



## A study on implementation of six sigma process in industry

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### ABSTRACT

*This work is based on the study on Implementation of Six Sigma Process in Industry. 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, and 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 an 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 the implementation of these initiatives is successful only in a few organizations. 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 the effectiveness of Six Sigma in Indian Organizations. For this, a Six Sigma Implementation model exclusively developed for Indian Organizations considering the 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 the 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 the Implementation model in this research. In this research models developed are Indian organization and SIX SIGMA application, Implementation and Project and operation management through SIX SIGMA model. Validation of the model is done by comparing the internal customer satisfaction survey before and after implementing the model. Extensive*

*data is gathered for this and analyzed. A full study from the particular organization is taken to check Six Sigma model 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 the cycle time of the business process.*

**Keywords**— DAMIC, Kiezen, Kanban, Lean Manufacturing, Productivity, Six Sigma concepts, TQM

### 1. INTRODUCTION

All over the world, many companies are adopting Six Sigma methodology as process excellence tool. GE, Motorola, ABB, City Bank and Ford are few of them. Some Asian companies are also have been implemented Six Sigma. Toshiba, Honda, Sony, and Samsung are a 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 the world market to Indian organizations, which in turn forcing them to bring their products & services to a 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 & economic differences between India & western countries, a different implementation strategy is required for India. To evolve this strategy & model for implementation, a thorough study of Indian work & organizational environment in Indian industries is required.

Many organizations in India are also implementing Six Sigma to Improve Business Processes. But Geographical, Cultural & Work environmental differences influence this implementation process. An implementation strategy developed for Indian work environment will increase the effectiveness of Six Sigma in Indian Organizations. For this, a Six Sigma Implementation model exclusively developed for Indian Organizations considering the experiences of representative organizations is required. Through this study, we can say that effective Six Sigma model will lead every organization of India. 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 the organization.

Define → Identify → Design → Optimize → Verify

- Define**– Define what the customers want, or what they do not want.
- Identify**– Identify the customer and the project.
- Design**– Design a process that meets customers’ needs.
- Optimize**– Determine process capability and optimize the design.
- Verify**– Test, verify, and validate the design.



Fig 1: 6 Sigma

**2. PROBLEM DESCRIPTION**

In this 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 the final model.

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 used 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 organizations, the success of implementation depends on the 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.

**3. DATA COLLECTION**

The major source of data for this study is internal but a lot of external sources like a 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 outside the organization is called external data which can be obtained from the 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. The 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 the effectiveness of Six Sigma implementation.

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

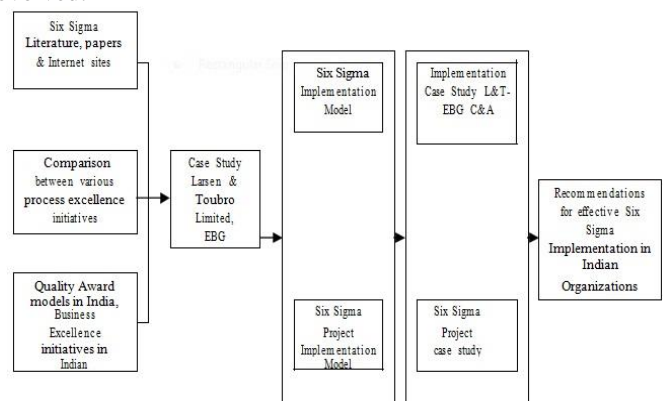


Fig. 2: Research method

#### 4. AN INTRODUCTION TO SIX SIGMA METHODOLOGY

In today’s competitive world, the customer wants perfection and there is no room for error. Delighting the customer and new ways to exceed their expectations is a 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 the 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.

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 the 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.”

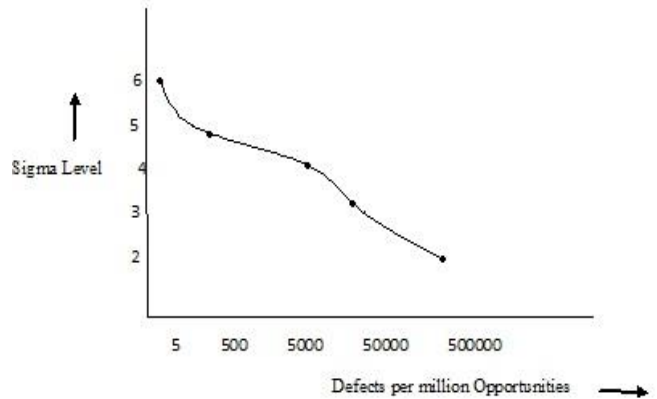
GE defines Six Sigma as a process “a highly disciplined process that helps us focus on developing and delivering near-perfect products and services. Why ‘Sigma’? The word is a statistical term that measures how far a given process deviates from perfection. The central idea behind Six Sigma is that it 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 for nonconformance, or not meeting the required specifications. This means we need to be flawless in executing our key process” Everyone is right, but each one 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.

**Table 1: Probability of defects of different sigma levels**

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

In short, Six Sigma is several things:

- A statistical basis of measurement: 3.4 defects per million opportunities
- A philosophy and a goal, as perfect as practically possible
- A methodology
- A symbol of quality



**Fig. 3: Graphical representation of probability of defects of different sigma levels**

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 an output which exceeds customer’s expectation.

**Customer:** Anyone Who Receives Product, Service, or Information.

**Opportunity:** Every Chance to Do Something either “Right” or “Wrong.”

**Successes vs. defects:**

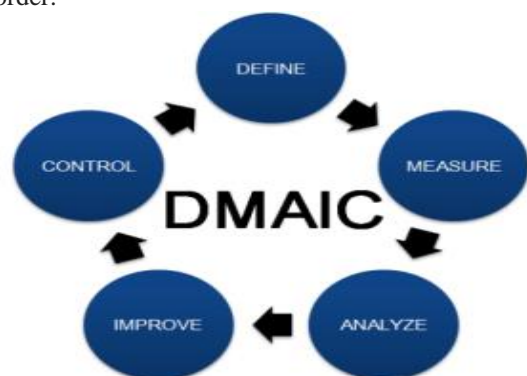
- Every Result of an Opportunity Either Meets the Customer Specification or it doesn’t.
- Employee creates results, so we have to involve all employees to achieve six sigma goals.
- All employees shall be trained in the strategy, statistical tools and techniques of Six Sigma quality.
- Quality is the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

**4.1 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.

**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) DMAIC is an abbreviation of the five improvement steps it comprises: Define, Measure, Analyze, Improve and Control. All of the DMAIC process steps are required and always proceed in the given order.



**Fig. 4: DMAIC methodology of Six Sigma**



## DMAIