researcher is having access to the data and close monitoring of Six Sigma implementation process could be done.

1.2 Comparative study of various process excellence initiatives

History and description of various Process Excellence Initiatives

Quality Approach	Approximate Time Frame	Brief Description	Implementing Organization
Quality Circles	1979-1984	Quality improvement or Improvement activities by small groups, composed of a small number of employees (10 or few).Quality Circles Structure and the working concepts originated in Japan	In Japanese context, most of the visitors to JUSE were shown the working of Quality Control Circles. In Indian context, BHEL under the leadership of Mr. Udupa implemented the concept with very good results. Jyoti Ltd, Kirloskar, Tata group etc. are among others who implemented the concept successfully.
Statistical Process Control (SPC)	1923(being practiced in India from 1980 till date)	Data based techniques to control a process	Many organization in India initiated of SPC, like BHEL, Indal Electronics ltd.(Now known as AT & S),Kirloskars and Automobile part manufacturing companies. Organizations who still maintain the initiative purposefully are Motor Industries company, TVS Group among others.
Quality Management	From 1987 till date	A set of standards on Quality, Environmental,	In the world scenario, most of

Systems		Security and other related process management developed to help companies effectively document the related system elements to be implemented to maintain an effective and efficient system.	European companies got busy with it. In India, Sundaram fastner, Kirloskar Cummins, Kirloskar Brothers, and L&T etc. implemented the QMS with astounding results. Most of the public sector plants followed suit, more as a routine with a lot of fanfare but without much of results. At present the system implementation has lost its glamour and is being pursued mostly to satisfy the auditors of the Certification Bodies.
Business Process Re-engineering (BPR)	From 1990 till date	Business Process Reengineering is a management approach that examines aspects of a business and its interaction and attempts to improve the efficiency of the underlying processes. It is a fundamental and radical approach by either modifying or eliminating non-value adding activities	Many organizations specially the IT/ITES and Services Providers like Tata group, ABB etc. have tried this approach with very satisfactory results.
Bench-marking	1988-1996	An improvement process where an organization measures its process performance against that of best –in-class companies ,determine show those companies	In Indian context, most of the large & medium scale organizations in the private sectors have been practicing this for

		achieved their performance levels and uses the information to improve its own processes. The areas of benchmarking usually	quite sometime effectively. L&T, Elgi Equipments, Kirloskar Copeland, Jyoti Ltd, TVS group of companies are some of them include strategies, operations, processes and structures.
Lean Concepts	From 2000 till date	Methodology and tools for transforming processes to deliver customer value faster improve workflow and eliminate waste.	The concept in this from has been borrowed from Toyota Production Systems, and most of the automobile & its part – manufacturing units in the world implemented the principle and were rewarded with excellent results. In India a good number of organizations have implemented the Lean Concepts in manufacturing and transactional processes successfully
Six Sigma	From early 1980s till date	Methodology for Specific Improvements Projects that are attacking process variability to eliminate defects, increase speed and reduce cost of doing business	It started with Motorola in early 1980s and spread world over like wild fire. GE made it more popular. In India, among the Non-US origin plants, first to implement it seriously was Wipro and Thermax. Reliance

			came next along with Godrej Saralee,BHEL ,MICO,Tata Motors and Ashok Leyland etc.At present, IT/ITES Sector Companies are vigorously implementing Six Sigma
Business Excellence	From 1987 till date	Excellence is defined as the outstanding practice in managing the organization and achieving results. Truly Excellent organization are those that strive to satisfy their stakeholders by what they achieve, how they achieve it, what they are likely to achieve and the confidence they have that the results will be sustained in the future.	Many companies in the west went for EFQM and Malcon Balrige Excellence Model. Now almost every country has its own excellence model, and some of these countries has made it mandatory for their industries to go for the assessment. Some of the industrial groups have their own model too like,Tata Business Excellence Model, Philips Business Excellence Model. It can be said that Kirloskars in 1980s developed such a model and awarded the best plant"RAVI KIRLOSKAR AWARD"
Theory of Constraints	From 1990 till date	The Theory of Constraints is the practical results of Eli Goldrall's work on "how to think". It is the Thinking Processes and their applicatios.TOC is a verifiable philosophy.	Among others, Godrej and Tecumseh attempted the concept of TOC with moderate success.

		By knowing how to think, one can understand the organization; by better understanding one can improve the organizational processes. Central to the concept of TOC is the acknowledgement of cause and effect.	
Balanced Score Card	From 1980s till date	Balanced Scorecard is focused on the future. It is derived from the strategy. It is not a controlling system, it is a balanced management system, incorporating all KPI's	The practice flowed down from US to India VIA US origin companies.Among others Johnson & Johnson has implemented Balanced Business Score Card remarkably

Table 1.1 History and description of various Process Excellence Initiatives (Ref: 'Guidebook for Six Sigma Implementation with Real Time Applications', *Indian Statistical Institute, Bangalore, 2007)*

1.3 Process Excellence in India

The movement towards total quality or performance excellence as the operating model for organizations is growing at an accelerated pace. This approach is applicable to organizations of all sizes, in the manufacturing, service, education and healthcare sectors.

In India, the criteria for performance excellence come in two versions: The Malcolm Baldrige performance excellence criteria have been adopted for the IMC

Ramkrishna Bajaj National Quality Award; and the European quality award criteria for the CII-Exim Business Excellence Award. In terms of core values, the two are similar.

Each of the two models emphasizes that work flows horizontally across functions to the customer. This work, a process, should be managed efficiently in order to deliver quality outputs to the customer.

At the recent Nasscom India Leadership Forum 2009, N R Narayana Murthy, chief mentor of Infosys, said that though the world has seen tough times in 1989-1993 and 1999-2002, the present global recession could be the mother of all recessions. There was a wide consensus that quality and efficiency of management processes is the key to survival, and perhaps progress.

The case for using process improvement methodologies is now beyond question. Care should be taken to adopt a structured process improvement methodology such as Six Sigma, Lean, TPM, or 'Juran on Quality Improvement.' The power of any such methodology, when integrated with the IMC RBNQA or CII EXIM criteria, provides for outstanding monetary and non-monetary performance results.

Here are some outstanding examples from the Indian Industry.

Larsen & Toubro: Testing service level improvement

Larsen & Toubro undertakes non-destructive testing for the welded seams and joints of its fabricated products, which had to be focused on for reducing the total manufacturing time. A Six Sigma team was formed to standardize the process and reduce delays. The goal was to achieve 80% of the service requests received within 48 hours and 95% of the requests within 72 hours. Tools such as high level process mapping, customer-output-process-input supplier (COPIS), and voice of customer (VOC) were used to identify critical to quality (CTQ) characteristics. Vital CTQs were prioritized through a Pareto diagram and a brainstorming session identified direct improvement causes. Based on a cause-and-effect diagram, a series of direct improvement actions were implemented. The resulting benefits were: an increase in sigma levels by factor of 2.5; reduction in project cycle times by 7-15 days per project; overall increase in sales by Rs.600 crore; and an expansion in capacity. L&T has included the IMC RBNQA criteria and as part of its quality management system.

Sterlite Industries: Cycle time reduction of Cenvat credit availment

Sterlite Industries, a leading copper producer of India, was facing an accumulation of working capital in the form of Cenvat owing to the cycle time taken between goods received, consumed and credit availed. It urgently needed to significantly reduce the Cenvat availment cycle time from the current 58 days. A brainstorming session, followed by a fish bone diagram plot, data gathering, and a Pareto analysis prioritized the high level causes. A why-why analysis

identified a few root causes. A feasibility and cost analysis helped select the solution.

Consequently, a SAP R/3 system and SOPs were implemented along with the corresponding training. The tangible benefits included reduction in working capital by Rs.8.40 crore annually and the related interest, and system improvement for Cenvat availment. The intangible benefits included training of team members in the structured 'Juran on Quality Improvement' methodology; better teamwork amongst departments; increase in confidence and attitude of employees; and development of a paperless and person independent office system. Sterlite too has the IMC RBNQA criteria integrated into its process improvement methodology.

Tata group: Habit of process improvement

At several Tata companies, such as Tata Steel, Tata Chemicals, Titan and Tata Motors, process improvement is a habit. This has been accomplished by integrating quality improvement into strategic plans as well as job design, performance appraisal, promotion policy, induction training and so on. In addition, the leadership at each unit invests time in identifying improvement

opportunities and reviewing the progress of improvement teams with the same intensity that they review financial performance.

It should be noted that the Tata Business Excellence Model (TBEM) is a clone of the Baldrige. all Tata companies are required to adopt TBEM practices.

Process improvement is not sustainable without a performance excellence framework.

1.4 TATA Business Excellence Model

Tata Business Excellence Model is a framework which helps companies to achieve excellence in their business performance. This is the chosen model by the TATA group to help in building globally competitive organizations across TATA Group companies. TBEM is based on the Malcolm Balridge National Quality Award Model of the U.S.

The Criteria have three important roles in strengthening competitiveness:

- To help improve organizational performance practices, capabilities, and results
- To facilitate communication and sharing of best practices information among all organisations within TATA Group.
- To help in guiding organizational planning and opportunities for learning

TBEM Criteria is designed to help organizations use an integrated approach to organisational performance management that results in

- Delivery of ever-improving value to customers and stakeholders, contributing to organizational sustainability
- Improvement of overall organizational effectiveness and capabilities
- Organizational and personal learning

The Criteria are built on the following set of 11 Interrelated Core Values and Concepts:

- Visionary Leadership
- Customer-driven Excellence
- Organizational and Personal Learning
- Valuing Employees and Partners
- Agility
- Focus on the Future
- Managing for Innovation
- Management by Fact
- Social Responsibility
- Focus on Results and Creating Value
- Systems Perspective

The Core Values and Concepts are embodied in seven Categories, as follows:

- Leadership
- Strategic Planning
- Customer and Market Focus
- Measurement, Analysis, and Knowledge Management
- Work force Focus
- Process Management
- Business Results

The TBEM criteria are the operational details of the Core Values, applied to the different facets of a Business organization.

The 7 Criteria Categories are divided into 18 items and 32 Areas to Address The TBEM framework has the following characteristics

- Focus on Business results
- Non-prescriptive and Adaptable
- Maintains System Perspective
- Supports Goal based diagnosis

TBEM instills a process centric approach in an organization as a means to achieve the chosen Business Goals

Tata Teleservices Limited as a part of the TATA Group has adopted the TATA Business Excellence model as an intricate part of its operation structure and uses it to grow from strength to strength, keeping Operational excellence and Business results in focus.

Situation in India:

Over the past decade, over 500 organizations have adopted performance excellence criteria in India (Suresh Lulla, 2009). Several have earned recognition for their best practices. Some that have earned accolades in India have even gone on to win the Asia Pacific Quality Award (a competition amongst winners in the Asia-Pacific region).

Apart from process management, what are the common best practices amongst the winners? Without a doubt, the practices of governance and social responsibility. These practices are exemplified by operational units in the House of Tatas, Aditya Birla Group, HDFC Group, Godrej Group, Mahindra Group, Wipro Group, Infosys and a few more. In essence, each of these organizations has solid practices for most of the following:

1. Accountability for management's actions
2. Fiscal accountability
3. Transparency in operations
4. Independence in internal and external audits
5. Protection of stakeholder and stockholder interests
6. Performance evaluation of senior leaders
7. Performance evaluation of members of the governance board
8. Impact of products, services and operations on society

9. Ethical behaviour in all interactions
10. support for key communities.

World-class organizations do not have a choice when it comes to governance and social responsibility.

1.5 CII-EXIM Bank Award for Business Excellence

CII and Export-Import (EXIM) Bank of India jointly established the Award for Business Excellence in 1994 with the aim to enhance the 'Competitiveness of India Inc.' The Award is based on the EFQM (European Foundation for Quality Management) Model for Excellence.

The Excellence Model is based on universally accepted standards and practices prevalent across the world. Apart from recognition, the model provides a holistic management framework to achieve Excellence. A large number of organizations have successfully used this model to:

- Define Excellence across the organization.
- Develop an integrated approach for achieving sustainable competitiveness.
- Measure progress on the journey towards Excellence.
- Review and improve Strategy, Processes and Performance.
- Identify and share good practices.
- Provide learning opportunity to develop Business Leaders.

CII ensures that the model remains dynamic and contemporary to management thinking. Both CII and EFQM are committed to researching and updating the

model with practical and academic inputs drawn from organizational experiences across the world.

Recognizing the growing significance of Small and Medium Businesses in the growth of Indian Industry and Economy, the assessment process has been simplified and the fee for participation has been reduced. This is to promote the adoption of Excellence framework among Small and Medium Businesses derive the benefits to enhance their competitiveness.

Award Winners

2006 : Tata Consultancy Services Limited

2005 : Commercial Vehicle Business Unit (CVBU),
Tata Motors Limited

2002 : Infosys Technologies Limited

2000 : Tata Iron & Steel Co. Limited

1998 : Maruti Udyog Limited

1997 : Hewlett Packard (India) Limited

Prize Winners

2008 : The Tinplate Company of India Limited

2006 : Heavy Electrical Equipment Plant, BHEL, Haridwar

Commendation Certificates

Over 150 Commendation Certificates have been awarded during the last fifteen years.

Organizations from various sectors of Industry viz. Manufacturing, Services, Power, Process, etc. and both with Public and Private ownerships are participating in the award programme.

1.6 IMC RAMKRISHNA BAJAJ NATIONAL QUALITY AWARD

Background:

The following essentials for total quality are embodied in the IMC Ramkrishna Bajaj National Quality Award criteria :

- Customer oriented quality focus.
- Senior corporate leadership must formulate clearly defined values and inculcate them into their company's operations.
- Excellent quality evolves from well-designed and well-executed Systems and processes.
- Continuous improvement must be integrated into the management of all systems and processes.
- Companies must develop goals as well as strategically aim to export their products and services.
- Minimizing the response time for all operations and processes must be part of quality improvement efforts.
- Operations and decisions of the company must be based on facts.
- All employees must be appropriately trained, developed, and involved in quality improvement activities.

- Designing quality and error prevention must be key elements of quality systems.
- Companies must communicate quality requirements to suppliers and work to evaluate their performance.
- Values of the Late Shri Ramkrishna Bajaj must form an integral part of executive leadership.
- Companies must plan to create an impact on society in the areas of education, women's welfare and rural development.

The Evaluation Process:

IMC Ramkrishna Bajaj National Quality Award Trust, comprising of prominent leaders from Indian Companies as Trustees, has been created to foster the success of the program. The Trust selects the winners based on the recommendations of a Panel of Judges.

Board of Advisers:

The Board of Advisers is the advisory body on the Award to the IMC. The Board is appointed by the IMC and consists of distinguished leaders from all sectors of the Indian economy. The Board evaluates all aspects of the Award program, including the adequacy of the award criteria and processes. An important part of the Board's responsibility is to assess how well the Award is serving the national interest. Accordingly, the Board makes recommendations to the IMC regarding changes and improvements in the Award Program.

IMC Quality Cell:

The Award process is administered by the IMC Quality Cell under the guidance of the IMC Award Sub-Committee. It conducts the following training programs :

- IMC RBNQA Executive Briefing (half day)
- Understanding the IMC RBNQA Criteria and Process (two days)
- IMC RBNQA Certified Examiner for Quality Management (four and half days).

Award Recipients' Responsibilities and Contributions:

Award recipients will be required to share information on their successful performance and quality strategies with other Indian organizations except proprietary information. The principal forum for sharing information will be the annual Making Quality Happen Conference.

Larsen & Toubro Limited, Electrical Standard Products has won IMC RBNQ TROPHY 2009 in manufacturing category.

1.7 An Introduction to Larsen & Toubro Limited-EAOC

Larsen & Toubro Limited is a $ 7 billion, technology, engineering, construction and manufacturing company. It has a strong, customer-focused approach to business, a culture of innovation, collaborations with global players and the resource and ability to respond positively to challenging requirements.

L&T's operations extend across the globe. It markets plant and equipment in over 30 countries, has manufacturing facilities in India, China and the gulf, and a supply chain that extends to five continents. Within India, L&T has a presence in virtually every district through a nationwide network of distributors for its products.

The company operates through multiple divisions:

- Engineering & Construction, Projects
- Construction
- Heavy Engineering
- Electrical & Electronics
- IT & Technology Services
- Machinery & Industrial Products

The L&T team comprises over 45000 people, based in plants and offices worldwide. The company's wide shareholders base exceeds 6,50,000.

Financials

Total income for the L&T group of companies for the year ended march 31, 2008 stood at Rs. 29848 crore. Group profit After Tax (excluding gain on divestitures) was Rs. 2304 crore.

Record of Achievements

L&T's signature of excellence is evident on:

. Hydrocarbon projects executed in India, the Middle East and South East Asia

. Power projects executed in India, the gulf and Sri Lanka.

. The world's largest coal gasifier made in India and exported of China

. The world's biggest EO reactor for a petrochemical complex in gulf

. The world's largest FCC regenerator for a refinery

. Asia's highest viaduct

. Infrastructure projects in Jordan, U.A.E and south East Asia

. The world's longest coal conveyor

. India’s widest range of switchgear

. A wide range of construction and mining equipment.

Electrical Business Group

ELECTRICAL STANDARD PRODUCTS

L&T is India’s largest manufacturer of low-voltage switchgear.

Range includes:

Controlgear: Control and power contactors including bar-mounted contactors, complete range of thermal overload relays and motor protection circuit breakers, programmable logic controllers, control and indicating devices, like push-button units, indicating lamps push-button pendants, timing devices, supply monitors, rotary switches panel meters etc. various solutions for motor control including drives, motor starters (direct-on-line, star-delta starters, soft starters) and submersible pump controllers.

Powergear: Air circuit beakers with state-of-the-art communicable releases, Moulded case circuit Breakers, switches, switch fuses, switch-Disconnector-Fuse units, switch-disconnectors and HRC fuses on-load changeover switches including motorized versions.

Energy Management Devices: Digital protective relays, demand controllers, energy meters, power capacitors, harmonic filters and reactive power management systems.

Building Electrical Products: MCBs, RCCBs, RCBOs, ELCBs, distribution boards & enclosures , house wires, flat cables, flexible wires and building automation devices.

Manufacturing Facilities

L&T's manufacturing facilities for standard switchgear products are located at Mumbai Ahmednagar. A modern manufacturing, Forced Draft Ventilation System (FDVS), TQM, value Engineering, JIT, Six Sigma and e-commerce.

Distribution & Logistics

L&T switchgear is available through a network of close to 500 authorised stockists, one of the largest distribution networks for switchgear products.

Training & After Sales Service

L&T Switchgear Training centers at Pune, Lucknow and Coonoor conduct customer-oriented training programmes to give customers, engineers and professionals the 'hand-on' experience necessary for a better understanding of switchgear applications.

Training programmes impart knowledge and upgrade maintenance skills to minimize downtime and costs. Over 35,000 participants have benefited from these facilities.

L&T has over 100Approved Service Centers to provide effective service. They are managed with hardware and software support provided by L&T. The company's switchgear engineers offer sales and service from 40 locations across the country.

International Sales

L&T's ACBs, MCCBs, contactors and motor starters are marketed in the Far East, the Middle East, South East Asia and neighbouring countries.

Electrical Systems & Equipment

L&T is Indian's largest manufacturer of Low Voltage (LV) switchboards and probably the world's only company manufacturing the highest quantum of LV switchboards in a single country.

L&T manufactures custom-built switchboard with conventional as well as intelligent protection, control and communication to meet the power distribution and motor control needs of industries. L&T's experience of around four decades has led to the development of innovative and trendsetting solutions that

encompass safety and reliability in operation and maintenance. L&T's switchboard incorporate features specially designed to suit tropical conditions.

Range

The range comprises power control centres (PCC), motor control centres (MCC), Distribution Boards and control panels. PCC and MCC are suitable for MVA transformer (113kA fault-withstand capacity). These switchboard can be offered with internal separation up to Form 4 and conform to IEC 60439-1 and IS 8623.

PCC type TF is rated up to 6000A and houses L&T's range of Air circuit Breakers (ACBs) to take care of power distribution. ACBs can be mounted in a multi tier arrangement.

MCC type TQ is rated up to 5000A and is available in draw out design with both single front and double front execution. The draw out modules offer five unique positions thereby making operation and maintenance extremely fast and easy. The modular construction allows interchangeability of feeders and offers complete flexibility in accommodating customer's specific requirement. By ensuring higher packing density per vertical panel it offers optimum utilization of space.

L&T also offers fixed distribution boards suitable for segments like buildings, infrastructure, automobile, etc.

These switchboards incorporate a novel concept of sleeved interleaved busbar system which enhances current carrying capacity of the bus bars, reduces power loss in the switchboards and optimizes the burden on the ventilation system, resulting in saving to the end user.

Other Products and Systems

L&T offers Intelligent Relays integrated with the PCCs and MCCs along with customized Human machine Interface software for protection, complete plant monitoring, control and data acquisition. This system is offered up to 33kV power distribution with interface to higher level automation systems like DCS/ECS EDMS,making it most preferred plant control system across industry.

L&T offers power quality management system from its business associates. It includes system study, harmonic analysis and engineered solutions.

Manufacturing Facilities

L&T has been manufacturing these switchboard at state-of-the-art manufacturing facilities at powai and faridabad. To cater to increased market demand, L&T has also opened up manufacturing facilities at coimbatore and Ahmednagar. Similar to the factories at powai and faridabad, these have fully integrated manufacturing facilities for complete in-house production . These modern manufacturing facilities include electrostatic powder coating, computer controlled

fully automatic electroplating lines, CNC turret punch-ing, CNC bending machine, gang punching machine for droppers,etc.

L&T has set up a state-of-the-art manufacturing facility in Saudi Arabia.

Project Services

L&T offers allied equipment like busducts, transformer, MV switchgear industrial batteries and cables, and undertakes turnkey contracts for comprehensive system engineering, supply, installation, testing and commissioning of switchboards and allied equipment.

L&T offers assistance in product selection, application engineering and detailed engineering , installation & commissioning , retrofitting and upgradation of switchboards, after-sales service and training .

L&T offers total power distribution solution encompassing switchboards, distribution boards, starters, changeover switches, etc. along with automated power management system & platform management system for marine application.

International Sales

L&T switchboards are installed worldwide at industrial & commercial establishments and power distribution networks. L&T switchboards are sought by

multinational consultants and clients like Snamprogetti Spa (Italy) , Technip (worldwide), Bechtel (UK), Chiyoda corporation, Takuma, IHI (all in Japan), AES (UK) , PDO (Oman), Qatar petroleum (Qatar) , Lafarge, Total Fina Elf, Saipem (all in France), petrofac (UAE) , Daelim, Samsung, Hyundai, LG (all in Korea),etc

L&T exports switchboards &allied equipment &system mainly to countries in the middle East such as Oman , Saudi Arabia, Qatar, UAE, Kuwait, Yemen, etc. L&T supplied to countries in south-East Asia, Africa & Europe.

L&T designs & manufacturing enclosures in flat pack systems for switchboard assemblers worldwide. Retrofitting solutions are offered for a wide range of LV & MV switchgear including IMCS.

Electronics Sector I

METERING & PROTECTION SYSTEMS

L&T manufacturing and markets a comprehensive range of high quality electronic energy meters and numerical protective relays for utilities, industries commercial establishment and individual users. L&T provides comprehensive end-to-end metering solutions that involve installation and commissioning of meters, automatic meter reading and accuracy checking. Networking of meters, collecting data from them and transporting data over suitable for display, analysis and

report generation are part of the Automatic meter Reading system implemented by L&T.

Meters

The range includes meters for metering of electrical energy for all categories of consumers- domestic, agriculture, commercial, industrial LT or industrial HT. L&T also offers special high accuracy energy meters for measurement of energy flow in generating station and transmission system. L&T is among the few manufacturing in India to have development meters for Availability Based Tariff (ABT) metering.

The single-phase meter of L&T is a unique, aesthetically designed product that has successfully challenged the conventional style of designing meters. The meter offers consumer friendly features like kW demand and backups of monthly consumption on display .L&T has also developed prepaid meters based on smartcard technology which automatically disconnects the supply.

L&T meters conform to relevant IS and IEC standards, and are ISI-marked.

Meters for remote Reading

Intelligent single and three-phase meters are available with communication interface, to serve as RTUs in energy management systems/SCADA/automatic

meter reading. L&T has developed a GSM modern that helps in transferring meter data to a remote computer.

Protection Systems

L&T offers total solutions for protection in all the three segments of power systems-generation, transmission and distribution.

It manufacturing single-phase and three-phase over-current/ earth fault relays, voltage relays, motor protection relays, auto re-close relays, and intelligent power factor controllers that helps in maintaining the plant PF at an optimum value and contribute to improving distribution efficiency. All relays conform to relevant IS and IEC standards

Other Products

L&T markets motor protection relays, feeder protection relays and generator protection relays, manufactured by Microelettrica Scientifica of Italy. These are high-end protective relays for medium and high voltage power systems, and offer many advanced features like fault-data record , event record and waveform capture. The relays have remote communication and control facility.

Manufacturing Facility

L&T's meters and relays are manufactured at its Mysore complex.

The facilities include:

. Air-conditioned dust-free production area

. Cell concept for efficient and lean manufacturing

. Computer-based functional test setups

. CAD/Pro-E for solid modeling and CAD-star for circuit design

. Test set-ups for electro-magnetic compatibility that includes high energy lightning surge test facilities & Radiation susceptibility

. RE/CE test set-up

. Magnetic induction test facility conformingtoCBIP-88 specifications

. Vibration and shock test set up

. Environmental test Chambers

. Automatic energy meter calibration

. Automatic relay test set-up

. Thermal cycling and burn-in at elevated temperature for high reliability

. Ultrasonic welding for meter enclosure for tamper resistance

International Sales

L&T is exporting meters to select countries n Africa an Asia, where the products have gained wide acceptance. Apart from Trivector meters, L&T is exporting prepayment metering system has been supplied to Bangladesh.

MEDICAL EQUIPMENT & SYSTEMS

L&T's range of medical products meets international regulatory and safety requirements, and have various certifications/ approvals, such as CE (GMED, France), CMDCAS (underwriter laboratories) for exports to Canada, SFDA for

export to China and U.S. FDA for exports to the USA. L&T addresses almost every facet of healthcare with its wide range of products. It is committed to making available contemporary world-class medical equipment to the medical fraternity at an affordable total cost of ownership for the entire lifecycle of the product.

Range

L&T's product range includes colour Dopplers (Entry & premium level Radiology System), ultrasound scanners (Black & White – premium, portable & Entry level models), vital sign patient monitors (Multi parameter, 3- channel, Dual parameter, pulse Oximeters, cardiac monitors & central Nurses' station), ECG machine and surgical Diathermies.

L&T medical has exclusive distributorship agreements for sales and service of Anaesthesia Delivery systems & ventilators, Defibrillators & cardiac Resuscitation systems , Handheld pulse Oximeters, Foetal monitors, X-Ray & C-Arm Image Intensifiers and syringe pumps. L&T medical also offers tele-medicine solutions.

Manufacturing Facility

L&T medical has its state-of-the-art manufacturing facility at Mysore in the south of India. L&T Medical's Mysore campus, spread across 40 acres, is the country's first ISO 9001 certified medical equipment factory. It has accreditations such as ISO 13485:2003, ISO 14001:2004, OHSAS 18001.

L&T medical follows best manufacturing practices and ahs infrastructure for quality and reliability evaluation of products and EMI/EMC test facilities. Some of the manufacturing, value practices being followed are six sigma tools, lean manufacturing, value engineering etc. The IT backbone consists of SAP with the service and quality module cutting across the supply chain. The products comply with International safety and performance Standards as per IEC 60601-1with product design having embedded systems software from L&T's CMMI level 5 Certified Embedded systems (EmSyS) development center at Mysore.

L&T medical equipment are exported to USA, Latin America, Europe ,south-East Asia, the Middle East, Africa and neighbouring countries. L&T medical has received approvals from the U.S.FDA for various models of these monitors have been installed in the U.S market.

Selected medical products, designed and manufactured by L&T are being branded for reputed international firms.

Electronics Sector II

CONTROL & AUTOMATION

L&T offers control Automation solutions for the following major industry verticals:

Oil & Gas , Water: Turnkey solutions for pipeline SCADA, tank farm automation system; compressor control system, emergency shutdown system (ESD), fire& gas.

Cement, Metal & mining, Paper, Port:

Packaged solutions for plant wide electrical, automation and instrumentation from switchyard to sensors.

Power Distribution: Turnkey solutions for control & instrumentation for power generation , SCADA for transmission, distribution management system & substation automation meter reading- for ABT& utility

Special Projects: Packaged solution for data acquisition &control systems, automatic power management system and auxiliary for marine applications; power electronics applications for navy; test rigs and simulators for naval application.

Automotive: Automated robotic manufacturing assembly lines

Infrastructure (Airport, Highways, Metro Railways & Retail): Turnkey solutions for automatic baggage handling system, airport IT system, aviation fuel handling system ,highway traffic management system, automatic fare collection system ,retail automation.

The solutions are based on the 'open Architecture' concept providing easy portability to the end users, incorporating state-of-the-art auto-mation products.

L&T drive systems are built around high performance inverters from Yaskawa Electric, for energy saving and process control. L&T also offers digital DC drives, slip power recovery systems and power conditioning equipment.

Automation system incorporate programmable process controllers, plant control through DCS, supervisory color graphic operator stations, network communication hardware and software, sensors, instruments consoles and other accessories, LnTEMSTM (Energy Management Software), ESD PLCs from HIMA Germany.

SCADA solution are based on technology from leaders- Telvent (Canada) for pipelines and Telvent (Spain) for power transmission/ distribution. L&T offers system for Automation meter Reading (AMR), Distribution Management Systems (DMS) and Electrical control system (ECS) for substations.

Plant integration solutions are based on soft platform from OSIsoft (USA). Capabilities include areas like Manufacturing Execution Systems (MES), integration of process control systems with business systems (IT mation), and web enabling of legacy systems.

L&T provides globally benchmark manufacturing assembly lines with features like robotic, fixturing , welding, handling for the automation industries.

The system offering includes end-to-end solutions from concept to commissioning. Expertise extends to basic and detailed engineering, procurement, application software, driver development project management, commissioning and lifecycle services.

L&T offers a range of control products such as AC/DC drives, servo drives, soft-starters and PLCs. These are widely used in equipment such as elevators and cranes, HVAC, food and breweries, pharmaceuticals, chemical process, textiles, printing & packing, machine tools and plastic machinery.

System solution as well as engineering and software service are exported to the Middle East, South East Asia, Africa and neighbouring countries.

Engineering, software development and system integration are carried out at L&T's ISO 9001 certified state-of-the-art Automation Systems centre at Navi Mumbai, India with support structure throughout India and an Integration centre at Jebel Ali, Dubai.

RESEARCH & DEVELOPMENT

The R&D activities at Electrical & Electronics Division include product and process development. Several innovative products have been introduced by different businesses over three decades as a result of R&D.

Design and development activities are integrated with L&T Embedded Systems & Software leveraging domain knowledge to build intelligent communication capable technology in various switchgear products, energy meters, petroleum dispensing pumps and medical equipment.

L&T's R&D achievement include a high rate of introduction of new products. Every third rupee of the turnover today comes from new products introduced in the last five years for switchgear products,

Many of the products have won international awards. L&T has a large number of patents to its credit.

The Switchgear Design and Development Centre (SDDC) spear-heads new product development strategies and product life cycle management of L&T's electrical sector. It has two development centers, one in Mumbai and the newly established centre in Coimbatore. Backed up by more than four decades of experience, SDDC presently has more than 130 engineers with diverse skill sets engaged in developing innovative solutions in an environment conducive for growth and learning. Strategic alliances with several leading research organization, test laboratories enable SDDC to offer technologically superior products & service setting their own benchmarks in the industry.

Infrastructure

A fully integrated IT enabled CAD/CAM facility with more than 50 pro/Engineer work stations inter-linked on a fibre optic backbone support concurrent product development. The design concepts are optimized and verified using advanced software tools like Pro/Mechanica, ANSYS- Multi Physics & ADAMs that ensure robust design while cutting down product development time. The engineering & enterprise data are seamlessly integrated through a SAP-based product life cycle management module that fosters concurrent development.

SDDC has a modern NABL-approved testing laboratory, fully equipped with a short circuit test capability of 85 ka up to 750V with an online data recording system that helps in interpretation and analysis of results. It also has other facilities like temperature rise test up to 10,000 A, electrical & mechanical durability tests, environment test and EMC/ EMI tests.

Business Processes

Robust design & development process with fully integrated DFSS (Design for Six Sigma) principles and methodologies ensure a high degree of reliability in product design. The five phase gate concept & concurrent working through cross-functional teams help increase the success rate of new product development.

SAP-based knowledge management module captures all learning and compresses the learning curves for designers. Strong IPR culture in SDDC helps constant value creation in terms of patents, design registrations and copyrights.

ENGINEERED TOOLING SOLUTIONS

L&T's Engineering Tooling Solutions (ETS) designs and manufacturing a wide range of high precision tools, a prerequisite for high quality products. The range includes press tools, moulds for thermosets and thermoplastic materials, pressure de casting dies, jigs, fixtures, gauges and tools for special machines, processes, etc

ETS's Tool Engineering and Design Department at Mumbai is equipped with high-end CAD systems and is linked to the integrated CAD facility of product Design, product Engineering and Tool Manufacturing.

Tool Rooms are equipped with computer Aided Manufacturing facilities (CAM), high-precision machines like jig boring, jig milling ,CNC vertical machining centres, CNC jig grinder, CNC wire erosion machines, CNC surface grinders and CNC spark erosion machines. Set over 40 years ago, the centre has over 200 trained engineers and technicians, excellent networking of computers and a high level of CAD-CAM integration.

With continuous investment to keep pace with world class tool room technology and its thrust on technological developments, L&T's Engineered Tooling Solutions facilities enhancement of product quality, supply of complex and critical items for various projects and helps introduction of new products in the shortest possible time.

Tool manufacturing facilities are located at Mumbai and Ahmednagar.

Chapter 2

Research Methodology

In this chapter Research methodology used is discussed in detail. It also discusses various issues relating to decisions regarding the purpose of the study (exploratory, descriptive and explanatory). The level at which the data will be analyzed is SBUs that is the data will be collected from several SBUs of Larsen & Toubro Limited.

2.1. Research Problem:

A research problem is one which requires a researcher to find out the best solution for the given problem, i.e., to find out by which course of action the objective can be attained optimally in the context of a given environment.

In this study the research problem is to develop a strategy for effective implementation of the Six Sigma in Indian organizations for achieving Process Excellence.

2.2. Type of Research:

This is an **exploratory research** where both qualitative and quantitative type of research methods used.

Exploratory Research is designed to generate basic knowledge, clarify relevant issues uncover variables associated with a problem, uncover information needs, and/or define alternatives for addressing research objectives. It is a very flexible, open-ended process.

2.3. Research methods:

Quantitative Research:

It involves the collection of numerical data in order to explain, predict, and/or control phenomena of interest; data analysis is mainly statistical (deductive process)

It is generally undertaken to establish facts, demonstrate relationships, determine effects, or test theory.

Quantitative researchers are particularly interested in discovering cause-and effect relationships and generating data that allow outcomes to be predicted.

An additional purpose of quantitative research is to generalize sample findings to more broadly defined populations.

In this study quantitative data is collected to establish various facts and relations to evolve final model.

Qualitative Research

It involves the collection of extensive narrative data in order to gain insights into phenomena of interest; data analysis includes the coding of the data and production of a verbal synthesis (inductive process)

Qualitative research is based on a paradigm that posts that truth is dynamic and can be found only by studying persons as they interact “as unitary (beings) in mutual process with the Universe”.

The purpose of all qualitative studies is to discover, explore and describe phenomena.

More significantly, the purpose of qualitative research is to identify the dimension of the phenomenon under study from the subject’s viewpoint in order to interpret the totality of the phenomenon

Qualitative research may make its greatest contribution in areas in which little research has been done and theory testing cannot be carried out because the variables related to the concept of interest have not yet been identified.

In clinical practice, the results of a qualitative study may be valued and useful in their own right, or they may be used to develop or guide a subsequent quantitative or qualitative study.

Experience shows that for implementation of any new initiatives in an organizations, the success of implementation depends on soft skills of people of

organizations. In this study an emphasis is given on human angle in context with Indian Culture and work environment. Here mainly qualitative research is used.

2.4 Data Collection

The major source of data for this study is internal but lot of external sources like library, government data, records, internet sites also used.

Internal

Data generated within the organization, Copies available particularly sales, purchase, production, number of employees, salaries, wages, profits etc.

Data available in the books, compile reports and other details

For this study main internal data is sourced from L&T's central Business Excellence group. Some data is compiled in C&A SBU.

External

Information collected from out side the organization is called external data which can be obtained from primary source or secondary source.

This kind of data can be collected by census or sample method by conducting surveys and investigations.

As most of the Six Sigma related data is technical & product design related and confidential, many organizations were reluctant to give data. So only final results studied from these organizations.

Descriptive Research:

- Observation Method
- Interview Method
- Focus group discussion
- Questionnaire Method

Questionnaires

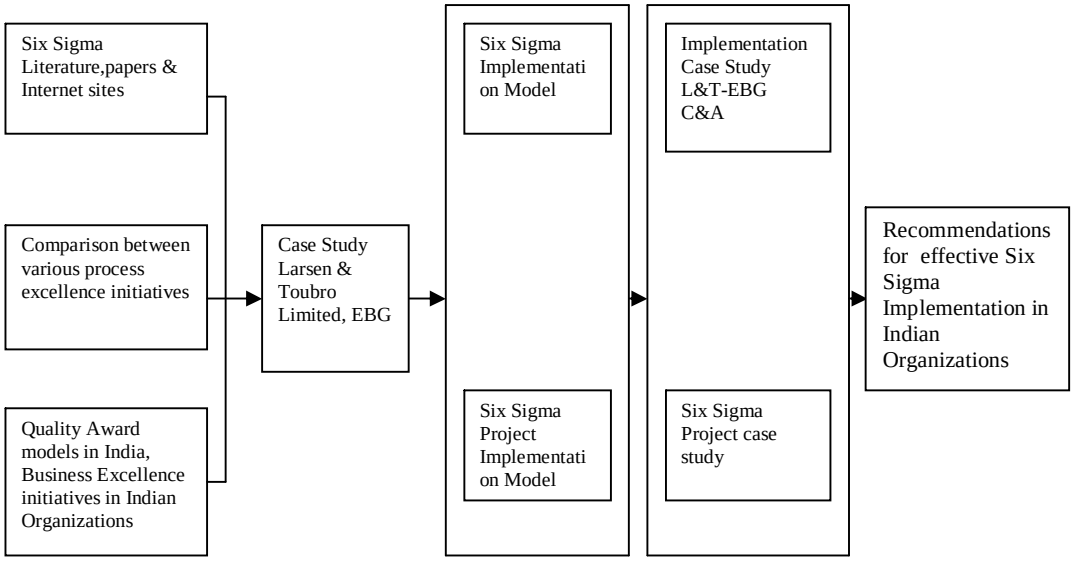
Questionnaires are a popular means of collecting data, but are difficult to design and often require many rewrites before an acceptable questionnaire is produced.

Questionnaire used for this study is given in Annexure.

Data Analysis: Data analysis is done to derive results and to finally evolve model. A continuous assessment system is used in this study for rating Line Managers. This rating is used for measuring effectiveness of Six Sigma implementation.

Case Study: Case study is used to validate the models evolved.

2.5 Research Process:



Literature Review **Questionnaire**

Questionnaire

Participant Observation **Participant**

Observation

Direct Observation **Direct**

Observation

Fig. 2.1 Research Methodology

Chapter 3

Review of Literature

3.1 Literature Review

A case study of General Electric (Eckes, George, The Six Sigma Revolution, *John Wiley & Sons,Inc,* 2001) gives us knowledge regarding problems & solutions for Six Sigma deployment. A Six Sigma Approach developed by GE was customer focused which starts with determining customer needs and ends with meeting or exceeding customer expectation. This approach is also suitable for manufacturing and customer centric service industry.

Jack Welch, Ex-CEO of GE says “The only way I see to get more productivity is by getting people involved and excited about their jobs. It’s matter of understanding customer needs instead of making something and putting it in to a box” (Six Sigma-A Breakthrough Management Strategy Mikel Harry, Richard Schroeder, Currency, New York,2005)

In Ultimate Six Sigma (PHI, 2007) Author emphasizes using Six Sigma for Business Excellence. Also he advises that ultimate goal shall be customer satisfaction. Author Keki R. Bhote also gives importance to employee involvement. Giving reference to Maslow’s theory he suggests that employees will get motivated if all their needs get satisfied. Though Author gives reasons for

failure of Six Sigma Implementation in an organization, he doesn't give any plan for successful implementation.

"The Toyota Way" shows the way of Lean organization. Many of the lean tools can be used in Six Sigma projects. The process excellence journey starts with Lean and completes with Six Sigma. (Liker, Jeffrey K. The Toyota Way, *Tata McGraw-Hill*, 2004). Author also describes how concepts of Toyota Production Systems are extended to Supply chain of Toyota. Just in time concept can be adopted in manufacturing industry.

George Byrne, Dave Lubowe, Amy Blitze, in their paper "Driving Operational Innovation using Lean Six Sigma" *IBM Institute for Business Value, 2007*

Around the world, CEOs are searching for blockbuster products and services, making major operational changes, and even redesigning their fundamental business models. This trend toward broad-based innovation was evident in the 2006 IBM Global CEO Study. Based on in-depth conversations with 765 corporate and government leaders worldwide, the study found that CEOs' innovation priorities were spread across all of these different dimensions. And yet CEOs ranked an "unsupportive culture and climate" as their biggest obstacle to innovation success. Their organizations lacked the processes, discipline and organizational mindset to foster meaningful innovation on a continuous basis.

This emphasizes the need to understand culture & climate of an organization and the country in which the organization situated while implementing Six Sigma.

Caulcutt, Roland(2001) in his paper titled "Why is Six Sigma so successful?', *Journal of Applied Statistics, 28: 3, 301 — 306* has mentioned how Six Sigma was contributing organizations to become more successful.

"Many other organizations have adopted a Six Sigma approach, but these particular companies have publicized their success and have publicly emphasized the part played by Six Sigma in the achievement of this success. None more so than General Electric (GE), as its Annual Report for 1998 states very clearly:

. . . we plunged into Six Sigma with a company-consuming vengeance just over three years ago. We have invested more than a billion dollars in the effort, and the financial returns have now entered the exponential phase more than three quarters of a billion dollars saving beyond our investment in 1998, with a billion and a half in sight for 1999.

GE is perhaps best known for its manufacturing divisions, but Six Sigma has been very successfully applied in GE Capital, which yielded a substantial proportion of GE pro® t in 1998. Clearly, Six Sigma can be implemented in a non-manufacturing environment. Furthermore, it can be successful in many countries. Several of the Six Sigma companies are truly global. They have implemented Six Sigma throughout the company, not just in their home country, as Black and Decker make clear in their annual report for 1999:

Having begun, in late 1998, to coordinate Six Sigma strategies and measurements on a worldwide basis, our experience clearly shows that the

potential benefits are enormous in terms of productivity improvement, product quality, customer satisfaction, more efficient capital spending, and overall corporate profitability . . . Savings attributable to Six Sigma were more than $30 million in 1999, and we expect to generate twice that

amount in 2000 as we intensify our efforts."

Annual reports of many organizations have mentioned their efforts in implementation of Six Sigma and benefits they received from implementing Six Sigma.

In Annual Report 2008-2009 of Reliance Industries Limited, organization's effort towards Six Sigma implementation is mentioned. In 2008-09, 63 Six Sigma projects were completed leading to financial benefits (annualized) amounting to Rs.67 crores. Presently, 528 Black Belts and Green Belts are associated in Six Sigma projects at different sites. For the success of the projects, 1817 team members and supervisory personnel are providing active support.

3.2 Key elements of successful six sigma applications.

In paper "Benefits, obstacles, and future of six sigma approach" *(Young Hoon Kwak, Frank T. Anbari, 2004)*, the authors identified four key elements of successful six sigma applications.

i) Management involvement and organizational commitment

Six sigma requires top management dedication and contribution to resources and effort. A good example is General Electric's former CEO Jack Welch's

involvement. He was charismatic and influential enough to restructure the business and change the attitudes of the employees toward six sigma. The organizations' CEOs are often involved in the successful 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 from entire organization.

ii) Project selection, management, and control skills

Six sigma projects have to be carefully reviewed, planned, and selected 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. The 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. The project should be well documented to track project constraints, mainly cost, schedule, and scope. There should also be a lessons learned mechanism to capture the key issues of previous projects.

iii) Encouraging and accepting cultural change

People facing cultural change and challenges due to the implementation of six sigma must understand the change first. 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. Announcing the results of six sigma projects including successes, obstacles, and challenges will help future projects to avoid making similar mistakes and adopt only the very best practices.

iv) Continuous education and training

Education and training give a clear sense for people to better understand the fundamentals, tools, and techniques of six sigma. Training is part of the communication techniques to make sure that managers and employees apply and implement the complex six sigma techniques effectively. There is usually a ranking of expertise identified by the belt system. Four different Belt levels (Master, Black, Green, Yellow) make sure that establishment and execution of six sigma projects are done seamlessly. The curriculum is customized and needs to be provided by identifying key roles and responsibilities of individuals implementing six sigma projects. Organizations need to continuously learn and adapt the latest trends and techniques that are outside the six sigma domain that might be useful to complement the six sigma approach. The authors found that selection of knowledgeable, well-respected employees for Black Belt assignments was a critical success factor for six sigma projects.

3.3. Obstacles and challenges of six sigma method

Paper “Benefits, obstacles, and future of six sigma approach” *(Young Hoon Kwak, Frank T. Anbari, 2004)*, the authors also discusses Obstacles and challenges of six sigma method as follows.

i) Issues in strategy

Six sigma has been the target of criticism and controversy in the quality community characterizing it as 'Total Quality Management on Steroid'. One of the main criticisms is that six sigma is nothing new and simply repackages traditional principles and techniques related to quality. Organizations must realize that six sigma is not the universal answer to all business issues, and it may not be the most important management strategy that an organizations feels a sense of urgency to understand and implement six sigma. To ensure the long-term sustainability of the six sigma method, organizations need to analyze and accept its strengths and weaknesses and properly utilize six sigma principles, concepts, and tools.

ii) Issues in organizational culture

Quality concepts need to be embedded into the process of designing rather than just monitoring the quality at the manufacturing level. The more important issue is the change in organizational culture that puts quality into planning. Addressing the problems and issues that are easy to correct and claiming that the 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 are likely to fail. Senior management's strong commitment, support, and leadership are essential to dealing with any cultural issues or differences related to six sigma implementation. If the commitment and support

of utilizing various resources do not exist, organization should probably not consider adopting six sigma.

iii) Issues in training (Belt Program)

Training is a key success factor in implementing six sigma projects successfully and should be part of an integrated approach. The belt program should start from the top and be applied to the entire organization. The curriculum of the belt program should reflect the organization's needs and requirements. It has to be customized to incorporate economical and managerial benefits. Training should also cover both qualitative and quantitative measures and metrics, leadership, and project management practices and skills. It is important to note that formal training is part of the development plan of producing different belt level experts. Participants need to be well informed of the latest trends, tools, and techniques of six sigma, and communicate with actual data analysis. The authors found that selection of less-capable employees for Black Belt assignments was associated with challenges to six sigma projects.

Ricardo Banuelas Coronado, Jiju Antony, in their paper 'Critical success factors for the successful implementation of six sigma projects in organisations' *The TQM Magazine, Volume 14, 2002* presented the key ingredients for the effective introduction and implementation of six sigma in UK manufacturing and services organizations as the following.

a) Management commitment and involvement.

b) Understanding of six sigma methodology, tools, and techniques.

c) Linking six sigma to business strategy.

d) Linking six sigma to customers.

e) Project selection, reviews and tracking.

f) Organizational infrastructure.

g) Cultural change.

h) Project management skills.

i) Liking six sigma to suppliers.

j) Training.

k) Linking six sigma to human resources

3.4 The Literature survey outcome:

An organization shall well prepared for effective implementation of Six Sigma. Top Management support and employee involvement is essential for success of Six Sigma.

Based upon this surveys, it has been decided to study Six Sigma in context with Indian work environment and develop model for Six Sigma Implementation for Indian Organizations.

Chapter 4

An Introduction to Six Sigma Methodology

In today's competitive world, customer wants perfection and there is no room for error. Delighting the customer and new ways to exceed their expectations is requirement of today's business world. Six Sigma helps to achieve this goal. Six Sigma is a highly disciplined process that helps us focus on developing and delivering near-perfect products and services. Six Sigma helps us to reduce variation in process and keep them within tolerance limit. The central idea behind Six Sigma is that if you can measure how many "defects" you have in a process, you can systematically figure out how to eliminate them and get as close to "zero defects" as possible. The term "sigma" is used to designate the distribution or spread about the mean (average) of any process or procedure.

4.1 Definition

But what is Six Sigma? ... Although Six Sigma has been defined in many ways as per the statement below we are not very sure how to provide an all encompassing precise definition for it.

The UK department for Trade and Industry while defining says; Six Sigma is: "A data driven method for achieving near perfect quality. Six Sigma analysis can focus on any element of production or service, and have a strong emphasis on statistical analysis in design, manufacturing and customer-oriented activities"

Motorola University while defining Six Sigma management system says : ‘’..The Six Sigma management system drives clarity around the business strategy and the metrics that most reflects success with that strategy. It provides the frame to prioritize resources of projects that will improve the metrics, and it leverages leaders who will manage the efforts for rapid, sustainable, and improved business results..”

GE defines Six Sigma as process…”a highly disciplined process that helps us focus on developing and delivering near perfect products and services. Why ‘Sigma’? The word is a statistical term that measures how far a given process deviates from perfection. The central idea behind Six Sigma is that if can measure how many ‘defects’ you have in a process, you can systematically figure out how to eliminate that and get as close to zero’ 3.4 defects per million opportunities. An ‘opportunity’ is defined as a chance fore nonconformance, or not meeting the required specifications. This means we need to we need to be flawless in executing our key process”

Everyone is right, but each ones looks at it in its own way.

Thus Six Sigma is a statistical concept that measures a process in terms of defects. Achieving six sigma means your processes are delivering only 3.4 defects per million opportunities (DPMO). Six Sigma is also a philosophy of managing that focuses on eliminating defects through practices that emphasize understanding, measuring and improving processes.

Sigma Level (Process Capability)	Defects per million Opportunities
2	308537
3	66807
4	6210
5	233
6	3.4

Table 4.1 Probability of defects of different sigma levels

In short, Six Sigma is several things:

i) A statistical basis of measurement: 3.4 defects per million opportunities

ii) A philosophy and a goal, as perfect as practically possible

iii) A methodology

iv) A symbol of quality

There are three key elements of quality: customer, process and employee.

Customers expect performance, reliability, competitive prices, on-time delivery, service and more. We have to delight our customer to ensure our market position.

Process: Process shall add significant value and produce output which exceed customer's expectation

Customer: Anyone Who Receives Product, Service, or Information

Opportunity: Every Chance to Do Something either "Right" or "Wrong"

Successes Vs. Defects …

- Every Result of an Opportunity Either Meets the Customer Specification or it Doesn't
- Employee creates results, so we have to involve all employees to achieve six sigma goals.
- All employees shall trained in the strategy, statistical tools and techniques of Six Sigma quality
- Quality is the responsibility of every employee. Every employee must be involved, motivated

4.2 The Six Sigma Strategy

To achieve Six Sigma quality, **a process must produce no more than 3.4 defects per million opportunities.** An 'opportunity' is defined as a chance for nonconformance, or not meeting the required specifications. This means we need to be nearly flawless in executing our key processes.

Strategy

- **Know What's Important to the Customer**
- **Reduce Defects**
- **Reduce Variation**
- **Center Around Target**

Key Concepts of Six Sigma

- At its core, Six Sigma revolves around a few key concepts.

- **Critical to Quality:** Attributes most important to the customer
- **Defect:** Failing to deliver what the customer wants
- **Process Capability:** What your process can deliver
- **Variation:** What the customer sees and feels
- **Stable Operations:** Ensuring consistent, predictable processes to improve
- What the customer sees and feels

4.3 DMAIC Methodology of Six Sigma:

The method GE and several other organizations use to improve processes is summarized by the initials DMAIC (The Six Sigma Revolution, George Eckes, 2001):

Define: Defining the team to work on improvement, defining the customers of the process, their needs and requirement, process mapping. In define phase customer requirements are derived and documented.

Measure: Identifying key measures of effectiveness and efficiency and translating them in to concept of sigma. In Measure phase detail Data collection plan is prepared

Analyze: Through analysis, the team can determine the causes of the problem that needs improvement. In Analyze phase root causes are identified, verified and quantified. Analyze phase contains Cause and Effect diagram, Hypothesis testing.

Improve: The sum of activities that relate to generating, selecting and implementing solutions. In Improve phase solutions are validated and cost benefit proposal presented to champion.

Control: Ensuring that improvement sustains over time. Process is standardized in control phase and procedures are documented.

4.4 Design For Six Sigma:

Design for six sigma (DFSS) is an approach to designing or redesigning product and\or service to meet or exceed customer requirement and expectations.

The new product is definitely not operating at six sigma level. In fact, it's closer to the average four sigma quality level at which many companies operate today. Plus, even as manufacturing problems are corrected by deploying six sigma methods, newly developed products often are the source of new problems. So, an organization practicing the methodology in various functional areas and attaining six sigma status may well be far below that level in developing new products or services.

Once you have mastered the essentials of six sigma, you may well be ready for the essential of DFSS, to carry that improvement into development and design of your new products.

DFSS is based on notion that when you design six sigma quality at the output of new product development it is probable that you will sustain that gain as customer accept that product. By incorporating DFSS, you were virtually assured that the product or service you launching will perform dependably in the marketplace, thus setting it up for very positive acceptance.

Like its parent six sigma initiative, DFSS uses a disciplined set of tools to bring high quality to launches.

It begins by conducting a gap analysis of your entire product development system. A gap analysis as explained in chapter 3, finds the gap in your process that are negatively affecting new product performance, it also addresses a high significant factors, the voice of the customer (VOC). Every new product decision must be driven by the VOC, otherwise, what basis do you have for introducing it? By learning to identify voice and response to it, you are in a far better position to deliver a new product or service that a customer actually wants!

Once the gap analysis is done and VOC is identified,

DFSS goes to work with its own version of the DMAIC (Define, Measure, Analyze, Improve and Control) of six sigma; five step process known by the acronym PIDOV:

Plan-enable the team to succeed with the product by mapping it vital steps

Identify-hear the voice of the customer to select the best product concept

Design – build a through knowledge base about the product and its processes

Optimize- achieve a balance of quality, cost, and time to market

Validate- demonstrate with data the voice of customer has been heard and that customer expectations have been satisfied.

Some Six Sigma people equate DFSS with another five step process –**DMADV;**

Define – determine the project goals and the requirements of the customers (external and internal)

Measure- asses customer needs and specifications

Analyze – examine process options to meet costumer's requirement

Design- develop the product to meet the customer requirements

Verify – check the design to ensure that it is meeting customer's requirements

DFSS can be a very tool to companies as they get comfortable with Six Sigma and looks to grow its benefits in other areas.

Ultimately DFSS is not that different from the six sigma work you are undertaking. In fact it is the natural progression to continually-and relentlessly-root out defects and root hidden dollars to the bottom lines.

Because of the similarity between Six Sigma and DFSS, people frequently talk about DFSS as the logical expansion of Six Sigma at the manufacturing and the service level, DMAIC. This may be true but it may be important to realize the initiatives are tremendously different.

4.5 Basic differences between Six Sigma DFSS and DMAIC methodologies

DMAIC is more focused on reacting, on detecting and resolving problems, while DFSS tends to be more proactive, a means a preventing problem

DMAIC is for product or services that the organization offers currently; DFSS is for the design of new product or services and processes.

DMAIC is based on manufacturing or transactional processes and DFSS is focused on marketing, R& D and design.

Dollar benefits obtained from DMAIC can be quantified rather quickly , while the benefits from DFSS are more difficult to quantity and tend to be much more long term .It can take six to twelve months after the launch of new product before you will obtain proper accounting on the impact of a DFSS initiative.

DFSS involves greater cultural change than DMAIC, because, for many organization DFSS represent a huge change in roles. The DFSS team is cross functional: it is key for the entire team to be involved in all aspect of the design process, from market research to product launch.

4.6 Design for Six Sigma Defined and Explained

DFSS is a business process focused on improving profitability. Properly applied, it generates the right product or service at the right time at the cost. Through its use of product and team scorecards, it’s a powerful program management technique.

DFSS is an enhancement to your new product development process, not a replacement for it. A documented, well understood, and useful new product development new process is fundamental to a successful DFSS program.

Your new product development process provides the roadmap to success. DFSS provides tools and teamwork to get the job done efficiently and effectively. By rigorously applying the tools of DFSS, you can be assured of predictable product quality.

Considering tremendous competition due to globalization for Indian organizations DFSS is more important as it's ensure that at design level it self product meets Six Sigma quality requirement.

4.7 LEAN approach of Process excellence

Taiichi Ohno, founder of Toyota Production System (TPS), said that "All we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes. (Ohno,1988)

Lean is a five step process (James Womack and Daniel Jones, Lean Thinking, 2003) , defining customer value, defining the value stream, making it "flow", "pulling" from the customer back, and striving for excellence.

Manufacturing sector has gained many benefits by implementing Lean like increased productivity, decreased delay in delivery, reduced cost, improved quality and increased safety.

Lean helps in creating value throughout the supply chain involving customer. This very nature of Lean shows that we can extend it to manufacturing and service sector.

Lean is

- Eliminate waste through continuous improvement
- Define value from the client's perspective
- Identify the value stream
- Only make what the client pulls
- Keep the flow moving continuously
- Always improve the process
- Lean addresses continuous improvement, waste identification and elimination, work place organization, process standardization

Lean tools:

i) 5S

ii) Waste Elimination

iii) Value stream mapping

iv) Pokayoke (Mistake proofing)

i) 5S

5S is the Japanese concept for House Keeping. It is first step towards Lean Six Sigma excellence. 5S is explained in brief below.

1S Seiri (Sort) - Put things in order Remove what is not needed and keep what is needed

2S Seiton (Straiten) - Proper Arrangement Place things in such a way that they can be easily reached whenever they are needed.

3S Seiso (Shine) - Clean Keep things clean and polished; no trash or dirt in the workplace

4S Seiketsu (Standardize) - Purity Maintain cleanliness after cleaning - perpetual cleaning. Create standard operating procedure.

5S Shitsuke (Sustain) – Commitment & Self discipline

Inspire pride and adherence to standards established

ii) Seven types of waste

- Over production
- Correction
- Inventory
- Processing
- Motion
- Conveyance
- Waiting

iii) The value is a

- Right capability provided to a Client at the right time and the right price…as defined by the Client
- Clear understanding of who the Client is, is critical
- In Knowledge Flow, value is addition, modification or screening of useful knowledge or information that facilitates a commercial transaction.
- Activities that add no value to the client are by definition “waste”

The Value Stream is a

- Time Series of all activities & steps (Both Value Add and Non-value Add) required to bring a Product, Service or Capability to the Client
- Value Streams cut across Functional Boundaries
- Value Streams are usually mapped out by product or product family

Value Stream Mapping is

- A pencil & paper tool that helps you to see and understand the flow of material & information as product makes it’s way through the value stream

Flow is

- A perfect process has continuous flow as products, services and knowledge are transformed continuously without delay from step to step

- Flow is created by eliminating queues and stops and improving process flexibility & reliability

PUSH vs PULL

- A “push” system is where work is created or assigned regardless of the requirements rather than a "pull" system which reacts to the demand of the user for the next work.
- Batch or static workload distribution and assignments can lead to overburden and/or overproduction

Gemba Kaizen

In Japanese, Kaizen means continuous improvement. The word implies improvement that involves everyone-both managers and workers. The kaizen philosophy assumes (Massaki Imai, ‘GEMBA KAIZEN A Commonsense, Low-Cost Approach to Management’, *McGraw-Hill, New York, 1997*) that our way of life be it our working life, our social life or our home life should focus on constant improvement efforts.

4.8 Six Sigma Organization

Champions

The executive leader, or Senior Champion, selects individuals who will ‘champion’ Six Sigma within specific businesses across the organization and can

ensure that all the key functions of an organization are connected to Six Sigma. There are two types of Champions: Deployment Champions and Project Champions. Both must have key executive leadership roles in the business. In industry vernacular, they are typically strategic business unit leaders (SBUs), site management team leaders, or head of major functional organization. A Champion may be anyone from an executive vice president to a vice president in charge of a functional group at an operating site.

Deployment Champions play role similar to the CEO, president, executive vice president in terms of leadership and commitment, but take on the additional responsibilities necessary to nurture the success of Six Sigma. Deployment Champions work to implement Six Sigma throughout their respective businesses. We recommend that Deployment Champions have solid business experience at the strategic and tactical level, be experienced in leading a major change initiative, be experienced in leading cross-functional teams, and be able to develop business wide financial targets for Six Sigma.

Project champions function at the business unit level as they oversee Black Belts and focus on Six Sigma at the project level. They break down corporate cultural barriers, create support systems, make sure financial resources are available, and identify improvement projects. Projects Champions perform assessments of the organisation’s capabilities, benchmark the organization’s product and services, conduct detailed gap analyses, create an operational vision, develop a cross-functional Six Sigma deployment plan, and provide managerial and technical leadership to Master Black Belt and Black

Belts. Project Champions must integrate the methodologies and tools of Six Sigma into their existing jobs. They have to be knowledgeable in the underlying philosophy, supporting theory, practice, and implementation of Six Sigma strategies, tactics, and tools. Project Champions focus on changes in operation and functional results, and directly support the Master Black Belts as they implement Six Sigma methodology. Theses Champions select, review and nurture Black Belts as they come up with solutions to key problems in their projects. They are usually functional group vice presidents or directors, and select projects that will provide substantial benefit to their business.

Deployment and Project Champions organize and lead the initialization, deployment, and implementation of Six Sigma across organization. It is they who choose specific projects and begin the task of implementing Six Sigma strategies and tactics. They understand the underlying theories, principles, and practices of Six Sigma from a management perspective, but also have a technical understanding that allows for effective and efficient communication. They are able to pave the way for change and integrate the results. These Champions are grounding force in making the strategy work and supporting the triangle. They are the ‘glue’ that keeps the initiative moving forward.

Master Black Belts

Master Black Belts – individuals selected by the Champions to act as in-house experts for disseminating the Breakthrough Strategy knowledge throughout the organization – work with the Champions to coordinate project

selection and training. Master Black Belts devote 100 percent of their time to Six Sigma, assisting Champions in identifying improvement projects. They train and coach Black Belts and Green Belts, and communicate the overall progress and status of the projects within their areas or business. Master Black Belt training is extensively, and includes Champion training as well as training in statistical problem solving. However, 90 percent of the Master Black Belt's work has nothing to do with statistics. Master Black Belts spend significant amount of time using what we call 'soft skills' – organizing people, designing cross-functional experiments, structuring and coordinating projects and meetings, teaching, coaching and collecting and organizing information. They help inculcate Six Sigma into an organization's culture, and are responsible for creating lasting changes in an organization, getting all employees to think in terms of Six Sigma vision. They negotiate for resources and clear the path to apply the Breakthrough Strategy to targeted Black Belts projects, particularly those that cut across the organization's boundaries.

Black Belts

Black Belts, working under a Master Black Belt, apply the Six Sigma Breakthrough Strategy's tools and knowledge to specific projects, Black Belts dedicate 100 percent of their time to working on Six Sigma projects

Unlike the executive leadership and Champions who decide *what gets done,* Master Black Belts and Black Belts work full time figuring *how to get it done.* Like Master Black Belts, project Black Belts undergo extensive training in

statistics and problem-solving techniques, and should train in statistics and problem solving techniques, and should train 100 Green Belts a year. Although there is less focus on developing people skills, Black Belts are clearly seen as leaders and must possess both management and technical skills.

Since the bulk of executing the Breakthrough Strategy falls upon Black Belts, we have devoted the chapter that follows to discussing their roles and responsibilities in greater detail.

Green Belts

Green Belts are employees throughout the organization who executed Six Sigma as a part of their overall job. They have less Six Sigma responsibilities and their energies are focused on projects that tie directly to their day-to-day work. Green Belts receive a more simplified version of Black Belt training, although they are still required to enter training after being assigned to a sanctioned project important to their operations success. Green Belts have two primary tasks: first, to help deploy the success of Six Sigma techniques, and second, to lead small-scale improvement projects within their respective areas, much as a Black Belt does. Green Belts can do much of the legwork in gathering data and executing experiments in support of a Black Belt project. As they become more proficient, they can increase the Black Belts effectiveness. By working with Black Belts, Green Belts gain experience in the practical application of the Six Sigma tools that help support management's effort to capture and sustain Six Sigma gains.

While Green Belts dedicate only part of their overall jobs to Six Sigma projects, there is no one formula for how their time should be divided. Some Green Belts work full time with a Black Belt in order to thoroughly learn the Breakthrough Strategy's tool, and work projects on a part-time (two to three days each week) basis thereafter. Other Green Belts might limit their Six Sigma involvement to collecting and analyzing certain types of data to help speed up the Measure phase. Others help run designed experiments during the improvement phase. Today, many companies will not consider for promotion full-time, salaried employees who don't have at least Green Belt training.

Many hourly workers are trained in the fundamentals of Six Sigma, which typically involves two or four days of rudimentary training in the use of basic tools to apply the Measure, Analyze, Improve, and Control phases of Six Sigma. This gives them a stronger understanding of the process so that they can assist Black Belts and Green Belts on their projects. In this sense, they can be thought of as 'White Belts' – newcomers to the Six Sigma infrastructure.

The long-term objective of any company wanting to successfully implement the Breakthrough Strategy is to train all employees in such a way that they make the methodology integral to improving everything they do.

4.9 Six Sigma Project Cycle DMAIC

Six Sigma Project Cycle DMAIC – (Define, Measure, Analyze, Improve and Control) is a process for continued improvement. It is systematic, scientific and

fact based. This closed-loop process eliminates unproductive steps, often focuses on new measurements, and applies technology for improvement.

The method GE and several other organizations use to improve processes is summarized by the initials DMAIC (The Six Sigma Revolution, George Eckes, 2001):

Define: Defining the team to work on improvement, defining the customers of the process, their needs and requirement, process mapping. In define phase customer requirements are derived and documented.

Goals of the Define Phase are given below:

a) Understand the organizational context for process improvement projects.
b) Understand how to select a DMAIC project and be able to apply the criteria to the project.
c) Know the basic elements of the project charter and be able to develop a charter for the project.
d) Understand the basics of estimating the business impact of a project and be able to relate them to the project.
e) Be able to identify key players and stakeholders and incorporate them into the communication plan for the project.

Measure: Identifying key measures of effectiveness and efficiency and translating them in to concept of sigma. In Measure phase detail Data collection plan is prepared

Goals of the Measure phase are given below:

a) Detailed problem statement.
b) Process definition in SIPOC (Supplier, Input, Process, Output, Customer) form.
c) CTQ's and it's operational definition of measure.
d) Target improvement value.
e) Estimation of benefits.
f) Project owner.

Analyze: Through analysis, the team can determine the causes of the problem that needs improvement. In Analyze phase root causes are identified, verified and quantified. Analyze phase contains Cause and Effect diagram, Hypothesis testing.

Goals of the Analyze phase are given below:

a) Brainstormed on X's. Here X is the independent variable affecting final output Y.
b) Found change of which X's affect Y and in what manner
c) Ultimately found which X's are critical to move the Y in the desired direction and to be maintained at what level

Improve: The sum of activities that relate to generating, selecting and implementing solutions. In Improve phase solutions are validated and cost benefit proposal presented to champion.

Goals of Improve Phase are given below:

a) Select the solution

b) Pilot the solutions

c) Assess the risks

d) Implement the solutions

Control: Ensuring that improvement sustains over time. Process is standardized in control phase and procedures are documented.

The goal of Control Phase is to hold the gains through control of input variables.

Chapter 5

Six Sigma Implementation Model Development & Application

5.1 An Approach context to Indian organizations

Six Sigma is a methodology that provide us an insight into the products/process or in case necessary, to re design these products/process. All these Products/Process are selected based on issue in result to increasing market penetration or improving organizational speed or reducing cost of doing business. Some people always couple the word Six Sigma with use of statistical tools or cost reduction drive or only a measurement gimmick. That is a mistakes, Six Sigma is a set of principles that accelerate the speed of improvement process across the enterprise. It also provides much needed confidence in the solutions that emerge out of the project studies. How to implement a system so that use of Six Sigma Methodology gets integrated with a company's working ethics? The way it is being implemented in some of the organizations, it looks like structure and formats of so called Six Sigma implementation is getting precedence over the core essence of it. Also in India people protest any new initiatives initially unless properly and systematically convinced to them. **This requires carefully developed Implementation model exclusively for Indian organization.** A step by step approach is more effective than any other approach.

The following Implementation model is developed and tested in L&T's EBG-C&A SBU. A detail study (Refer 5.2) of organizational culture at L&T, EBG, C&A is done where this implementation model is developed & implemented. In L&T we can say the model is evolved as many things added or modified during implementation suitable to it's employees and environment. Thus the final model is perfect for Indian Organizations.

5.2 Organizational culture at L&T, C&A

A comfortable and conductive work atmosphere at C&A helps its employees to increase their productivity and efficiency. Both the individual and the organization play an important role in doing so. The former's initiative, caliber and creativity matters and while the latter's motivational attitude does the miracles. This inspires, guides and leads others towards a positive and productive work culture, resulting in organizational development and also satisfaction to its personnel.

The company values the diversity of its employees and their unique perspectives. By valuing each other's differences, the organization demonstrates its commitment to treating everyone with fairness and respect.

The first step

The organization believes in bringing out the best from its people. Freshers are provided with trainings to equip them to give their best to the workplace which not only helps the organization to achieve its targets but also helps their employees'

learning and development. It mandates training on various technical and soft skill aspects for all its employees.

The aggregate of the Individual Development Plan of all its employees forms the basis of the annual training calendar of the company. The training department aggregates the areas of development as identified by all the employees and plans an annual training calendar to support their requirements.

The training calendar has a fair mix of all kinds of trainings like technology or process training, domain training, soft skills training, and other work related trainings like time management, stress management, negotiation skills, art of living etc. The training department circulates the training calendar every month and employees can nominate themselves for the same through SAP. These are conducted by both in-house and external faculties and cover the role-based and self-development areas.

It has a documented training policy for this and a full-fledged training department that is driven with support and supervision from the senior management.

Training is conducted at Training Centre at Madh, Mumbai & Management Development Centre, Lonavala.

Nurturing the potential talent

The most important resource that builds and transforms any organization is its human resource. Charles Schwab has rightly mentioned “All successful

employers are stalking men who will do the unusual, men who think, men who attract attention by performing more than is expected of them".

Taking a cue from the above statement, career management at Larsen & Toubro Limited does not refer to just securing upward career possibilities, but to recruiting, assessing and developing individual talents, to the mutual benefit of both the corporation and the employee.

Larsen & Toubro Limited is among the top engineering companies of India, aspiring to be an Indian multinational. Owing to the nature of our businesses, we need talented people to take up leadership positions in *management* as well as *technology*.

As an organization, we are also sensitive to the aspirations of our employees. To address these needs, we have developed a unique leadership module. The module offers two sets of leadership role paths- one for the would-be managers (MLPs), and another for technologists (TLPs) who prefer to remain close to technology throughout their careers. The leadership programs are based on the type of roles the Leaders will be expected to perform:

- Strategic: Management/ Business & Technology Leadership Programmes
- Operational: Supervisory Leadership Programme

Leadership Roles

We offer our high potential employees who have been identified for strategic roles alternate career paths aimed at business leadership positions (Management Leadership Programme) or related to cutting edge of technology

(Technology Leadership Programme). The employees are groomed and developed along these career progression paths.

Management Leaders are expected to seek and grow business opportunities in line with our organizational competencies and capabilities. Technology Leaders will be involved in core Technology areas and enhance the performance of our businesses through the route of technology.

Employees who are part of the Supervisory Leadership Programme are expected to gain and deploy in-depth knowledge and effect operational efficacies in their respective work areas. The Supervisory Leadership Programme will yield some employees who will grow into either Management Leaders or Technology Leaders.

Selection Criteria

The primary screening criteria for the leadership identification process is the FAIR rating. The employees who are nominated to the process are high performing individuals and the organization recognizes their contribution. The leadership process gives them an opportunity to understand their strengths and areas for improvement in the competencies critical for a leader at their level of management.

Crucial pointers

Promotion to the next level and salary increment is purely based on merit. Promotion is not an entitlement after serving a certain time in a job or grade and performance rating but will also depend on the responsibility actually assumed by

the employee and the company's needs for people in the higher grade. The company truly believes in a participatory culture. All the day-to-day management with respect to food, recreation and corporate social responsibility is handled by the employees through employee-run committees elected democratically. The mission of the company is to help clients achieve their strategic goals and profit from the use of information technology

Gender breakup

Total	Women	Men	Total	% of Women Employees
Grand Total	51	305	356	13.85

Table 5.1 Gender breakup at C&A

Out of 356 employees at C&A 51 are women employees. Though at present 13.85% employees are women, there is an increasing trend in recruiting women employees. While formulating any business strategy gender breakup shall be taken in to consideration.

Bridging the gaps

The open-door philosophy is adopted which translates to all managers in the organization. Open house meeting initiative aimed at building a connection between the HR and the employees and enhancing the organization's culture of openness and trust. Employees are encouraged to be honest and forthcoming about improvements that they think can be made.

As shown in table 5.2, 82% employees at L&T-C&A are below 35 years of age. This young resource base is another consideration fro formulating strategy.

Canvas, the company's House Magazine for employees carries stories about their recent wins, employees speak, senior management speak, customer satisfaction scored, monthly cascade of all departments, etc.

Age categorization at C&A

AGE GROUP	PERCENTAGE OF TOTAL
20 to 25 years	45.1%
26 to 30 years	25.3%
31 to 35 years	11.7%
36 to 40 years	6%
41 to 45 years	4.1%
> 45 years	7.9%

Table.5.2 Age categorization at C&A

Beyond work

To keep the environment joyful, they have recreation rooms across all campuses which includes breakout areas, carom boards, etc., where tiring minds can relax. Facilities like gymnasium to take care of the physical health of the employees.

Corporate Social Responsibility

Larsen & Toubro Limited was founded in the year 1938 on the pillar of business ethics and good governance . Right from inception the culture of sharing knowledge and caring is being practiced throughout all our factories and offices located across the country.

All our skilled and experienced personnel always strive to perform better. To make this possible L&T strives to create physical and mental balance of not only

the employees but also their families through professional Human Resource Development and Employee welfare services.

We have decided to invest in skill development and increasing industry standards by setting up professional training institutes. We set up the first Switch Gear Training institute in 1986 and in the last two decades we have set up several institutes with specialized training in Electrical, Maintenance, Welding and Construction Skills.

For women workforce, we have set up systems for protection of women' rights at workplace.

L&T believes that a stable community around the factory is important for the growth of business. We began our social investment by assessing the needs of the community residing in our backyard at most locations like Mumbai, Hazira, Ahmadnagar, Mysore, Kansabahal, Chennai, Ahmedabad, Hyderabad, Delhi, Chandigarh, Kolkata, Fariabad, Bangalore, etc. We continue to activate social initiatives in communities where are offices and campuses are located in India.

Over the years our commitment and responsibility has taken new dimensions. Living in a world which is becoming increasingly inter dependant, we have constituted a CSR Policy which basically reflects our commitment and vision. In 2005'a CSR Policy was announced through office of our chairman Mr A.M Naik and a special CSR Cell is set up in Mumbai.

Looking at the gaps existing in our country's health system has made us direct our endeavors towards public health intervention. The Health centre in Mumbai renders free health services including family planning, Mother & Child Health care, immunization, skin and leprosy clinic, eye check up and cataract screening services. Keeping our focus to make health service accessible to the needy community, a team of dedicated doctors and professional social worker conduct medical camps with special attention towards ante - natal care, family planning and immunization around L&T locations across the country. Nutritional supplements and medicines are given to the under privileged community free of cost.

While we as a company strive to be best, we also believe in improving the quality of education in India. The sole means of education for an overwhelming majority of Indian children is govt schools. Keeping this factor in mind we have stated initiatives to bridge the critical gaps in the nearby municipal and govt schools, to impart training to the teachers and students, provide teaching aids and educational materials, recreational activities and construct or renovate school infrastructure. All this is done with the intention of making the schools more children friendly within a child friendly learning environment.

For employees children there are 2 all India schemes which encourage children who are achievers in academics and other potentials as well as a scheme to assist the child of a deceased employee to continue education. The Larsen &

Toubro Institute of Technology conducts diploma courses in 3 specializations for employees children.

Each year the L&T Build India scholarship give 40 promising engineering students the opportunity to pursue higher education in M Tech with IIT's

We have large population of youth who are out of school and unskilled. The Larsen & Toubro Public charitable Trust has evolved " Udyam "a strategy to address this concern and is operationalising Vocational training institutes across the country. Two of which are already operational at Mulund in Mumbai and Kharel in Gujarat.

The Psychology of Six Sigma: Employee motivation is a complex science, but it rests upon the principles that people need recognition for their successes, particularly people implementing Six Sigma, where they stepped outside the established role to take on assignments beyond the scope and structure of their existing role. The nature of being a Champion, Master Black Belt or Black Belt allows employees the authority to make and execute important decisions without top-down interference.

Abraham Maslow's Hierarchy of Needs motivational model

Abraham Maslow developed the Hierarchy of Needs model in 1940-50's USA, and the Hierarchy of Needs theory remains valid today for understanding human motivation, management training, and personal development. Indeed, Maslow's

ideas surrounding the Hierarchy of Needs concerning the responsibility of employers to provide a workplace environment that encourages and enables employees to fulfil their own unique potential (self-actualization) are today more relevant than ever. Abraham Maslow's book Motivation and Personality, published in 1954 (second edition 1970) introduced the Hierarchy of Needs, and Maslow extended his ideas in other work, notably his later book Toward A Psychology Of Being, a significant and relevant commentary, which has been revised in recent times by Richard Lowry, who is in his own right a leading academic in the field of motivational psychology.

1. Biological and Physiological needs - air, food, drink, shelter, warmth, sex, sleep, etc.

2. **Safety needs** - protection from elements, security, order, law, limits, stability, etc.

3. **Belongingness and Love needs** - work group, family, affection, relationships, etc.

4. **Esteem needs** - self-esteem, achievement, mastery, independence, status, dominance, prestige, managerial responsibility, etc.

5. **Self-Actualization needs** - realizing personal potential, self-fulfillment, seeking personal growth and peak experiences.

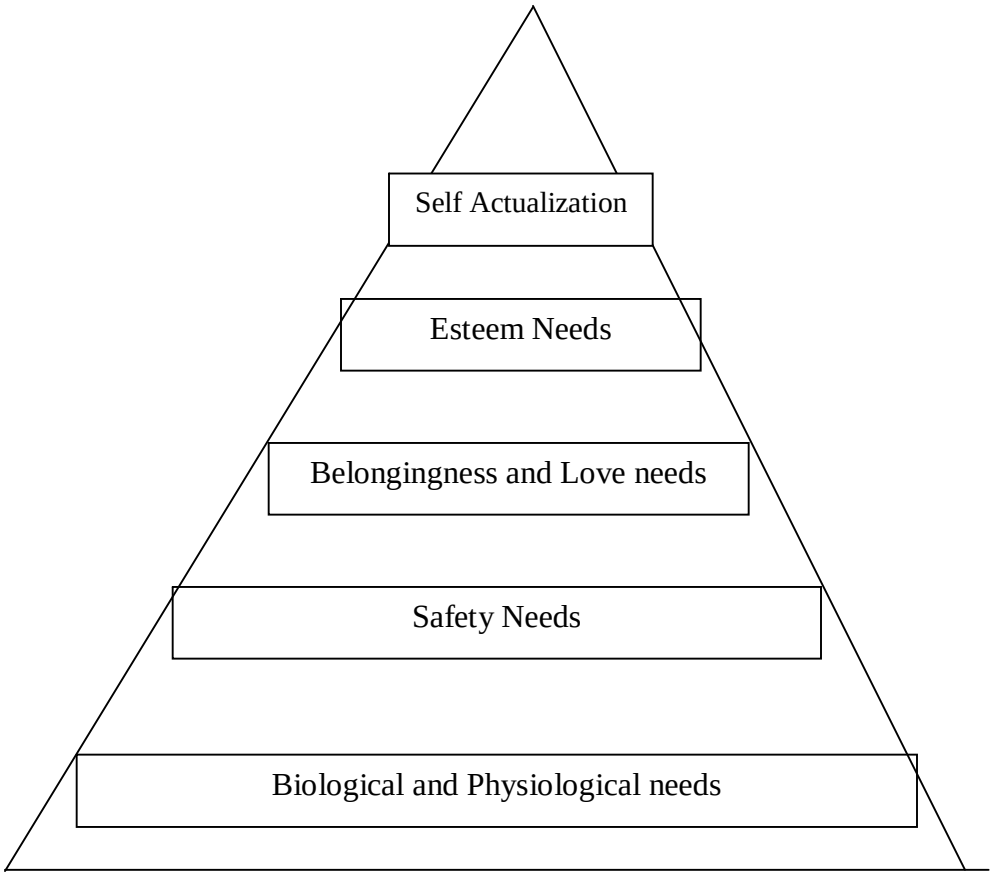


Fig.5.1 Maslow's Hierarchy of Needs

A person starts at the bottom of the hierarchy (pyramid) and will initially seek to satisfy basic needs (e.g. food, shelter)

- Once these physiological needs have been satisfied, they are no longer a motivator. the individual moves up to the next level

- Safety needs at work could include physical safety (e.g. protective clothing) as well as protection against unemployment, loss of income through sickness etc)

- Social needs recognize that most people want to belong to a group. These would include the need for love and belonging (e.g. working with colleague who support you at work, teamwork, communication)

- Esteem needs are about being given recognition for a job well done. They reflect the fact that many people seek the esteem and respect of others. A promotion at work might achieve this

- Self-actualization is about how people think about themselves - this is often measured by the extent of success and/or challenge at work

Maslow's model has great potential appeal in the business world. The message is clear - if management can find out which level each employee has reached, then they can decide on suitable rewards.

5.3 Implementation Plan Development

Considering work environment in India, the implementation plan should be different in different sizes of organization and the implantation strategy should depend on the organization's existing culture and structure. One should not try to export an alien culture just because we have implemented Six Sigma in our organizations .No doubt we have to change, we have to transform our processes through more value creation but that did not mean we just change organization structure for sake of implementing Six Sigma.

As already discussed, the implementation plan will evolve based upon the size of the organizations and also the product and service portfolio they offer, We need to lay down different plans for large organizations and Small & medium Enterprises (SMEs). Inherent variations in the structure and portfolios might change the numbers indicated in the respective plans.

We divide the phases of implementation into three broad categories:

Pre Implementation

Implementation

Establishment

5.4 Pre Implementation

Typically large organizations have multiple sites of operations for example organization like Reliance Industries Limited, Ashok Leyland, MICO-Bosh, Wipro, Timken, TCS, and Infosys, etc operate from multiple sites. Large organization could also operate from a single location, for example Bharat Forge in Pune . By our definition large organization have a very large number of employees and large number of operations.

Commitment by Senior Management

In Pre Implementation Phase, Six Sigma implementation could start at the plant level with an aim of resolution the local resources. However, almost all members of the location leadership team participate in kick off meeting and set a high but reasonable expectation.. Necessary resources in terms of trained manpower, time are planned and if this are not available in the beginning the leadership team hires good consultants or gets resources from elsewhere,. A leadership is formed with a local CEO as its chairman and local deployment coordinator as its member secretary. Coordination activity is very critical and the coordinator did not always be the QUALITY LEADER. The person acting as a deployment coordinator should have wave like passion and sea of patience**. A commitment by senior management** is most essential at this phase. Examples of few organizations showing such commitments are L&T, Johnson &Johnson, Reliance(Polyester Group), Mico, Ashok Leyland, Infosys BPO, WIPRO and many others.

At the Leadership the overall objectives are made clear to gain organizational support. The processes requiring immediate attention are identified after performing the casual analysis.

Awareness Programs:

Awareness programs are arranged for all employees in organization. A typical awareness program is 4 hour duration. This shall be followed by programs for champions or process owners.

The process owner undergo three day program where in following topics are discussed:

Overview of Six sigma Methodology, Review Strategies for effectively implementing six sigma in an organization, Understanding of Deployment Strategies –Business Goals/ Dashboards/ Balance Business Score Card or Customer Goals including linkages with financial goals, Executive and roles and responsibilities in Six Sigma implementation, Six Sigma Project selection linkage to strategy, overview of Six Sigma Project Execution process (DMAIC and/or DMADV) (Define-Measure-Analyze- Improve and Control, Define, Measure, Analyze, Design and Validate), Project review guidelines and selection of Belts for the projects, process and closing the project. A few sample Six Sigma project gone through in details, which have relevance to the operations, being performed in these locations. An external expert can be hired for awareness program.

Expectations from Six Sigma Implementation:

The deliverables of awareness programs & programs for champions should be the list of probable projects along with likely project leaders. We will call this trained process owners as champions or sponsors. The total cost time devoted to direct instruction should be around 21-23 hours of which significant time should be allotted to group activities like process mapping, validation of deployment of plant objectives in terms of process objectives and development of selection strategy of projects.

Expectations from customers (e.g. Quality, Price, Delivery, Service etc.) & Business expectations shall be considered for implementation strategy.

Internal Customer Satisfaction Survey (Refer Appendix-VI) shall be conducted to assess Internal customer's requirement.

Readiness Assessment:

An assessment shall be carried out through out organization on following points to ensure readiness of an organization for Six Sigma Implementation.

i) Higher management awareness

ii) Employee awareness

iii) Customer need

iv) Business need

Once the organization is ready for Six Sigma Implementation, actual implementation process will start.

External Consultant Appointment:

To develop internal resources it's advisable to appoint external consultant initially. Consultancy service shall be used for training and developing resources, for project selection and periodic review of projects. Once internal resource is developed consultant shall handover responsibility to internal resource.

Gap Analysis:

A gap between organization's expectations from Six Sigma implementation and it's present status shall be analyzed for designing implementation strategy.

5.5 Implementation

Formation of Implementation strategy:

Output of Gap analysis, customer & business expectation study and readiness assessment shall be used to form implementation strategy.

Tools and methodology finalization:

Six Sigma is a collection of many tools. Some tools are suitable for particular organization and some for the other. The selection of tools depends upon the projects selected.

Six Sigma organization (Proposed)

Proposed Six Sigma organization shall be prepared to define role & responsibility of each Six Sigma family member in organization.

Training for BB,GB, Champions

The next step is to train the project leader. What should we called them Black Belts or something else? Should these people be earmarked for full time improvement job? I believe the answer to the second question should be an emphatic “NO”. In the form of Black Belts let’s not create another team of ‘ELITES’ who will go on begging for time from the process personnel and more so when it comes o data collection & implementation of the solution. In fact if we plan for making at least 30% of the executives as Black Belts, then they will not have full time job for same

We can call these project leader as Black belts or advanced green belts depending on the initial time devoted to training.

Selection criteria for the Black belt should be simply “fire in the belly” not mere intelligence. Their Leadership Quality Should be un Questionable and they should have a good communication skill and respected among the peer

Each one them need to enter the classroom with a draft project character of its own prepared by the sponsor or champion. The cost time devoted to direct instruction and to assigned team and individual activities should be at least 100 hours of which at least 30%should spend on practical skills based activities like

workshop, case-study and role playing. Most of the analytical tools should be discussed with participant's data and not using synthetic data . The course can end with a test. A participant should called Black Belt if he/she is success in test, complete Six Sigma projects within four month from the end of classroom training& identifies one more New projects

The entire program can be conducted in four session over 5-6 months each session covering five days

The suggested course coverage for Black Belt ('Guidebook for Six Sigma Implementation with Real Time Applications', *Indian Statistical Institute, Bangalore, 2007*) should be as follows:

Introduction

Overview of Six Sigma methodology Identifications, Prioritization and selection of Improvement opportunities Roles and responsibilities in Six Sigma implementation .Overview of Six Sigma Project execution (DMAIC and DMADV) (Define-Measure- Define-Analyze- Improve & control and Define-Measure-Analyze-Design and Validate), and Gate Review Questionnaire.

Define Phase

Development of Project Team & Character Organizational structure and context Ganging potential benefit Define and Map process to be improved (SIPOC(

supplier , input, process, output, and customer) / COPIS (customer, output, process, input and supplier).

Activity Flow Chart, Voice Of Customer and Quality function Deployment Identification of critical to customer/critical to customer characteristics (concept of tree diagram)

Measure Phase

Type of data statistical distribution Binomial, Poisson, Normal and other relevant distribution Prioritization Matrix and FMEA and use of it in Data Collection Planning . Introduction to software packages for Data displays and analysis I-understanding in usage & Interpretation of output along with each topic Measurement System Evaluation (Gauge R&R) for variables as well as for attribute measurements (Kappa value and confidence interval for agreement with expert)

Understanding variation-special causes vs, common causes (like dot plots, Box plots, histogram, and control charts) stratification methods(like Pareto, Bar diagrams, Stratified dot plot, Stratified scatter plot, box plot, multi vary charts, etc) normality test of data, evaluation of process capability for data from a normal distribution and concept of confidence interval Evaluation of process capability for data from a normal and non-normal distribution concept of short term, long term process capability and assessment of sigma level.

Analyze Phase:

Identification of value added and non-value added activities (use of lean concept). Organizing for potential causes using cause and effect diagram. FMEA and tree diagram verification /validation of causes using work place investigation(GMBA)Concept of co-relation and regression and use of the same in validating causes Concept of test of hypothesis like 2 sample t, paired t, chi square, ANOVA, etc and use of the same in validating the causes. Sample size determination for a given confidence level concept of Multi regression and use of same in validating the causes. Concept of logistic regression and use of same in validating the causes. Exploratory data analysis and use of same in validating the causes. Concept of design of experiment and details of full factorial, fractional factorial and screening designs.

Improve Phase:

Generate improvement ideas using creativity techniques (traditional and non-traditional) Lean concept including Kaizen and SMED (single minute exchange of dyes) solution evaluation criteria, evalution of solutions and selection of solutions. Change management process dealing with resistance to change process of piloting the solutions Risk analysis through use of FMEA or related methodologies concept and examples of Poke Yoke visual workplace and 5S planning for full- scale implementation (us of Gantt charts, Microsoft project, planning grid, involvement Matrix)

Control Phase:

Evaluation of results after implementation

Monitoring the result through statistical Process Control like (Control Charts, Pre Control Charts etc) after implantation of the solutions

Monitoring the result as a part of established QMS through use of process audit, product audit, and internal audits

Institutionalization and integration of the solutions

Process of Closing the Project

Working through at least Six Sigma Projects of relevant applications

Documentation of a projects

Additional Topics(Optional)

Additional topics from the topics shown below could be considered depending on the type and maturity level of the organization

Response Surface Methodology (RSM)

Reliability Theory

Accelerated Life Testing Design FMEA

Pugh Matrix

TRIZ

DMFA

Taguchi Methods of Parameter design

Tolerance analysis

Value Stream mapping

Multivariate Analysis like (cluster analysis, factor analysis etc)

Conjoint Analysis

CPM &PERT

Introduction to Operations Research

Linear Programming

Advance Product Quality Planning

Advanced Green Belt Course Could of 72 hours duration with customized topics (out of course content of Black Belt program) of instruction over four session, each session having three days with similar conditions as in Black belt course.

Along with Black Belts the project team member need training and they can be termed as Green Belts. The course content of Green Belt training could as follows:

Introduction

Overview of Six Sigma Methodology

Identification, Prioritization and selection of improvement opportunities

Roles and responsibility in Six Sigma Implementation

Over view of Six Sigma Project execution (DMAIC or DFSS\DMADV) (Define-Measure-Analyze-Improve &Control, Design for Six Sigma, Define Measure, Analyze, Design and Validate)

Define Phase

Development of Project team and charter

Define and Map Process to be improved SIPOC (supplier, input, process, output, and customer), Activity Flow Chart, Identification of critical to customer / critical to business characteristics (concept of tree diagram)

Measure Phase

Type of Data and Data Collection Planning

Introduction to various software packages for data display and analysis

Measurement System and Evaluation (Gauge R&R) for variables as well as attribute data

Understanding variation (like dot plots, box plots, histogram & control chart)

Stratification methods (like Pareto, Bar Diagrams, Stratified dot plot, etc)

Evaluation of process capability and assessment of Sigma level

Analyze Phase

Identification of value added and non-value added activity (use of lean concept)

Organizing for potential causes and effect diagram, FMEA &Tree Diagram

Verification /validation of causes using work place investigation (GEMBA)

Concept of correlation and regression and use of same in validating causes

Concept of test of Hypothesis like 2sample t, Paired t, Chi Square, ANOVA etc and use of same in validating the cause

Concept of industrial experimentation

Improve Phase

Select and prioritize solutions for validated causes

Develop Plant for Pilot and Full-scale implementation

Concept and Example of Poke Yoke, Visual Work Place and 5s

Control Phase

Evaluation and Monitoring mechanism (like SPC, audit., Survelliance) of result after implementation of the solutions

Institutionalization and Integration of the solution

Process of closing the projects

Work through attest six sigma projects of different application

The Green Belts can be trained in one shot in five days. It should be ensure that before the project enters the analyze phase all the project teams members are trained

If the organization wishes to involve operations in this movement, One can start the Yellow Belt training, but one advice shall be" to hold on" at least for two years in a large organization. However in SMEs, The Yellow Belt could participate in the Six Sigma projects as team members in the initiation stage itself. However, For Large organization Yellow Belt training is recommended only at the integration stage

The Yellow Belt Curriculum can include the following topics

Project selection charter

Quality and Process, Process analysis

Data Collection, Measure of control tendency and dispersion

Understanding variation, looking into data (frequency plots, Pareto diagrams)

Time Plot (Run Chart), Control Chart for individual values

Brain strumming

Five Why's Cause and Effect analysis, Tree Diagram, FMEA

Validation of Causes, Graphical analysis (Scatter analysis, Comparison plot, Main effect plot and Cause solution matrix)

Evaluating Solutions Ideas, Planning Tools.

Introduction to control phase, Comparison of before and after improvement.

Project Identification

Once the list of probable projects is identified, then the names of likely projects are finalized. Finally, the local deployment coordinator should propose the same to the plant leadership team for approval. Six Sigma project implementation model shown in this chapter is designed to effectively implant Six Sigma projects in an organization.

5.6 Establishment

Initial Success Celebration

To motivate team members & to popularize Six Sigma culture among all employees initial successes of project completion shall be celebrated. Prizes can be given in function organized for celebration.

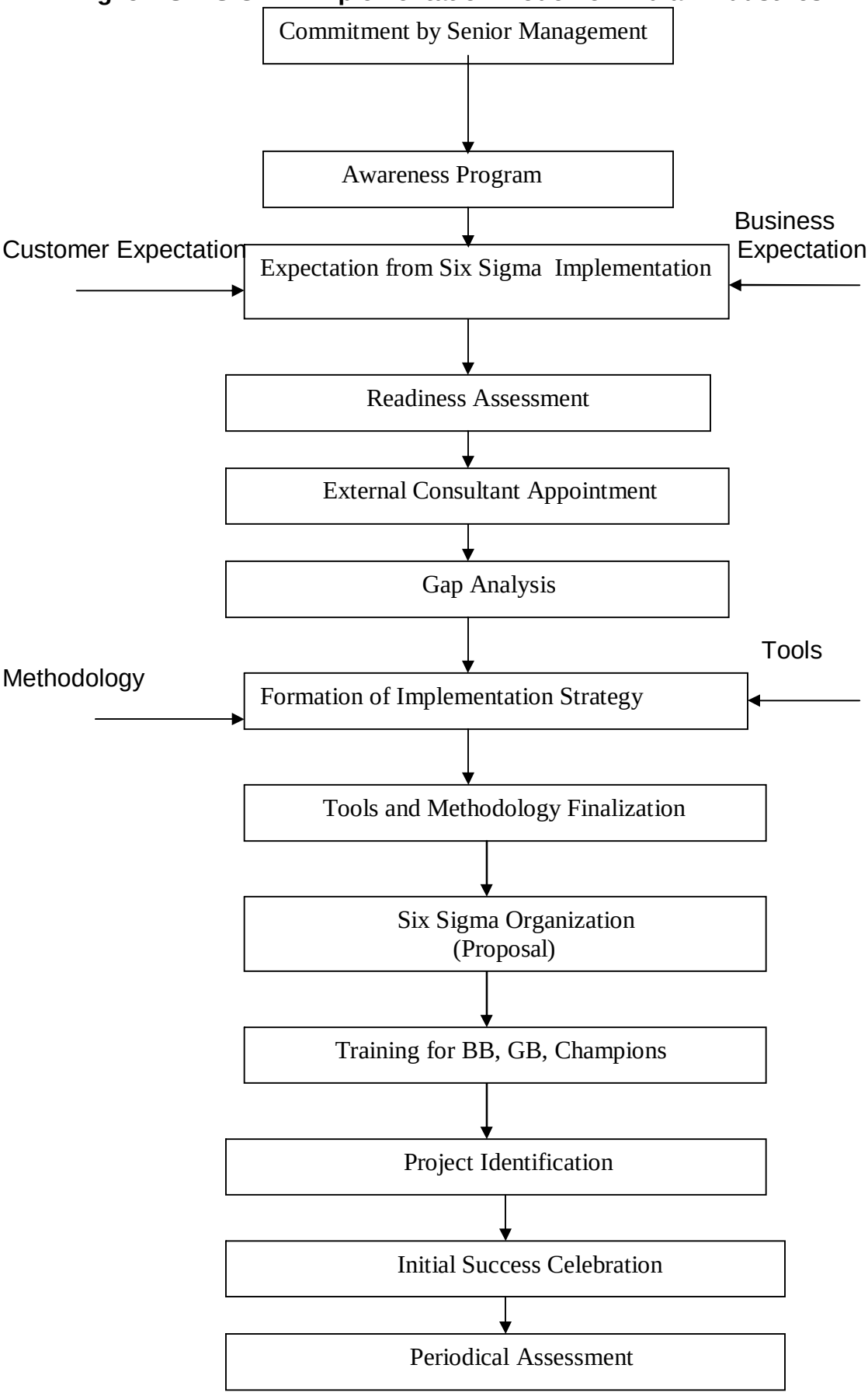
Periodical Assessment

To sustain the results of Six Sigma periodical assessment shall be done. In L&T this assessment is done SBU wise, department wise & Six Sigma co-ordinator wise.

A Six Sigma Implementation model developed after detail study at Larsen & Toubro Limited is given in following diagram.

5.7 Six Sigma Implementation Model:

Fig. 5.1 SIX SIGMA Implementation Model for Indian Industries



5.8 Evolving a Six Sigma Project Implementation model:

After Implementing Six Sigma in an organization, it is important to have project implementation model for successful completion of six sigma projects.

As already discussed, combination of Lean & Six Sigma is required for successful completion of projects and for fulfilling customer & business requirements.

Lean is used for reducing cost, shorten cycle time, expand capacity and improve productivity. Six Sigma is used for reducing process variation and defects.

A comparison of Lean & Six Sigma is given below.

Lean	Six Sigma
• Speed and flexibility • Involves all employees • Positive results in short time-frame • Focused on smaller scale projects • Less scientific: Often trial and error	• In-depth root cause analysis and solutions • Builds highly trained and skilled staff • Used for solving more complex, larger issues • Strong, positive results take longer to achieve • Robust infrastructure

Table 5.3 A comparison of Lean & Six Sigma

In many cases Business Improvement projects leverage a combination of Lean & Six Sigma approaches and tools. Lean leverages the existing Six Sigma infrastructure. Lean concepts/techniques are applied to speed up Six Sigma projects. So fusion of Lean & Six Sigma is done in this model.

Program	Six Sigma	Lean
Goal	Reduce Variation	Reduce Waste
Guidelines	• Listen to Client Voice • Data-based decision making • Identify critical "x's" • Keep fixed process in control	• Identify value • Identify value stream • Flow • Pull • Perfection
Focus	Problem-focused	Flow focused
Foundation	Leadership & Strategic Planning for continuous improvement	Leadership & Strategic Planning for continuous improvement

Table 5.4 Lean Six Sigma Business Improvement Approaches.

From above table we can conclude:

- Lean Speed Enables Six Sigma Quality (Faster cycles of experimentation/learning)
- Six Sigma Quality Enables Lean Speed (Fewer defects means less time spent on rework)

Lean and Six Sigma are highly complementary and together bring better results than separate programs. For supply chain, to gain maximum benefits Lean & Six Sigma shall be combined. A combined approach will change the sequence in which various tools of both approaches shall be used.

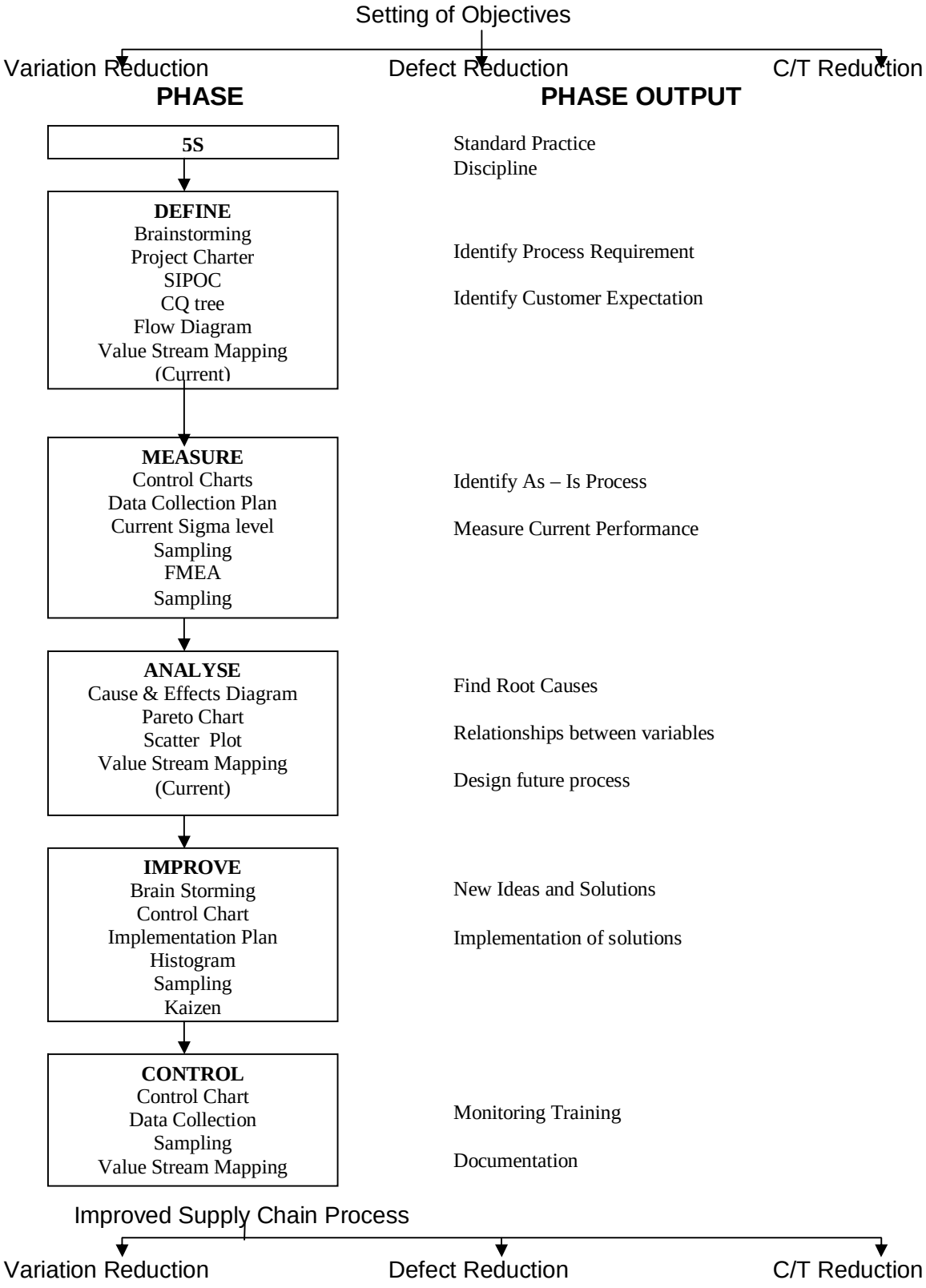
A detail study evolved a model which gives maximum benefits to Indian organizations. This model is now tested for it's effectiveness in manufacturing industry at L&T and can be extended to other Indian organizations.

Phase sequence of this model starts with 5S and followed by DMAIC. Fusion of Lean & Six Sigma tools is done at various phases. Gemba Kaizen

(Continuous Improvement at work place) is the part of Lean.

For each phase a tool set is given. A selection of tool depends on nature of the problem. We have validated this model in a case study given in next chapter.

Fig. 5.2 SIX SIGMA PROJECT IMPLEMENTATION MODEL



5.9 Benefits of Model

1. Best of the both lean and Six Sigma methodology is used.
2. Can be effectively used to reduce cycle time of supply chain process.
3. Can be used to face variability of demand and for reducing inventory levels.
4. Model can be used to reduce defective supplies
5. Customer satisfaction can be achieved along with business benefit

5.10 Validation of the model

The validation of the model is done in two steps. In first step validation comprised a semi structured interview with Lean & Six Sigma Practitioners in Industry. Inputs are also taken from service sector and retail industry. The Six Sigma Implementation model is validated by implementing it in L&T,EBG,C&A.

In second step model is validated by taking one Six Sigma project at receiving store in one organization. Details are discussed in next chapter.

Chapter 6

Validation of Six Sigma Implementation Model

6.1 Larsen & Toubro Electrical Business Group's Implementation of Six Sigma:

Larsen & Toubro's Electrical Business Group has implemented Six Sigma under the leadership & guidance of President-Operations & Member of the board, Mr.R.N.Mukhija.

Mr.R.N.Mukhija constantly expressed importance of Six Sigma for business through 'My word' in EBG's House magazine 'The EDGE'

Our lean efforts have started taking shape and this has been possible with the active involvement of all line managers. This needs to be nurtured and, of us have already started enjoying more fruits. As a step towards systematically institutionalizing lean actions, we have started Lean project charter Registration. This will help in regular reviews and sustaining the efforts as well as achievements in this journey. This documentation process will bring in clarity of thoughts. All projects, big or small, tangible or intangible, should be registered. While we are on the threshold of a new financial year, it is the right time for our line managers to set new challenging targets for the coming year. This will enable us to emerge stronger even in this current difficult situation.

In our six sigma journey participation from all sections of our business is quite essential. It is right time for all functions including service departments like HR, Accounts to initiate and build capabilities for developing a culture of six-sigma within. It is necessary to remove the notion that six sigma is a methodology that applies only to the manufacturing environment. Our sales and marketing department should take up this journey more aggressively. Lots of improvements are possible in this area.

From operational excellence point of view, the involvement of our major vendors in six-sigma is a big focus area that must draw the attention of all line managers. As we go into next financial year, line managers should be desirably flanked by all major vendors with six sigma projects. It would be good to organize a six sigma summit/competition for all

our vendor. Line managers along with our internal experts should take a structured lead towards that.

(The EDGE,Volume 6, issue 2, February 2009)

I am happy to know that after persistent efforts in 2008-09 our line managers have set their **ELITE** targets at the onset of new financial year. It is now speed, focus and aggression that will help us implement the action plans. Amongst other it should help trimming down inventories and operational expenses while simultaneously reducing the through put time. This will enable us to serve the customers better. Although we continue to focus on 5S, Six sigma and value Engineering, we must not forget the synergy that can be built around them.

Though the connections between 5S and six sigma are understood, we often miss out on how value engineering can benefit from these and add to the benefits.

(The EDGE, Volume 6, issue 3, March 2009)

For improving cash, we have to focus on reducing the outstanding and inventory by modifying the business processes so that lower need of cash (or working capital) is sustained. For cost, we have to re-look at design **FMEA** (failure modes and effects analysis) and process **FMEA**. The heads of design and production should use these tools on continual basis. For customer satisfaction, the Kano model should be used to identify what delights the customers while maintaining a good grip on the basic needs. Systematic approach to these areas will help us remain competitive.

Furthering our journey on **ELITE**, we can achieve for better result if we carry out value stream mapping (**VSM**) for each and very new product/ product up gradation/ enhancement. We should integrate **VSM** and value Engineering (VE) in our EPDS process. As we assume that VE has been done for every new product, another check point for VSM should be added, and soon this should also be a standard practice.

Lean is progressing steadily and, towards this, we have now taken one more step of creating a pool of internal auditors. These auditors have a very important

role to play. With the newly acquired audit skills they will now relook at their own workplace and improve it further and also extend their services for carrying out internal cross audit. This internal cross audit will give them an opportunity to know about good practice followed in other areas. They have to be vigilant and their contribution will facilitate to a large extent in driving the Lean journey.

However that is not all. Our approach to ELITE, VSM and LEAN are bound by dogmas in business that represent corresponding solutions and tried and tested responses. If a response to a business challenge worked will once, it develops into a dogma and we keep using it. In the process, we miss out on various new opportunities for achieving excellence. Dogma-busting may be the best way to unleash new ideas in these areas.

(**The EDGE,Volume 6, issue 4, April 2009)**

All initiatives that support growth must be relentlessly pursued. As we continue on the Lean journey, we should be agile and alert to prevent any slide owing to complacence. We now have a pool of trained internal auditors. Their skills must be utilized in periodic self audits. As such audits will throw open areas that need improvements, Line managers must ensure that internal self audits periodically take place and prompt actions are taken on audits findings. With a proper schedule in place there should be no looking back on it.

Our ELITE journey is on the right track although the target taken can be more aggressive. Some of the six sigma project could be offshoot of the VSM projects. These initiatives will help us to reduce complexities in operations for which the customer is not interested to pay. There is an active involvement in six sigma initiative from our manufacturing colleagues. We should ensure similar kind of involvement in service and functions like sales, marketing HR that have good scope for adopting this wonderful technique.

(**The EDGE,Volume 6, issue 5, May 2009)**

Our process improvement initiatives and their adherence should help us achieve our business goals.

ELITE journey and Lean as a philosophy is becoming the part of our DNA. The recently- conducted preliminary round of ELITE encompassing VSM, VE, Six Sigma and POKA_YOKA has provided a good opportunity for all to understand the initiatives' application. The usage of these initiatives in isolation will produce result to the extent of Maximum individual initiative capacity but if used in conjunction will yield multifold benefits.

In the journey ahead, we need to use the combination of all initiatives. Line managers are now deeply involved in ELITE. To get faster result, I recommend they select project from critical, high impact areas, and also start 'looking beyond shop'.

We are on the threshold of moving towards a Lean Enterprises. A Lean Enterprises is a business system for organizing and managing product

development, operations, suppliers, and customer relation. Business and other organization use lean principles, practice, and tools to create precise, customer value goods and services with higher quality and fewer defects. Through a lean system, this would be done with less human effort, less space, less capital, and less time than the traditional system of mass production. It is clear that lean is a journey which not only requires stamina and perseverance, but also the ability to change and change fast.

(**The EDGE,Volume 6, issue 6, June 2009)**

6.2 Result of the Six Sigma Implementation at L&T

The Six Sigma Implementation Model is implemented in L&T with slight variation at each SBU. This is due to different needs of each SBU. It is exactly as it is implemented at C&A-SBU. The results are encouraging as you can see following graph. No. of Six Sigma projects increased by 58% in 2009-10 compare to 2008-09. Almost all Line Manager's rating is improved as shown in table followed by graph. The methodology used in L&T for rating Line Managers is explained in Appendix-I

Validation of Six Sigma Implementation Model:

Commitment by Senior Management: As mentioned in 6.1 above Senior Management is committed to Six Sigma implementation at L&T, EBG. A monthly review of Six Sigma initiative is done at senior level in ODSCM (Operating

Division Steering Committee) meeting. Best Six Sigma projects are presented by Team Leader in front of senior management in ODSCM meeting.

Awareness programs: A six sigma awareness program was conducted throughout SBU when Six Sigma implementation started. For new employees Six Sigma Yellow belt program is conducted.

Readiness assessment: Readiness assessment was done through internal survey **(Refer Appendix VI).** Result of survey shows that average satisfaction level was 6.64 (Sigma Level 1.92). Even if we want to cross Sigma Level of 4 satisfaction level shall be 9.9.

External Consultant Appointment: Consultancy from Indian Statistical Institute was hired during implementation phase

Gap Analysis: Gap analysis done while selecting projects in each area. For this mainly we have used present sigma level and Current State Value Stream Mapping.

Formation of Implementation Strategy: Implementation strategy formed considering organization's culture & structure. Customer and Business needs considered while selecting projects.

Tools & Methodology finalization: Tools & Methodology from both Lean & Six Sigma have been decided to use.

Six Sigma Organization Formation: Six Sigma organization is a sub set of ELITE organ gram. Core Team Member & Six Sigma co-coordinator head this initiative, under his guidance all Black Belts & Green Belts conducts projects.

Training for BB,GB, Champions:

Training is a continuous process for Six Sigma. There are three levels of certification of Six Sigma Green Belt, Black Belt & Master Black Belt. Total trained resources in C&A are as given in table below. Awareness programs are conducted for champions.

	Total	**Certified**	**Trained**
Master Black Belt	**1**	**1**	
Black Belt	**4**	**3**	**1**
Green Belt	**18**	**18**	

Table 6.1 Six Sigma Trained Resources

Introductory Yellow Belt program is designed for all employees. Total 50 employees are trained in Yellow Belt.

Project Identification: Project identification is done after brain storming session at individual departments. Projects are identified considering business & customer needs.

Initial Success Celebrations: In an annual function "**IMPRESSIONS"** a competition is arranged for Six Sigma project presentations. All successful project team members are given prizes for their achievement.

Testing of Effectiveness of Six Sigma Implementation Model

Internal Customer Satisfaction Survey:

Internal customer satisfaction survey conducted before model implementation (Appendix-VI) and after model implementation (Appendix-VII) . Hypothesis testing is used to test effectiveness of Six Sigma Implementation Model.

Hypothesis: There is no difference between Internal Customer Satisfaction level for C&A's Business Processes in Year 2008 & Year 2010
H0: μ1=μ2

Respondent No.	2008	2010
1	4.80	5.33
2	6.00	7.09
3	7.55	8.40
4	7.00	8.44
5	7.00	7.33
6	3.77	5.91
7	8.25	7.00
8	6.75	6.93
9	8.33	8.26
10	6.00	7.20
11	8.50	8.13
12	5.00	7.06
13	7.45	7.33
14	8.33	8.07
15	6.77	5.73
16	8.00	7.83
17	7.00	9.00
18	4.66	7.20

Table 6.2 Internal Customer Satisfaction Survey (Respondent wise)

To analyze whether Implementation of new Six Sigma Implementation Model made difference in internal customer satisfaction level we are using paired t-test.

Population Size: 275

Randomly selected sample size:18

Care has been taken to select sample from each department to ensure representation of all related departments. A questionnaire is prepared (Refer Appendix) as an instrument to collect information about 15 attributes related to business process. This survey has been taken as a regular exercise for ELITE internal customer satisfaction survey.

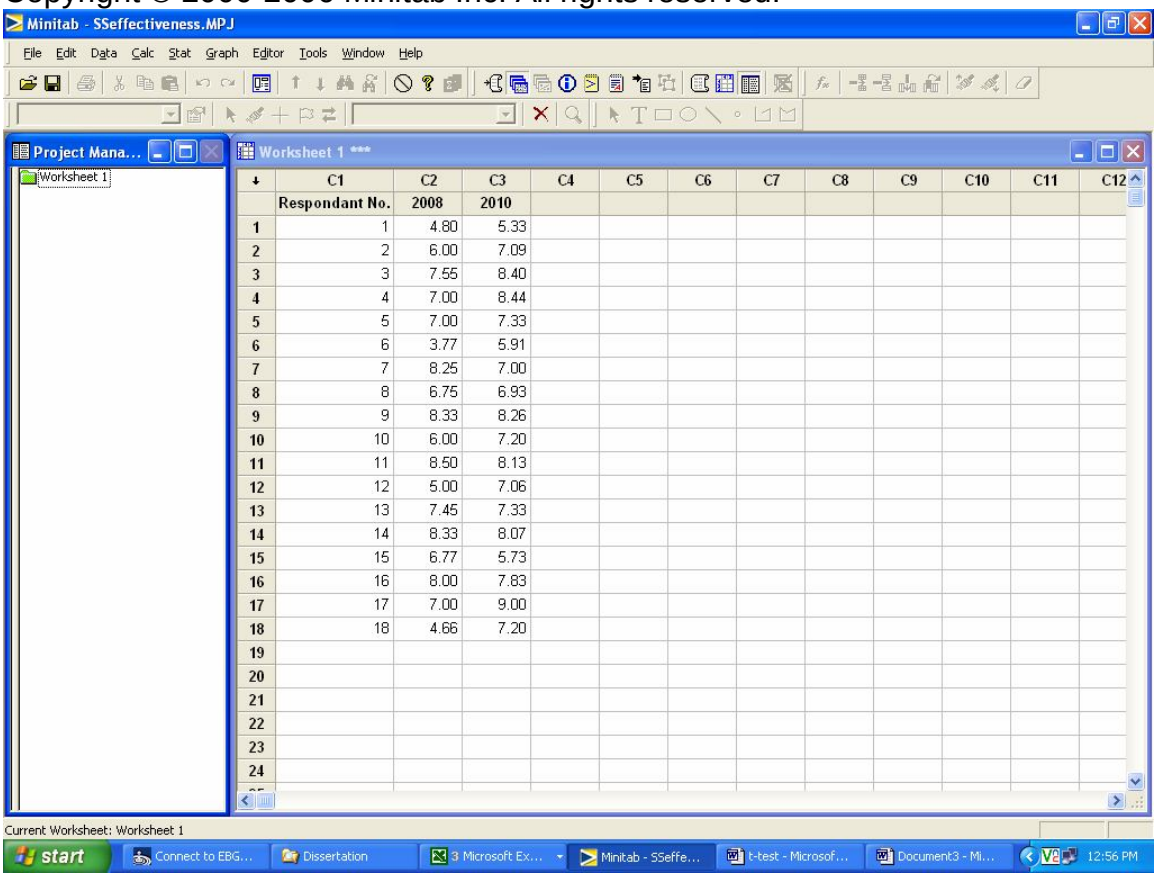
Survey has been conducted before Implementing New Six Sigma Model in year 2008 & after Implementing Model (March,2010).

Minitab statistical software is used to analyze the data.

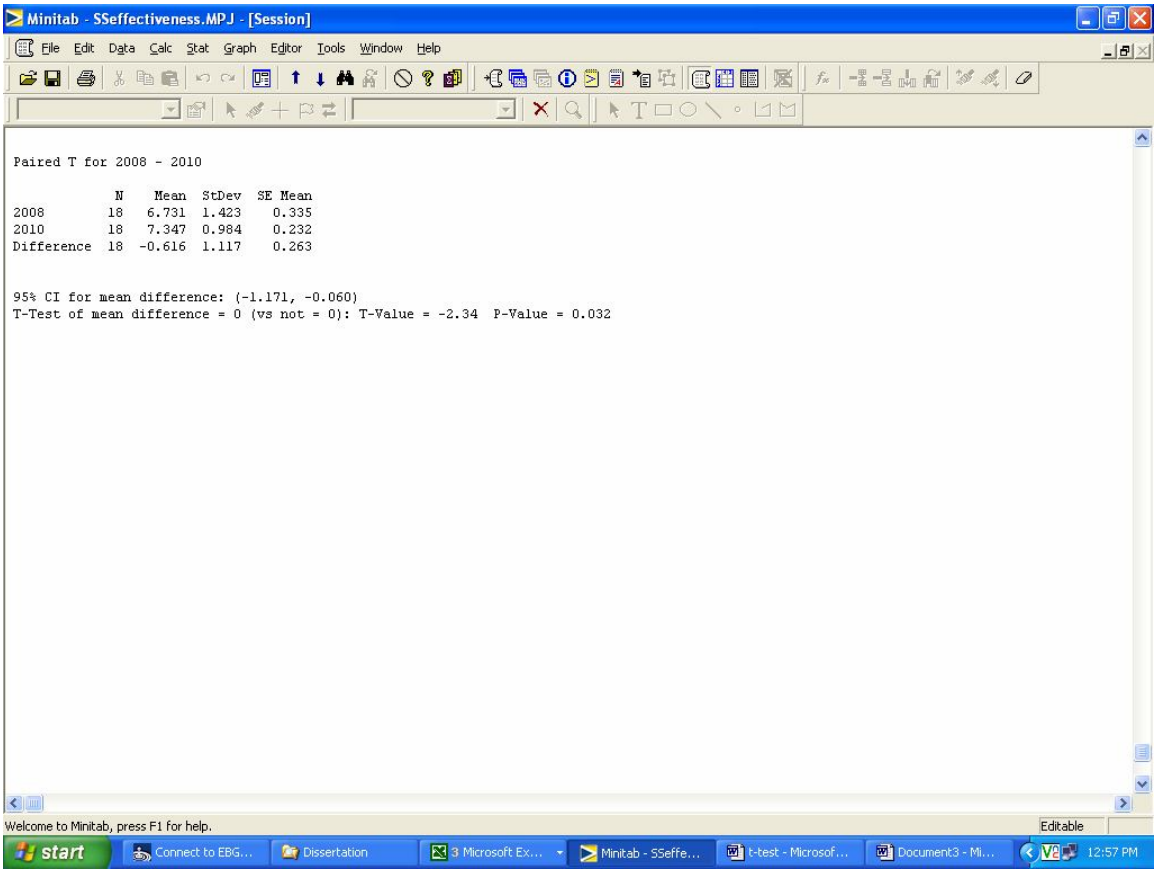
Paired t-test:

The paired t-confidence interval and test procedures are used to analyze the differences between paired observations. The procedures are used to determine if the mean difference for the population is likely to be different from a reference value (usually zero).

Suppose you have job satisfaction data for a random sample of employees who each filled out a survey before and after a new break was added to their daily work schedule. You could use a paired t-procedure to determine if the break influences overall satisfaction ratings. Or, you may have hardness data for a sample of metal parts collected before and after a new hardening process. You could use a paired t-procedure to determine if the process affects hardness.



	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	Respondant No.	2008	2010									
1	1	4.80	5.33									
2	2	6.00	7.09									
3	3	7.55	8.40									
4	4	7.00	8.44									
5	5	7.00	7.33									
6	6	3.77	5.91									
7	7	8.25	7.00									
8	8	6.75	6.93									
9	9	8.33	8.26									
10	10	6.00	7.20									
11	11	8.50	8.13									
12	12	5.00	7.06									
13	13	7.45	7.33									
14	14	8.33	8.07									
15	15	6.77	5.73									
16	16	8.00	7.83									
17	17	7.00	9.00									
18	18	4.66	7.20									
19												
20												
21												
22												
23												
24												



Paired T for 2008 - 2010

	N	Mean	StDev	SE Mean
2008	18	6.731	1.423	0.335
2010	18	7.347	0.984	0.232
Difference	18	-0.616	1.117	0.263

95% CI for mean difference: (-1.171, -0.060)

T-Test of mean difference = 0 (vs not = 0): T-Value = -2.34 P-Value = 0.032

Since the data were analyzed with an a-level of 0.05, a 95% (or 0.95) confidence interval was constructed. This interval tells you that, based on the sample data,

you can be 95% confident that m D is greater than or equal to -1.171 and less than or equal to -0.060.

Since the reference value of 0 is not within the confidence interval, you can reject H0 with 95% confidence and conclude that m D is not 0.

The 0.05 a-level is used here..

As μ1≠μ2 H0 is rejected, So alternate Hypothesis is accepted.

A considerable improvement is found in internal customer satisfaction level in 2010 compare to 2008, which conclude that Six Sigma Implementation model is effective.

There is a rise in average rating for attributes given by internal customer as given in following table.

	Month & Year of Satisfaction Survey	Average Rating for attributes given by internal customer
Before Model Implementation	September, 2008	6.640
After Model Implementation	March, 2010	7.315

Table 6.3 Result of Internal Customer Satisfaction Survey (Average Rating)

Periodical Assessment: Periodical assessment is done for Line Managers on monthly basis and presented in ODSCM. Yearly target is given to all Six Sigma

co-coordinators and at SBU level monitored on monthly basis. Line manager's rating is given in table below.

Though Six Sigma in small way started in C&A in 2001-02, there was a need to accelerate process. Above model is implemented in 2008-09. This model has shown very good results as shown in a table below.

EAOC– No. of Six Sigma Project Summary

Following Graph shows the No. of projects Completed in 2007-08 to 2009-10 at L&T-EBG

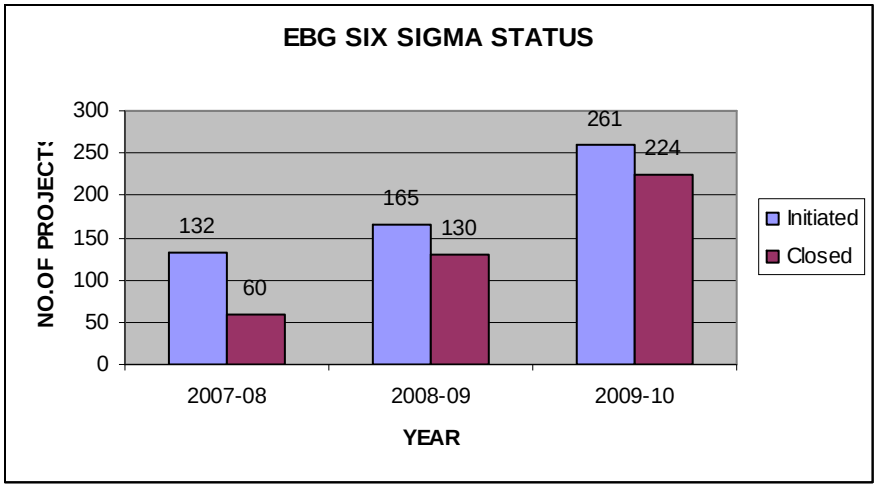


Fig. 6.1

Line Manager's Six Sigma Initiative Rating Status (Rating scale – 1 to 5)

SBU -Location	Line Manager	June'09 Rating	March '10 Rating
ESP-ACB	URJ	2	3
ESP-MCCB	GRT	1	3
ESP-C&F (Powai)	NRS	3	3
ESP-CG	APP	3	4
ESP-SDF/Starter	SDM	3	5
ESP-MDU	RVS	1	3
ESE-Powai	SVM	1	3
ESE-ASW	CP	1	3
ESE-CSW	JS	1	3
ETS-Powai	KSA	1	3
ETS-ASW	HSK	2	4
ETS-CSW (PMC)	AMG	1	2
MPS	LM	1	2
C&A	RLP	2	3
MED	VUR	1	3

Table 6.4 Line Manager's Six Sigma Initiative Rating Status

In C&A SBU of L&T we have deployed this model from December 2008 onward. Though Six Sigma projects were started in 2001-02 in C&A, all departments were not covered. Also no fixed strategy was followed. After implementing Six Sigma Implementation model No. of projects and No. of completed projects increased. It can be seen in following table and graph given in annexure.

Control & Automation C&A Six Sigma Project status		
Year	Total No. of Projects	Completed Projects
2001-02	3	1
2002-03	7	4
2003-04	7	2
2004-05	3	3
2005-06	3	3
2006-07	8	3
2007-08	5	4
2008-09	20	14
2009-10	23	9

Table 6.5 C&A Six Sigma Project status

Before **After Model Implementation**

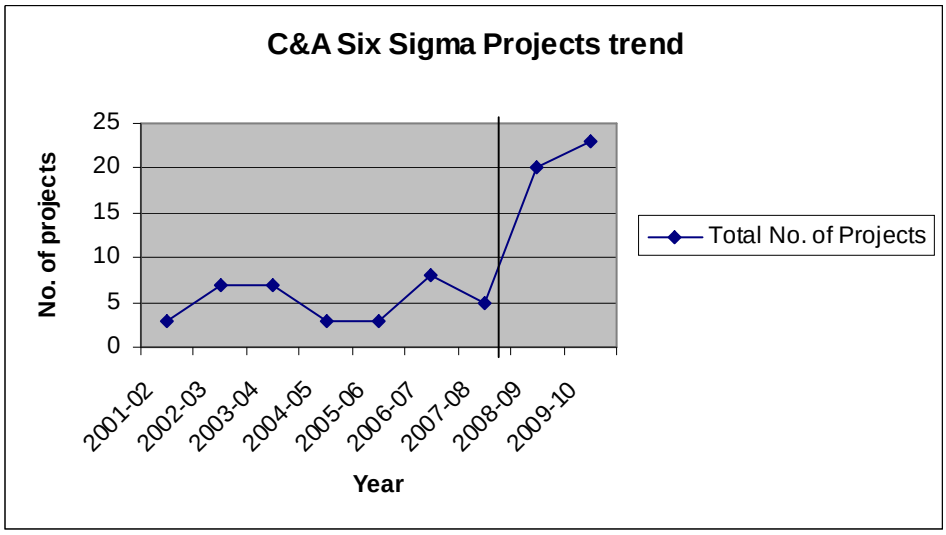


Fig.6.2 C&A Six Sigma Project trend

6.3 Case Study at Larsen & Toubro

In L&T-C&A Automation where this case study has been taken the time gap between the Receipt of material from supplier and the posting of goods receipt in ERP system was too high. This resulted in wrong inventory reporting, high inventory and delayed payment to supplier.

It has been decided to test lean Six Sigma implementation model finding solution for this problem.

Lean Six Sigma Implementation Model given in Figure 1 is followed step by step. Only tools relevant to project are selected and used. The tools used can be seen in Figure 4. The project started with 5S and after making Project Charter as shown in figure 2. Data for three preceding months collected and

analyzed. Sigma level at the beginning of the project calculated (1.74). Current state Value stream mapping done as per Lean principle.

After brain storming Cause & Effect Diagram prepared as per details given in 6.1. Root cause analysis done and solutions evolved through this analysis. Future state Value Stream mapping prepared. Implementation plan prepared and implemented. Refer Figure 5 for details.

The Lean Six Sigma Project Implementation model is tested in this project. The results are extremely encouraging. The sigma level improved from 1.74 to 3.09. The model we have to put further on testing in retail Supply Chain.

Figure 6.2

SIX SIGMA PROJECT CHARTER

Project Title: To improve GR posting cycle time

Problem Description (What & Why)**:** GR is not posted within one day after receipt of material which delays purchasing process cycle.

Current situation (Include Present Sigma Level): Current Sigma Level is 1.74

Scope of Project (from where it starts & where it ends) Material received at stores

Characteristics	**Measure**	**Defect Definition**
Posting of GR	*Days*	*GR Posting>1 working day*

Project Deliverables (state clearly with milestones)**:**

Define Phase by : 17/07/2009 , Measure Phase by : 20/07/2009, Analyze Phase by : 24/07/2009 Improve Phase by :31/07/2009, Control Phase by :05/08/2009

Product: …… **SBU:**

Cost impact of the Project (from the present status):

Savings from the Project: Intangible

Liked with (Please tick all relevant areas) ***: Production, Quality, Cost and Delivery****……*

Meeting frequency with Champion*: Weekly*

Meeting frequency without Champion: Everyday

Expected Completion date: 05/08/2009

Project Team members:

Project Champion: **Project Black / Green Belt:**

Master Black Belt: *…….....***Coordinator :**

6.3.1 CAUSE & EFFECT DIAGRAM FOR THE DELAY IN GR POSTING

Cause & Effect diagram is one of the tool from Six Sigma tool set. It is also called as fish bone diagram as it looks like that. Problem is written in head of the fish. Probable causes for problem is categorized via Man, Machine, Measurement, Material, Methods & Environment.

In this project Lean Six Sigma team gathered and discussed problem. After Brain storming, probable causes were written under each category. From the available data most likely causes were encircled. Root cause analysis done by gathering more data on these causes. This tool we have used in Analyze phase of the model.

Figure: 6.3

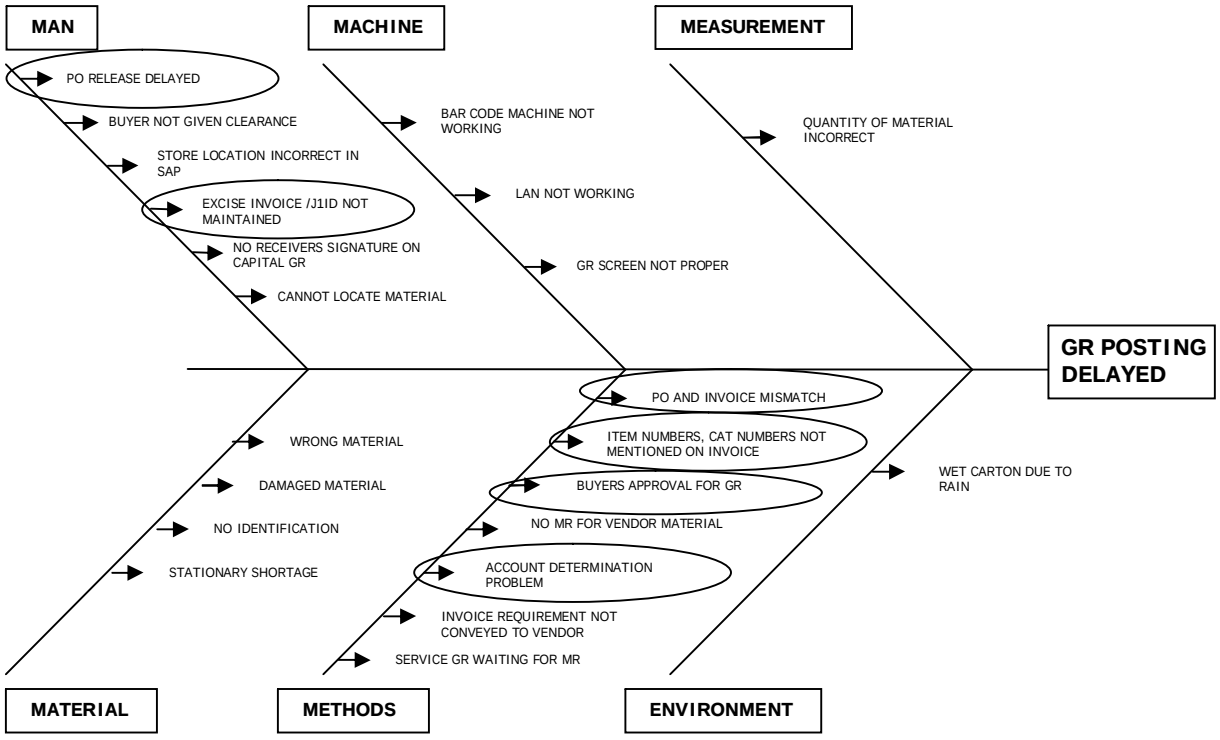


Figure: 6.4

Project to improve GR posting Cycle Time (Lean Six Sigma tools used at each phase of Project)

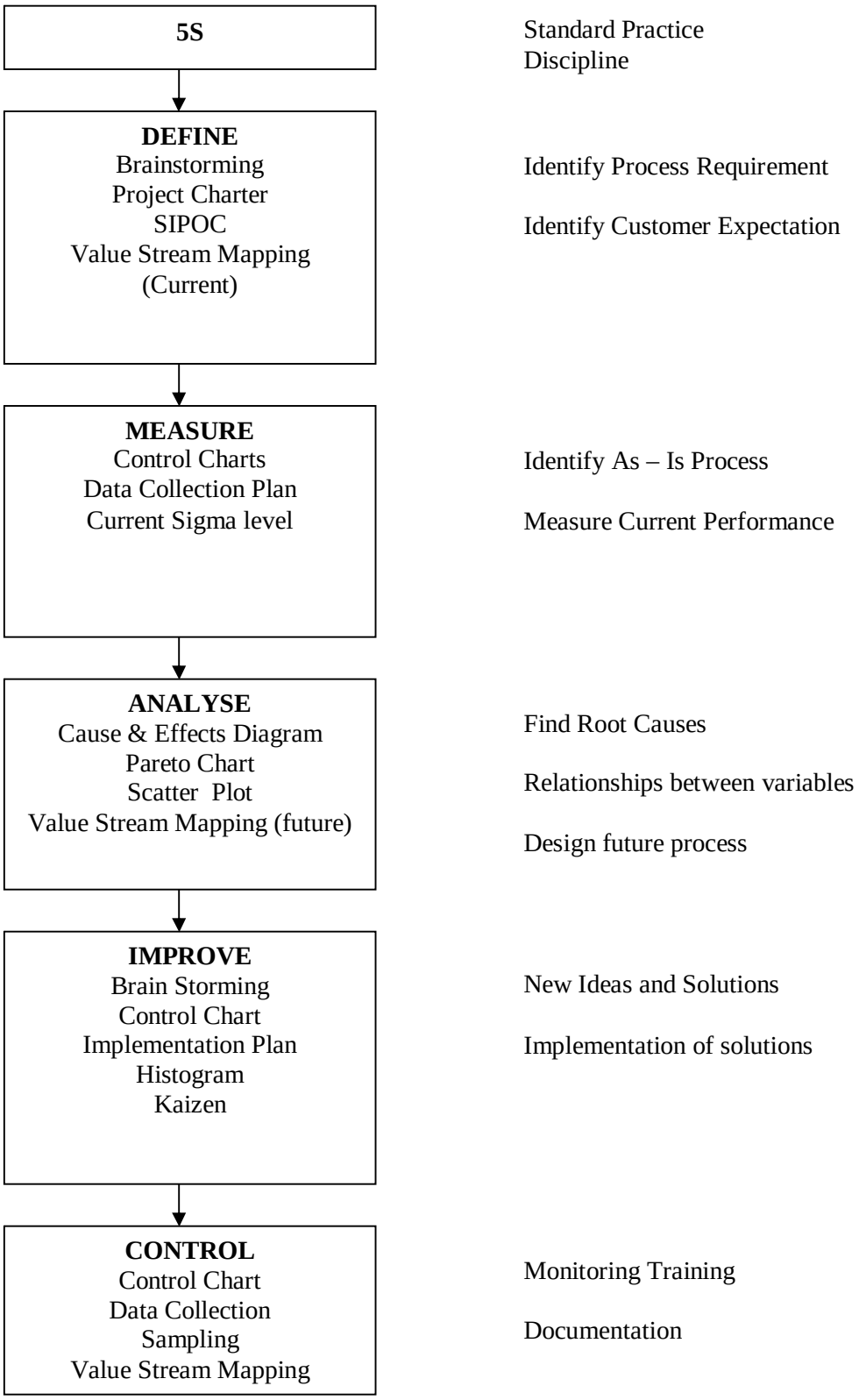


Figure: 6.5 Six Sigma Project Completion Form

Project No.	123	Strategic Planning & Initiatives	Date:07/08/2009
Project Title : To improve GR posting Cycle Time			
Product / Process: Receiving material & posting GR in SAP system			
Initial Sigma level :	1.74	Improved Sigma level As on: 07/08/2009	3.09
Project Start Date:	16/07/2009		
Implementation Cost Rs. (Material + Manhours)	Nil	Control Phase started on :	31.07.2009
SBU - Location		Completion Date:	07/08/2009

Major actions taken:

- Brain storming session conducted to find out all possible reasons for delay in GR posting.
- Cause & Effect Diagram made for GR posting process. Major causes highlighted.
- Present Sigma level calculated by taking one month data. Weekly Sigma level calculated to monitor improvement.
- Gemba investigation done & VSM Current state & Future state made. Muda of waiting for Invoice correction removed by starting practice of getting advance Invoice by fax/email for correction, before arrival of material.
- Buyer wise pigeon hole for incoming invoices made for quick review. Practice of same day GR is conveyed to all in purchase dept.
- Now material is accepted only if Invoice is having CAT No., Item No. as per PO. This saves time for invoice verification at receiving stores
- GR register is maintained (Hard copy & Excel) to track GR history

Savings: (Please delete whatever is not applicable)

Rs. L (Refer Annex for details)

No direct savings, as it is Quality Improvement Project

Areas where this project may be extended for more benefits:	

Champion		Black Belt	

Green Belt		Team Members		

CASE STUDY: SIX SIGMA IN AN OFFICE

Six Sigma can be effectively used to improve transactional processes. ICICI Bank & HDFC are successfully using Six Sigma, to improve their processes. This leads to improved customer satisfaction. Six Sigma can be used to improve processes in Logistics (Invoicing, transportation), Accounts (Billing) and other supporting departments.

Following case study in one office at Navi Mumbai is an example how we can improve customer satisfaction by deploying Six Sigma.

Six Sigma Project: <u>To Improve efficiency of Communication service at an office (ASC)</u>

The reason for selection of the project:

It has been observed that communication problems in office are on rise and considering the importance of communication in business even a single problem can cause loss of money & goodwill. Due to this it has been decided to select this project.

The measurement of current sigma level at the beginning of the project:

Communication breakdown problems were average 15 breakdowns per month for 159 telephones.

Sigma level at the beginning of the project: 2.81

Project deliverables: To bring the sigma level to 3.58

Project Charter:

PROJECT TITLE: TO IMPROVE EFFICIENCY OF COMMUNICATION SERVICE AT AUTOMATION SYSTEMS CENTRE

Problem Description (What & Why): It has been observed that communication problems in ASC are on rise. This leads to inconvenience to employees, vendors and customers, as they can't exchange information in time.

Current situation: Communication breakdown problems are average 15 breakdowns per month for 159 telephone connections.

Scope of Project (from where it starts & where it ends**):** Covers Communication network (EPABX, VOIP, Direct Lines, ISDN, Telephone instruments, Communication cabling) at ASC, reporting system like PM module in SAP

Characteristics **Measure** **Defect Definition**

Communication Service	Breakdown/equipment not working	Reported defect

Project Deliverables (state clearly with milestones)**:**

To bring from the sigma level of 2.81 to 3.58

Product:…… **SBU: C&A**

Cost impact of the Project (from the present status) **:** Indirect.....

……..

Savings from the Project: … To be estimated

Meeting frequency with Champion: Monthly.....

Meeting frequency without Champion: Weekly .....

Expected Completion date: .....

Project Team members:.....

Project Champion: **Project Black Belt:** .....

Connectivity to

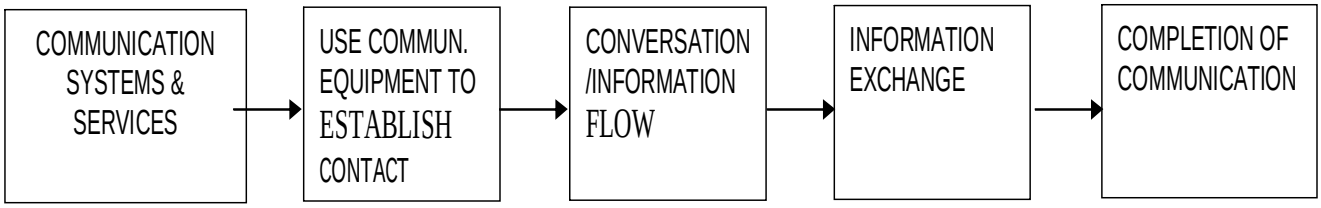
- **Group thrust Area:** .....
- **Department Thrust Area:** .....

TO IMPROVE EFFICIENCY OF COMMUNICATION SERVICE AT AN OFFICE

SIPOC

SUPPLIER	INPUT	PROCESS	OUTPUT	CUSTOMERS
MAINTENANCE DEPT	EPABX	COMMUNICATION	VOICE	EMPLOYEES
SERVICE PROVIDER	TEL INSTRUMENTS		DATA	VENDORS
(MTNL, TATA INDICOM)	**CABLING**		**INFORMATION**	CUSTOMERS

PROCESS


COMMUNICATION SYSTEMS & SERVICES
USE COMMUN. EQUIPMENT TO ESTABLISH CONTACT
CONVERSATION /INFORMATION FLOW
INFORMATION EXCHANGE
COMPLETION OF COMMUNICATION

Methods used:

1.DATA COLLECTION: The major source of data was **daily breakdown record** created by maintenance dept.

2.Continuous monitoring: The method used for continuous monitoring was **control chart.**

3. Cause & Effect Diagram

4. Failure Mode & Effect Diagram

5. 5S

The conclusion based on the data.

From data we found that following are the reasons for communication breakdown at ASC Office.

1. Faulty telephone instruments
2. EPABX related problems
3. Improper cabling
4. Poor workmanship
5. Material Quality

ACTION TAKEN:

1. 5S of the EPABX room done.
2. Survey of all telephone equipments taken. All faulty equipments replaced.
3. Rewiring of MDF done to remove mess of wires there.
4. Technicians trained for correct work practice.
5. Monthly analysis of problem was done to find out root cause for the problem. The problem studied in detail.
6. Control Chart monitored. Monthly Graph for communication breakdown prepared. We found that the trend is downward.

The Final Sigma Level:

The final sigma level we have achieved is 4.06

The Six Sigma Project Implementation model can be used for transactional processes also. In office area we can combine Lean & Six Sigma to achieve best results.

Chapter 7

Conclusions & Recommendations

Previous chapters we have analyzed the implementation process for Six Sigma in Larsen & Toubro Limited, Mumbai. We have also evolved model for Implementation of Six Sigma.

Based on this study for Indian Organizations, a model for Six Sigma project implementation also developed.

7.1 Research Findings:

This study aims to develop models for assisting organizations in India to implement Six Sigma. The Six Sigma Implementation model used to evaluate readiness of organizations in terms of commitment of management, awareness & methodology. It also evaluates cultural aspects which is more important to Indian work environment.

The model guides for step by step implementation process. It also helps in formulating Implementation strategy and selecting tools & methodology. Creating internal resource base is most important for any organization. The pool of Back and Green belts carry on Six Sigma revolution, in an organization after consultant role is over.

After developing implementation model a model for successful Six Sigma projects developed. This model uses some tools of Lean methodology. It has been proved by case study that Lean Six Sigma is the best combination for successful project.

7.2 Research Contribution:

The summery of the major contribution of this study is listed as follows:

1. The literature review compared the critical factors in six sigma implementation as viewed by different authors.
2. Various Process excellence initiatives compared along with their history in industry.
3. Cultural aspects studied with reference to India. A representative organization is studied in detail for it's employee's cultural and social aspects.
4. The study also gives importance of resource development, training & recognition for successful implementation of Six Sigma.
5. The study also indicates that implementation will be more effective if commitment by senior management is present. The organization under study demonstrated this.
6. The sustenance of six sigma is possible only through continuous evaluation process. This is proved by i) Line Managers rating ii) Operation manager rating in this study (Refer Appendix).

7.3 Limitation of Research Findings:

1. Data collected is from one representative organization with locations in southern & western India. Due to cultural diversity in India the findings are

having some limitations with reference to cultural aspects though in broad sense it is applicable to all Indian organizations.

2. As sharing of data was a problem study was limited to one engineering organization. Different type of industries like chemical, service organizations may require different strategies.
3. Six Sigma in India is only 10-12 years old and very few organizations have implemented it. Choosing more organizations for larger study surely fine tune the models.

7.4 Implication for future research:

1. "Cultural aspects & soft skills" and "methodology & tools" are different aspects of six sigma and can be studied separately in future research.
2. A fusion of Lean & Six Sigma methodology can be studied in detail separate research
3. Financial aspects and bottom line impacts can be studied separately in future research.

7.5 Six Sigma Implementation Strategy for Indian organizations:

i) Implementation strategy should be different in different sizes of the organization

ii) Strategy should depend on the organization's existing culture and structure.

iii) Organization shall not try to import an alien culture just because we have to implement Six Sigma in our organization.

iv) Though organizations have to change, we have to transform our processes through more value creation but that need not mean we just change organization structure for the sake of implementing Six Sigma in the company.

Following are the recommendations for Indian Organizations for implementing Six Sigma.

1. Readiness Assessment: As discussed in detail in earlier chapters, readiness assessment shall be done before starting implementation process for Six Sigma.

2. Follow the successful implementation model: Study other organizations. Follow successful implementation model. The model developed in this thesis is proven Six Sigma Implementation model. However some changes can be done as different organizations have different needs.

3. Keep focus on results: Clear vision is required for where organizations are and where they want to be in terms of decreasing costs and increasing bottom-line profits. Use a project tracking system to monitor results. In L&T project tracking is on line and available on intranet. Organization can usually get one from a qualified implementation partner (a consultant brought in to teach the Six Sigma methodology). After asking the hard questions like “What caused this?”

and “What is this, a function of?” you need to find out the answers. Again, keep it under control – you want to work on the vital few factors, not the trivial many.

4. Critical to quality expectations of customer: Remember those critical-to-quality expectations of your customers. Achieving phenomenal business growth depends on how well organization understand and meet those expectations. So stay in touch with the customers and keep current on what they want from you in terms of price, quality, and delivery.

5. Plan for success: Proper planning system, organizations will meet their goals. Planning gives you the milestones and progress reports that indicate how well and fast you’re reaching your goals.

6. Company-wide commitment: Tell everyone what you’re doing and what you intend to accomplish. From the CEO to the production line, every employee should have a vested interest and role in your Six Sigma projects – a sense of ownership goes a long way toward driving true commitment and enthusiasm at every level.

7. Commitment of company’s top management: Make sure company’s top management actively show their commitment to Six Sigma success. They need to be visible and show all employees that they’re prepared to do whatever it takes to get the results you want. They do this by serving as mentors and

champions, freeing up company resources and breaking down to support your projects.

8. Empower human resources. Pick the right people to lead you Six Sigma project teams – and empower those key players. Within the Six Sigma phases of Define, Measure, Analyze, Improve and Control, make sure that your black belts and team members have the essential quality tools for a particular project.

9. Provide on-site mentoring for black belts. As part of that empowerment, you must assure you black belts of your total support for their projects. Their access to information or data, from within your company and from outside, and their interpretation of it must be unrestricted. By applying Six Sigma statistical tools in critical data, black belts can mine hidden wealth. As long as you and other champions and your implementation partner are available on-site to mentor them, black belts will provide the return on investment you want.

10. Choose an implementation partner who will actively assist in screening and selecting Six Sigma projects. A qualified outside expert who is engaged in introducing, training, and supporting your Six Sigma initiative is of vital value in helping you select not only right project, but also the right people to run it.

11. Be patient at the inception of your Six Sigma initiative. Six Sigma projects require the front-end commitment of training, time, and resources to

deliver the end results. You and your employees have to learn how to select projects, develop metrics, and assign key roles, and that takes time. Proper planning makes for profitable outcomes – you can't rush results.

12. Celebrate Completion of projects: Although you need to be patient as your projects get under way, it's also very important to communicate and celebrate each milestone of success. This keeps your team's enthusiasm high and demonstrates how Six Sigma is working. Tell employees, upper management, customers, and vendors; they need to know the value of your efforts every step of the way.

13. Benchmark. Benchmarking is a key step. By formulating a benchmark plan that looks at both internal and external performance standards, organization can conduct the right gap analysis to know where it is and where it should be.

14. Establish project baselines and goals. You need to know your current defect levels, your defect-reduction targets, and how much money you want to save. Then you'll have the right baselines and goals to measure the progress of your projects.

15. Get approval of Accounts Manager. It's important – especially when you're talking about company money – to be "in sync" with the company controller! You need to be operating from the same monetary baseline: you both need to agree

on how you calculate real savings. If Six Sigma coordinator & accounts manager work together, project results can be verified by the accounts department, which further validates all Six Sigma work.

7.6 Readying the Organization

It's time to figure out how to ready and rally your organization for the Six Sigma journey. It's important and necessary for associates at every level to understand and embrace what you're about to do.

Communicate

Communication is key. Again, the clearest way to signal the importance of Six Sigma and your investment in it is to tell the story as often as you can.

First, use all the tools available, such as your company intranet, newsletter, or other communication channels. Post information on what, how, and when you plan to kick off you Six Sigma projects and publicize the roles and responsibilities of pose of your projects; outline the outcomes expected and communicate how the entire company benefits from your efforts.

As discussed earlier, another key element to initiating Six Sigma is to have the unqualified endorsement to senior management. You can communicate this through vehicles like e-mail and corporate newsletters, but you should also take it a step further and find a way for your company leaders to directly address employees. Use videos, company meetings, and the like to get the message out

– your executives will be indispensable to getting company-wide buy-in. By the consistent and continual reinforcement of their support, you can reduce fear of change and inform employees about how they are a part of the success or failure of what you're doing.

Survey Organization's Knowledge Base

Once you've expressed your expectations about Six Sigma throughout the organization, its time to survey your knowledge base. Surveying your knowledge base is as individual as your company culture. Every organization is different in terms of how prepared its personnel are to use Six Sigma tools and begin to manage the data.

Six Sigma can stand alone and still get results, but there are fundamental requirement and foundational training aspects to its process management tools that are necessary. You need to accurately survey your company's knowledge, to identify the gaps or misconceptions and determine how you can best prepare for their training experience.

- **Check sheet:** This is a list of check-off items that permits quick and easy collection of data in a simple, standardized format. It's a basic, vital tool.
- **Histogram:** This is a bar chart displaying the frequency of data in subgroups or categories.
- **Brainstorming:** This is a method of getting people together to openly exchange ideas and solutions for specific problems or opportunities. All

suggestions are recorded in the meeting's minutes, for possible use immediately or later.

- **Process mapping:** This is a graphical view of your process steps for a given situation. As mentioned in Chapter 3, you map the steps with boxes that show the work process in its entirety, with inputs and outputs for each aspect documented. It gives you an exact insight into a process flow.
- **Pareto Chart:** This is a bar graph breaking down a problem into relative contributions of its component, named for Vilfredo Pareto, the Italian economist, who originated the 80/20 principle. It identifies the vital few elements that form 80% of the problem, so you can focus on them and ignore the remaining 20%.
- **Run chart:** This chart displays any given measurement over a specified time sequence.
- **Cause-and-effect (fishbone) diagram:** This diagram is used to identify and classify causes of a given effect.

Once you and your staff fully understand these tools and their value, you can use them to identify the defects and waste in your processes.

Planning

Once organization is determined that it is ready to start Six Sigma, it need to know how to plan for it. There are certain phases in Six Sigma planning that

serve as foundation for any implementation; in each phase, there are certain steps that build sequentially to launch projects.

Communication and Education

As noted earlier, one of the best ways to build awareness about Six Sigma is through a company-wide communiqué from your CEO or president. In our study at Larsen & Toubro Limited, we have observed that Mr.R.N.Mukhija, President-Operations & member of the board regularly communicate with employees through house magazine “The EDGE”. This sets the tone and the expectation for all employees that Six Sigma depends on everyone’s support, regardless of their actual involvement.

Once that has been done, Six Sigma is further introduces in key sessions to executives and managers to reinforce their understanding and support. Beyond that, executive training should be offered to all senior managers and champion training should be offered to managers at all levels.

Executive training should include an overview of Six Sigma, a review of case studies, related product and service demonstrations, deployment strategies, and exploration of scientific tools methods, statistical analysis, improvement, measurements and management controls.

Champion training provides the managerial and technical knowledge necessary to plan and implement Six Sigma and mentor Black Belts. The goals is to transfer and reinforce fundamental Six Sigma strategies, tactics, and tools necessary for achieving the breakthrough in key processes. Training covers the

principles, tools, and applications of Six Sigma, including deployment tactics and strategies for establishing metrics.

After introducing Six Sigma to executives and managers and determining who will receive executive and champion training, the next steps in planning phase are to order training materials, select black belt candidates, and schedule training.

Identification of Projects

During this time, organization also starts to select it's projects. You should be familiar enough with your processes to identify the chronic issues that your Six Sigma teams should investigate and improve. Your outside consultant should support you in selecting the projects that will have high impact on quality and customer satisfaction and will deliver bottom-line savings. You should also identify departments and people that you'll need for support of your projects.

Infrastructure

As an organization compile list of black belt candidates, it develop "job descriptions" for their new roles and coordinate with it's human resources department to post them. Human resources should also benchmark compensation plans that reward black belts and their teams upon the completion of projects.

Once as an implementation co-coordinator you've selected you black belts, determined how they will be rewarded, and decided what your projects will

entail, it's time to kick off training phase. This involves coordinating all logistics for training sites, ensuring sites, ensuring that you and your executive teams are ready to serve as champions and that you training materials and instructors are ready to go. Then, you communicate with black belts about the training schedule and prep them for their first day of class.

Organization's aim in training black belts is to create technical leaders, advanced users, and teachers of Six Sigma. They should learn its philosophy, application tactics (including statistics, benchmarking, process-control techniques, diagnosis methods, and experiment design), and group dynamics. Then, once you've trained you black belts, you assign them to the project you've selected.

There are also periodical senior reviews. These are formal meetings involving you, other champions, senior leaders, and your outside consultant to discuss the progress of your Six Sigma initiative. The primary purpose of these sessions is to ensure that your teams are meeting you objectives and that the initiative is staying on track.

Implementation partner

These planning stages can be considered as the steps necessary to laying the foundation for Six Sigma. Each Six Sigma deployment follows essentially the same success model for implementation. This specifics of your particular situation, the projects you select, and the champions and black belts will determine how to create a plan and a schedule for all activities.

In case organizations are wondering how all of this gets done, they shall remember that their outside consultant is there to direct, train, and execute the critical elements of the planning process. Their implementation partner can help them orchestrate all responsibilities, roles, and schedules to make a smooth transition from planning to implementation.

Finally a successful six sigma implementation depends on a tested & proven Six Sigma implementation model. We developed this Six Sigma Implementation Model in this dissertation for Indian Organizations.

Chapter 8

Reference Section

GLOSSARY

Accuracy: A measurement concept involving the correctness of the average reading. It is the extent to which the average of the measurement taken agrees with a true value.

Analyze: The third step in the DMAIC problem – solving method. The measurements and data must be analyzed to see if they are consistent with the problem definition and also to see if they identify a root cause. A problem solution is then identified. Sometimes, based on analysis, it is necessary to go back and restate the problem definition and start the process over.

Black Belt: A person who had earned a Six Sigma black belt and has Six Sigma skills sufficient to act as an instructor, mentor, and expert to green belts. A black belt is also competent in additional Six Sigma tool- specific programs and statistics.

Control: The final step in the DMAIC problem- solving method. A verification of control must be implemented. AQ robust solution (like a part change) will be easier to keep in control than a qualitative solution.

Define: The overall problem definition step in the DMAIC process. The definition should be specific as possible.

DMAIC problem - solving method: Measure, Analyze, Improve and Control : The Six Sigma problem-solving approach used by green belts. This is the roadmap that is followed for all projects and process improvements with the Six Sigma tools applied as needed.

Fish bone diagram: A Six Sigma tools that use a representation of a fish skeleton to help trigger identification of all the variables that can be contributing to a problem. The problem is shown as a fish head. The variables are shown on the bones, Once all the variables are identified, the key two or three are highlighted for future study.

Green Belt: A person who had earned a green belt Six Sigma designation and who is the primary implementer or team leader of the Six Sigma methodology. He or She earn this title by taking class in Six Sigma, demonstrating and competency on Six Sigma tests, and implementing Six Sigma projects using the Six Sigma tools.

Improve: The fourth step in the DMAIC problem- solving method. Once a solution has been analyzed, the fix must be implemented. The expected result must be implemented. The expected results must be verified with independent data after the solution implementation.

Master Black Belt: A person who had earned a Six Sigma master black belt and who generally has management responsibility for the Six Sigma organization, These responsibility could include setting up its training, measuring its effectiveness, coordinating, efforts with the rest of organization, and managing the Six Sigma people (when six sigma is set up as a separate organization)

Repeatability: The consistency of measurement obtained when one person measure a part multiple times with the same device.

Reproducibility: The consistency of measurements obtained when two or more people measure a part multiple times with the same device

Variables Data: Continuous data that are generally in decimal form. Theoretically you could look at enough decimal place to find that no two values are exactly the same

5S: One of the most effective waste elimination tools, ensures elimination of waste elements such as Time, Motion, Space and Excess Inventory

Benchmarking: The concept of discovering what is the best performance (in a particular area or process) being achieved, whether in your company, by a competitor, or by an entirely different industry. Once this is determined, use this information to improve own processes.

Best Practice: A way or method of accomplishing a business function or process that is considered to be superior to all other known method.

Business Excellence: A level of performance in which a company achieve and sustains “best in industry (world-class) results” for critical factors deemed to be vital to business success, as defined by the key stakeholders of the business

Capability: The capability of a product, process, practicing person, or organization is the ability to perform its specified purpose- based on tested qualified or historical performance- to achieve measurable results that satisfy established requirements and specifications.

Champion: Business leaders’ ad senior mangers who ensure that resources are available for training and projects, and who are involved in project tollgate

Change agent: A person who leads a change project or business- wide initiative by defining, researching, planning, building business support, and carefully supporting volunteers to be part of a change team. Change agent must have the conviction to state the facts based on data, even if the consequence are associated with unpleasantness.

Charter: A document or sheets clearly scopes us and identifies the purpose of a quality improvement project. Items specified include background case, purpose, team members, scope timeline, expected results and benefits etc.

Continuous improvement: Adopting new activities and eliminating those that are found to add title or no value. The goal is to increase effectiveness by reducing inefficiencies, frustrations and waste (rework, time, effort, material etc.). The Japanese lean term is kaizen.

Critical to quality (CTQ): CTQs are key measurable characteristics of a product or process whose performance standards or specifications limits must be met in order to satisfy the customer. They align improvements or design efforts with customer requirements.

Customer: A person who purchase the end product or services that a business produces.

Cycle time: Cycle time is the elapsed time required to process one unit of good work through a process step. Often defined as the elapsed time from good piece to good piece at a single step in the process.

Data: Data is factual information or measures use as a basis for reasoning, discussion or calculation. The “right” data and its analysis are critical to achieve quality improvement

DFSS (Design for Six Sigma): An integral part of a Six Sigma quality initiative structure for designing and redesigning products and processes. Uses a DMADV framework, which consists of five interconnected phases: define, measure, analyze, design, verify(DMADV). Design for Six Sigma is used for new product ir services.

Gemba: A Japanese word meaning “real place” now adapted in management terminology to mean the ‘work place’ or that place where value is added. At manufacturing it is usually refers to shop floor.

JIT (just in time): A planning system for manufacturing processes that optimizes availability of material inventories at the manufacturing site to only what, when, and how much is necessary.

Kaizen: Japanese word that means continuous improvement. Continuously improving in incremental steps. The word translated from Japanese and embracing the cultural use in Japan is rapid continuous, good change.

Lead time: The time required for one piece to move all the way through a process or value stream, from start to finish. Envision timing a marked item as it moves from beginning to end

Lean Six Sigma: An integrated methodology and infrastructure using the tools, techniques, and skills from lean enterprises principles and Six Sigma necessary to optimize your process. Lean focuses on process speed, and Six Sigma focuses on process quality.

Poka- Yoke: Japanese term that means mistakes proofing. A single device used to prevent error in the process. A poka-yoke device is one that prevents incorrect parts from being made or assembled, or easily identifies a flaw or error.

Sigma Level- Determining sigma levels of press (one sigma, six sigma, etc.) allows process performance to be compared throughout an entire organization because it is independent of the process. It is merely a determination of opportunities and defects although the terms are appropriately defined for that specific process

SIPOC: Stands for suppliers, inputs, process, outputs, and customers. You obtain input from supplier, add value through your process, and provide an output that meets and exceeds your customer requirements. Visually depicted, it includes product and information flow.

Statistics: The mathematics of the collection, organization and interpretation of numerical data

Value Stream Mapping: A paper and pencil tool that helps you to see and understand the flow of material and information as product or service make its way to the value stream

ANNEXURE

ANNEXURE-I

SBU: C&A

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0724	2/4/2007	28/07/2008	15.86	1.1	6
2	SS0794	3/9/2007	3/6/2008	9		DFSS Project
3	SS0830	15/10/2007	12/11/2008	12.9	1.36	1.76
4	SS0834	21/12/2007	20/03/2009	14.03	3.88	4.14
5	SS0835	27/12/2007	30/9/2008	9.1	1.33	2.56
6	SS0840	15/1/2008	31/7/2008	6.51	3.79	4.62
7	SS0842	28/1/2008	2/5/2008	3.13	2.44	3.63
8	SS0844	30/1/2008	29/12/2008	11.03	3.64	4.08
9	SS0851	29/1/2008	11/11/2008	9.43	2.1	3.44
10	SS0943	21/8/2008	21/1/2009	5	0.82	2.34

SBU: C&A

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
11	SS0955	16/8/2008	28/2/2009	6.4	2.28	3.02 (For all projects) 6 (For OGW1)
12	SS0985	10/10/2008	30/10/2008	12.66		DFSS Project
13	SS1025	11/12/2008	12/1/2009	1.03	1.53	3.82
14	SS1049	6/1/2009	20/3/2009	2.46	0	1.93

SBU: MED

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0775	15/07/2007	12/6/2008	10.9	2.51	3.34
2	SS0786					
3	SS0815	15/10/2007	30/12/2008	14.5	1/1/1900	1/2/1900
4	SS0816	15/10/2007				
5	SS0817	15/10/2007	26/11/2008	13.36	1.47	6
6	SS0848	10/10/2007	31/10/2009	24.7	0	0.71
7	SS0885	25/05/2008				
8	SS0890	28/05/2008	16/01/2009	7.63	4.08	5.27
9	SS0893	20/06/2008	05/01/2009	6.53	2	3.4
10	SS0894	16/06/2008	25/03/2009	9.3	0	6
11	SS0913	18/06/2008	15/01/2009	6.9	0.75	3.51
12	SS0914	22/08/2007				
13	SS0944	19/07/2008	19/11/2008	4	2.25	3.31
14	SS0986	05/08/2008				
15	SS0988	01/09/2008	15/01/2009	4.46	0	5.9
16	SS1011	01/02/2008	10/08/2008	6.3	2.4	4.3
17	SS1087		15/01/2009		150 mins	69 mins

SBU: ESE

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0836	1/8/2008	31/03/2009		2.51	3.41
2	SS0911	10/7/2008	15/03/2009	8.16	0	1.8 (for completeness) And 2.76 (Cycle time with a target of 18 days)
3	SS0926	15/04/2008				
4	SS0933	21/04/2008	30/12/2008	8.3	2.57	4.1

SBU: ETS

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0810		10/12/2008		2.02	3.25
2	SS0873	25/05/2008	14/03/2009	9.63	1.03	3.27
3	SS0875	25/05/2008				
4	SS0897	18/06/2008	04/03/2009	8.53	0	2.58

SBU: MPS

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0749	18/05/2007				
2	SS0916	15/07/2008	09/12/2008	4.8	2.02	5.32
3	SS1051	15/07/2008	12/01/2009	5.9	3.88	5.02

SBU: SDDC

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0669					
2	SS0700		12/12/2008		NA	NA
3	SS0778		29/12/2008		NA	3.14
4	SS0792					
5	SS0799		13/11/2008		NA	NA
6	SS0800	01/11/007	13/11/2008		NA	NA
7	SS0807		15/12/2008		NA	NA
8	SS0808		14/02/2009		2.78	4.15
9	SS0837		14/11/2008		2	3.75
10	SS0924	07/07/2008	20/01/2009	6.43	1.5	6
11	SS0925	07/07/2008	20/01/2009	6.43	0	6
12	SS0940	24/06/2008				

SBU: ESP

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
1	SS0567		01/12/2008		1.5	3.55
7	SS0729		01/01/2008		1.21	3.47
8	SS0742					
9	SS0755		31/12/2008		4.26	4.6
10	SS0756	01/04/2007			0.2	4.5
16	SS0819		15/12/2008		2.29	3.17
17	SS0820		15/12/2008		2.27	2.84
18	SS0825	10/09/2007			3.85	4.2
19	SS0828					
20	SS0832	01/12/2007	31/12/2008	12.96	3.95	4.86
21	SS0833	01/11/2007	31/05/2008	6.96	0	6
29	SS0870	10/05/2008	01/02/2009	8.3	2.44	4.8

SBU: ESP

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
33	SS0879	04/05/2008	30/11/2008	6.83	3.22	3.55
34	SS0880	02/06/2008	01/12/2008	5.96	2.38	3.56
35	SS0881	02/06/2008	01/12/2008	5.96	2.68	6
37	SS0906	03/07/2008	31/12/2008	5.93	3.46	4.04
38	SS0953	04/08/2008	30/10/2008	2.86	0.63	6
39	SS0957	14/08/2008	30/09/2008	1.53	2.72	4.2
40	SS0959	13/08/2008	07/02/2009	5.8	2.98	3.73
41	SS0960	11/08/2008				
42	SS0965	14/08/2008			3.38	4
43	SS0966	01/11/2008	28/02/2009	3.9	2.5	5
44	SS0972	13/09/2008	28/01/2009	4.5	3.32	4.9
45	SS0977	14/08/2008	30/11/2008	3.53	3.5	4.04
46	SS0980	03/10/2008	30/01/2009	3.9	3.58	4.25
47	SS0983	28/09/2008	30/11/2008	2.06	2.34	4.49
48	SS0984	28/09/2008	29/01/2009	4.03	2.26	4.03
49	SS0987	14/08/2008	20/11/2008	3.2	1.4	4.45
50	SS0999	11/09/2008	16/03/2009	6.16		
51	SS1004	01/01/2008	30/08/2008	7.96	2.06	3.02

ESP

Sr. No.	Project No.	Date of Identification	Date of Completion	Project Duration (Months)	Initial Sigma Level	Improved Sigma Level
52	SS1006	16/07/2008	05/02/2009	6.7	1.2	2.34
53	SS1016	01/11/2008	21/03/2009	4.66	0.67	3.25
54	SS1035	20/11/2008	21/03/2009	4.03	3.56	4.15
55	SS1036	10/10/2008	26/10/2008	12.53	1.63	3.89
56	SS1043	20/10/2009	21/03/2009	5.03	0.67	2.49
57	SS1046	18/12/2008	21/03/2009	3.1	2.97	3.93
58	SS1047	20/12/2008	21/3/2008	3.03	3.03	4.61
59	SS1055	05/06/2008	24/10/2008	4.63	0.67	2.78
60	SS1060		05/01/2009		2.78	3.8
61	SS1064	04/01/2009	12/03/2009	2.26	2.02	3.25
62	SS1065	02/12/2008	02/08/2009	8	3.23	4.26
63	SS1067	04/11/2008	28/02/2009	3.8	3.3	3.01
64	SS1068	15/12/2008	20/03/2009	3.16	2.02	4.59
65	SS1074	04/01/2009	30/03/2009	2.86	4.9	5.9
66	SS1078	04/01/2009	20/03/2009	2.53	2.02	3.14
67	SS1083	29/09/2008	01/12/2008	2.06	2.05	3.03
68	SS1086	14/08/2008	27/01/2009	5.43	2.9	3.61

ANNEXURE-II

Six Sigma Implementation Model Effectiveness Analysis

SBU	INITIAL SIGMA LEVEL	FINAL SIGMA LEVEL
C&A	2.023	3.484
MED	1.524	4.008
ESE	1.693	3.755
ETS	1.017	3.033
MPS	2.95	5.17
SDDC	1.57	4.608
ESP	2.418	4.029

Note: Initial Sigma level is an average sigma level before Six Sigma projects and Final Sigma Level is an average Sigma Level after Six Sigma projects at various SBUs. The increase in Sigma level indicates that model is effective in increasing quality level of processes.

ANNEXURE-III

Six Sigma Implementation Effectiveness Questionnaire

1. Name of the operational division.

2. Year of implementation of Six Sigma.

3. No. of Six Sigma Projects started and completed.

Year	No. of Six Sigma Projects started	No. of Six Sigma projects completed

4. No. of Master Black Belts:

   Black Belts:

   Green Belts:

   Total:

5. Resource utilization in the year 2008-2009

$$\left(\frac{\text{No. of Belts}}{\text{No. of Projects}} \times 100 \right)$$

6. Average Duration of projects in months of the year 2008-2009.

7. Saving achieved through Six Sigma in year 2008-2009.

ANNEXURE-IV
Result of Six Sigma Implementation Effectiveness Questionnaire

Details on six sigma initiative-Line Manager wise Analysis 2008-09

Sr No	Data Description	URJ	GRT	NRS	APP	SDM	RVS	SVM	CP
1	No. of MBB with the line manager today	2	2	0	1	1	0	0	1
2	No. of BB with the Line manager today	5	11	8	6	4	2	20	0
3	No. of GB with the Line manager today	13	12	9	4	10	3	24	1
4	% involvement of resources today	100	100	100	100	100	100	38	100
5	No. of ongoing projects today	25	43	13	15	4	15	14	3
6	Average project duration today(unit = months)	8.38	13.33	7.33	8.3	4.66	4	9.67	No project completed in this year
7	Savings achieved till now (Rs Lacs)	16.53	0.00	13.00	17.07	14.73	6.19	8.27	0.00

Result of Six Sigma Implementation Effectiveness Questionnaire

Details on six sigma initiative-Line Managerwise Analysis 2008-09

Sr No	Data Description	JS	SAB	KSA	HSK	AMG	UVR	JPZ
1	No. of MBB with the line manager today	0	1	0	0	0	1	2
2	No. of BB with the Line manager today	0	6	3	0	1	22	12
3	No. of GB with the Line manager today	11	24	11	2	0	46	16
4	% involvement of resources today	100	73	86	50	100	56	36
5	No. of ongoing projects today	15	12	9	1	6	26	7
6	Average project duration today(unit = months)	No project completed in this year	6.82	10	No project completed in this year	No project completed in this year	7.27	9.67
7	Savings achieved till now (Rs Lacs)	0.00	193.42	3.36	0.00	0.00	12.74	6.69

ANNEXURE-V

SIX SIGMA SBU WISE ANALYSIS 2008-09

Data Description	C&A	MED	ESE	ETS	MPS	PDP	SDDC	ESP
No.of MBB	1	1	1	2	2	1	1	9
No.of BB	7	16	25	1	11	0	5	49
No.of GB	21	30	56	26	17	1	17	102
% involvement of resources	68.96%	68.08%	23.70%	34.48%	36.66%	33.33%	86.95%	54.37%
No.of project completed	14	18	6	5	3	0	16	66
Average project duration	10.63	9.87	8.23	9.08	5.35	0	6.43	5.03
Saving achieved 2008-09 (Rs.Lacs)	193.42	12.74	8.27	3.36	6.69	0	0	67.52

ANNEXURE-VI

Summery of Customer Satisfaction Survey to Assess Current State of Business Process (2008)

SR.NO		RATING(1-10)	DN-Project	KUR-Project	SSA-Project	SVS-Project
1	Issue time of stock items for stores		NA	NA	7	8
2	Delivery of magnetics		NA	NA	7	8
3	Delivery of imported items		NA	NA	8	7
4	Panel redness for customers inspections		3	6	5	NA
5	Overall panel delivery		4	6	8	NA
6	Time taken for order placement		NA	5	7	7
7	Awareness on panel status in shop		NA	6	8	NA
8	Time taken for testing of panels in shop		7	4	9	8
9	Quality of panels received for testing		NA	6	5	NA
10	Quality of panels received at site		NA	7	8	NA
11	Quality of tests carried out on panel		NA	6	8	NA
12	Correctness of drawings received for mfg		NA	NA	7	6
13	Correctness of material issued by stores		NA	NA	8	7
14	Do you feel mfg added value for end user		4	7	NA	NA
15	Do you feel testing added value for end user		6	7	10	NA
	Average rating of respondant		4.8	6	7.545454545	7

Summery of Customer Satisfaction Survey to Assess Current State of Business Process (2008)

SR.NO		AD-MFG	SMM-QA	VC-MFG	SJS-MFG	SP-Projects
1	Issue time of stock items for stores	8	NA	NA	NA	NA
2	Delivery of magnetics	6	NA	NA	NA	NA
3	Delivery of imported items	7	NA	NA	NA	6
4	Panel redness for customers inspections	NA	3	NA	NA	NA
5	Overall panel delivery	NA	NA	NA	NA	7
6	Time taken for order placement	7	NA	NA	NA	NA
7	Awareness on panel status in shop	NA	5	9	7	NA
8	Time taken for testing of panels in shop	8	NA	NA	NA	NA
9	Quality of panels received for testing	NA	3	8	6	NA
10	Quality of panels received at site	NA	3	NA	NA	9
11	Quality of tests carried out on panel	NA	3	NA	NA	8
12	Correctness of drawings received for mfg	6	3	8	6	8
13	Correctness of material issued by stores	7	4	NA	NA	NA
14	Do you feel mfg added value for end user	NA	5	8	8	9
15	Do you feel testing added value for end user	NA	5	NA	NA	9
	Average rating of respondant	7	3.7777778	8.25	6.75	8.33333333

Contnd....

Summery of Customer Satisfaction Survey to Assess Current State of Business Process (2008)

SR.NO		LSM-Projects	RP-Projects	RMK-Projects	MM-Sales	SPG-MFG	UKM-Projects
1	Issue time of stock items for stores	7	NA	NA	7	NA	NA
2	Delivery of magnetics	6	8	NA	NA	NA	NA
3	Delivery of imported items	3	4	NA	NA	NA	NA
4	Panel redness for customers inspections	8	8	NA	8	7	7
5	Overall panel delivery	7	10	NA	8	NA	5
6	Time taken for order placement	5	5	NA	7	NA	8
7	Awareness on panel status in shop	6	8	NA	6	NA	7
8	Time taken for testing of panels in shop	6	7	NA	8	9	7
9	Quality of panels received for testing	3	NA	NA	6	NA	7
10	Quality of panels received at site	6	10	5	8	NA	NA
11	Quality of tests carried out on panel	5	7	5	NA	NA	6
12	Correctness of drawings received for mfg	4	NA	5	7	9	6
13	Correctness of material issued by stores	6	10	NA	8	NA	8
14	Do you feel mfg added value for end user	8	10	5	8	NA	NA
15	Do you feel testing added value for end user	8	10	5	8	NA	NA
	Average rating of respondant	6	8.5	5	7.4545455	8.3333333	6.777777778

Contnd....

Summery of Customer Satisfaction Survey to Assess Current State of Business Process (2008)

SR.NO		AM-Projects	SSG-MFG	SMP-MFG
1	Issue time of stock items for stores	NA	6	6
2	Delivery of magnetics	NA	NA	NA
3	Delivery of imported items	NA	4	NA
4	Panel redness for customers inspections	8	8	5
5	Overall panel delivery	8	7	6
6	Time taken for order placement	5	5	5
7	Awareness on panel status in shop	9	8	4
8	Time taken for testing of panels in shop	9	9	NA
9	Quality of panels received for testing	NA	7	4
10	Quality of panels received at site	8	7	5
11	Quality of tests carried out on panel	7	7	NA
12	Correctness of drawings received for mfg	NA	7	3
13	Correctness of material issued by stores	NA	6	NA
14	Do you feel mfg added value for end user	9	5	5
15	Do you feel testing added value for end user	9	8	5
	Average rating of respondant	8	7	4.66666667

Summery of Customer Satisfaction Survey to Assess Current State of Business Process (2008)

SR.NO		Total RATING	Total Respond	Average Rating	
1	Issue time of stock items for stores	49	7	7	(lesser time, higher
2	Delivery of magnetics	35	5	7	(lesser time, higher
3	Delivery of imported items	39	7	5.571428571	(lesser time, higher
4	Panel redness for customers inspections	76	12	6.333333333	(100%completeness, higher rating)
5	Overall panel delivery	76	11	6.909090909	(On time, highest rating)
6	Time taken for order placement	66	11	6	(lesser time, higher
7	Awareness on panel status in shop	83	12	6.916666667	(No awareness, lowest rating)
8	Time taken for testing of panels in shop	91	12	7.583333333	(lesser time, higher
9	Quality of panels received for testing	55	10	5.5	(better quality, higher rating)
10	Quality of panels received at site	76	11	6.909090909	(better quality, higher rating)
11	Quality of tests carried out on panel	62	10	6.2	(better quality, higher rating)
12	Correctness of drawings received for mfg	85	14	6.071428571	(better quality, higher rating)
13	Correctness of material issued by stores	64	9	7.111111111	(better quality, higher rating)
14	Do you feel mfg added value for end user	91	13	7	(More value, higher rating)
15	Do you feel testing added value for end user	90	12	7.5	(More value, higher rating)
	Average rating of respondant				

ANNEXURE-VII

Summery of Customer Satisfaction Survey to Assess State of Business Process after Six Sigma Implementation Model (2010)

SR.NO		RATING(1-10)	PMC-Comm	SVS-Mfg	AK-Testing	KTP-Project
1	Issue time of stock items for stores			8		10
2	Delivery of magnetics			8		5
3	Delivery of imported items			8		7
4	Panel redness for customers inspections					
5	Overall panel delivery					
6	Time taken for order placement			7		6
7	Awareness on panel status in shop			8	10	10
8	Time taken for testing of panels in shop			9		
9	Quality of panels received for testing		6		7	
10	Quality of panels received at site		6			9
11	Quality of tests carried out on panel		5			
12	Correctness of drawings received for mfg		4	6	7	
13	Correctness of material issued by stores			8		9
14	Do you feel mfg added value for end user		5		9	10
15	Do you feel testing added value for end user		6	0	9	10
	Average rating of respondant		5.333333333	7.090909091	8.4	8.444444444

Summery of Customer Satisfaction Survey to Assess State of Business Process after Six Sigma Implementation Model (2010)

SR.NO		KRE-QA	PMD-Sales	LSM-Project	SKG-Projecs	PAM-Planning	AB-Projects
1	Issue time of stock items for stores		8	8	8	8	8
2	Delivery of magnetics	8	4	5	6	8	8
3	Delivery of imported items	9	4	4	5	9	7
4	Panel redness for customers inspections	7	8	6	7	8	7
5	Overall panel delivery	9	8	8	7	9	6
6	Time taken for order placement		4	7	7	8	7
7	Awareness on panel status in shop	8	6	9	9	8	8
8	Time taken for testing of panels in shop		8	8	8	9	8
9	Quality of panels received for testing	6	7	6	7	7	6
10	Quality of panels received at site	7		8	7	9	7
11	Quality of tests carried out on panel	6	6	6	6	9	6
12	Correctness of drawings received for mfg	5		6		7	7
13	Correctness of material issued by stores	9	8	8	7	9	7
14	Do you feel mfg added value for end user	7		8	7	8	8
15	Do you feel testing added value for end user	7	0	8	6	8	8
	Average rating of respondant	7.333333	5.9166667	7	6.928571429	8.266666667	7.2

Summery of Customer Satisfaction Survey to Assess State of Business Process after Six Sigma Implementation Model (2010)

SR.NO		PGT-Projects	SMM-Projects	SA-Projects	DS-Projects	VK-Quality
1	Issue time of stock items for stores	9	8	8	NA	NA
2	Delivery of magnetics	8	5	7	8	NA
3	Delivery of imported items	7	4	7	7	NA
4	Panel redness for customers inspections	8	8	6	8	3
5	Overall panel delivery	9	8	9	8	3
6	Time taken for order placement	8	3	7	7	NA
7	Awareness on panel status in shop	8	8	7	8	7
8	Time taken for testing of panels in shop	8	8	8	9	6
9	Quality of panels received for testing	7	8	5	NA	5
10	Quality of panels received at site	9	7	8	7	7
11	Quality of tests carried out on panel	9	7	8	9	6
12	Correctness of drawings received for mfg	7	8	7	9	5
13	Correctness of material issued by stores	9	8	9	9	6
14	Do you feel mfg added value for end user	8	8	7	8	7
15	Do you feel testing added value for end user	8	8	7	8	8
	Average rating of respondant	8.133333333	7.066666667	7.333333333	8.076923077	5.727272727

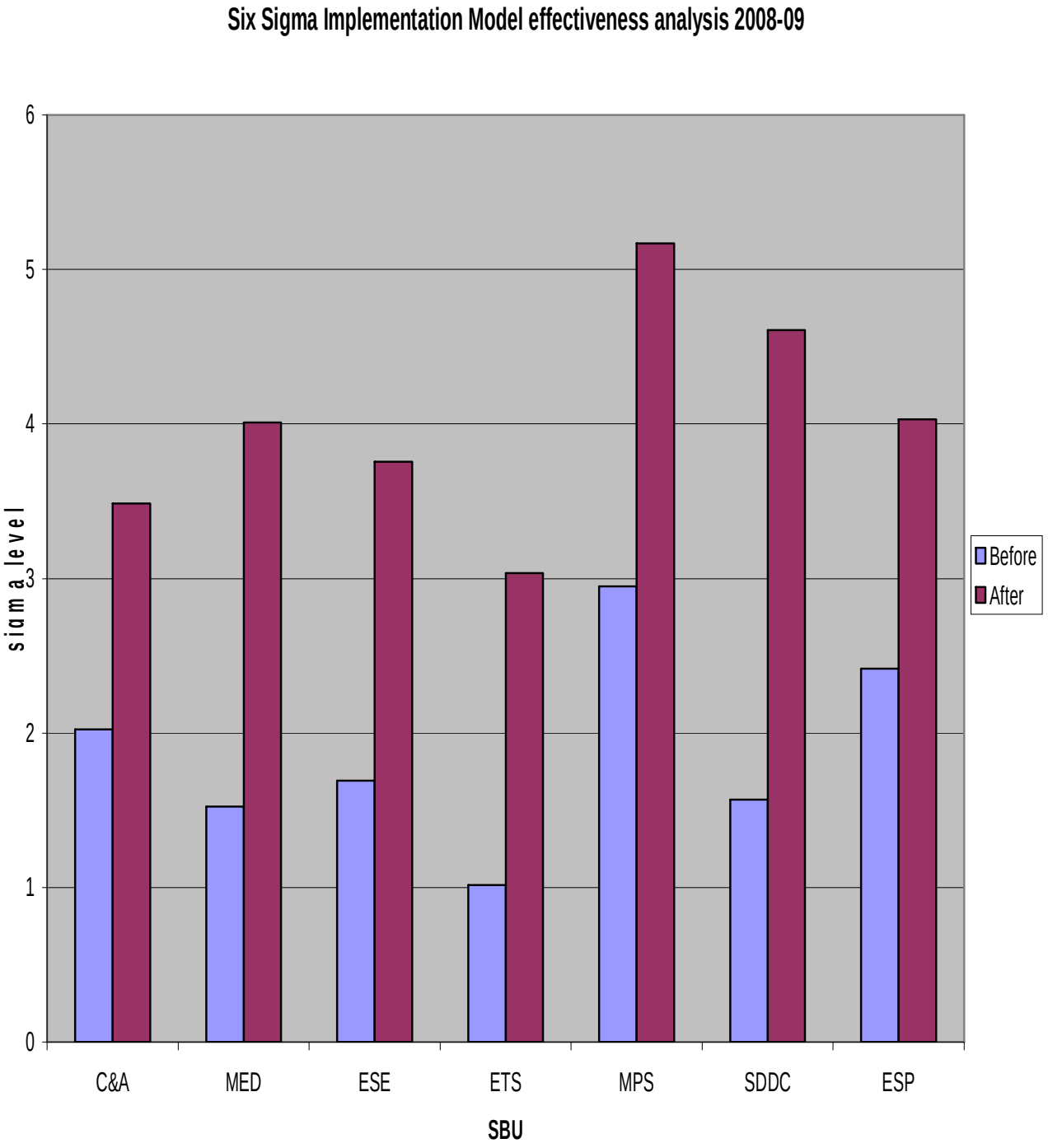
Summery of Customer Satisfaction Survey to Assess State of Business Process after Six Sigma Implementation Model (2010)

SR.NO		MMD-Purchase	RSR-Testing	SN-Testing
1	Issue time of stock items for stores	NA	NA	NA
2	Delivery of magnetics	NA	NA	NA
3	Delivery of imported items	NA	NA	NA
4	Panel redness for customers inspections	7	NA	NA
5	Overall panel delivery	8	NA	NA
6	Time taken for order placement	9	NA	NA
7	Awareness on panel status in shop	9	10	7
8	Time taken for testing of panels in shop	8	NA	NA
9	Quality of panels received for testing	7	9	NA
10	Quality of panels received at site	8	NA	6
11	Quality of tests carried out on panel	7	NA	NA
12	Correctness of drawings received for mfg	6	8	8
13	Correctness of material issued by stores	9	NA	NA
14	Do you feel mfg added value for end user	8	9	7
15	Do you feel testing added value for end user	8	9	8
	Average rating of respondant	7.833333333	9	7.2

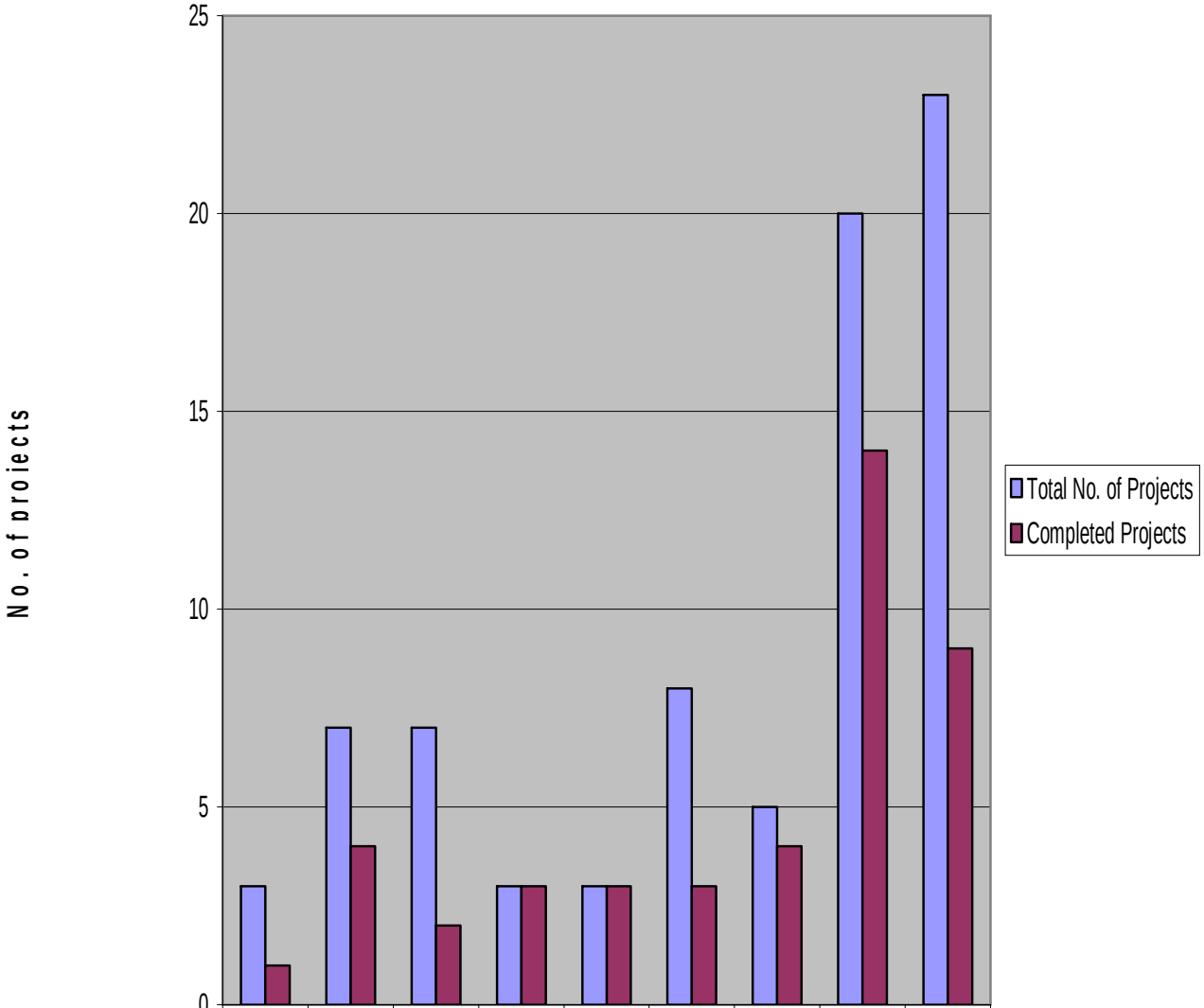
Summery of Customer Satisfaction Survey to Assess State of Business Process after Six Sigma Implementation Model (2010)

SR.NO		Total RATING	Total Respond	Average Rating	
1	Issue time of stock items for stores	83	10	8.3	(lesser time, higher
2	Delivery of magnetics	80	12	6.666666667	(lesser time, higher
3	Delivery of imported items	78	12	6.5	(lesser time, higher
4	Panel redness for customers inspections	83	12	6.916666667	(100%completeness, higher rating)
5	Overall panel delivery	92	12	7.666666667	(On time, highest rating)
6	Time taken for order placement	80	12	6.666666667	(lesser time, higher
7	Awareness on panel status in shop	140	17	8.235294118	(No awareness, lowest rating)
8	Time taken for testing of panels in shop	97	12	8.083333333	(lesser time, higher
9	Quality of panels received for testing	93	14	6.642857143	(better quality, higher rating)
10	Quality of panels received at site	105	14	7.5	(better quality, higher rating)
11	Quality of tests carried out on panel	90	13	6.923076923	(better quality, higher rating)
12	Correctness of drawings received for mfg	100	15	6.666666667	(better quality, higher rating)
13	Correctness of material issued by stores	115	14	8.214285714	(better quality, higher rating)
14	Do you feel mfg added value for end user	124	16	7.75	(More value, higher rating)
15	Do you feel testing added value for end user	126	18	7	(More value, higher rating)
	Average rating of respondant				

ANNEXURE-VIII



Control & Automation C&A Six Sigma Project Status



	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Total No. of Projects	3	7	7	3	3	8	5	20	23
Completed Projects	1	4	2	3	3	3	4	14	9

Year

BIBLIOGRAPHY

Eckes, George, The Six Sigma Revolution, How General Electric and others Tuned Process into Profit, *John Wiley & Sons,Inc,* 2001

Lulla Suresh, How L&T,Sterlite & TATA are trying to improve processes, *DNA, Mumbai, 30th March 2009*

Liker, Jeffrey K. The Toyota Way, *Tata McGraw-Hill*, 2004

Womack, James P. AND Daniel T. Jones, Lean Thinking; Banish Waste and Create Wealth in Your Corporation, *Simon & Schuster,2003*

Keki R. Bhote, Ultimate Six Sigma, *PHI India*, 2007

Mikel Harry, Richard Schroeder, Six Sigma- The Breakthrough Management Strategy, *Currency, New York*, 2005

George Byrne, Dave Lubowe, Amy Blitze, Driving Operational Innovation using Lean Six Sigma*, IBM Institute for Business Value, 2007*

Caulcutt, Roland(2001) 'Why is Six Sigma so successful?', *Journal of Applied Statistics, 28: 3, 301 — 306,2001*

Young Hoon Kwaka, Frank T. Anbari, 'Benefits, obstacles, and future of six sigma approach' *Elsevier Ltd.2004*

Young Hoon Kwaka, Frank T. Anbari, 'Success Factors in Managing Six Sigma Projects'
Project Management Institute Research Conference, London, UK, July 11-14, 2004

Reliance Industries Limited, *Annual Report, 2008-2009*

Ricardo Banuelas Coronado, Jiju Antony, 'Critical success factors for the successful implementation of six sigma projects in organisations', *The TQM Magazine, Volume 14, 2002*

Editorial Committee, 'Guidebook for Six Sigma Implementation with Real Time Applications', *Indian Statistical Institute, Bangalore, 2007*

Greg Brue, 'Six Sigma for Managers' *Tata McGraw- Hill, New Delhi, 2002*

www.cii-iq.in

www.imcnet.org

www.imcrbnqa.com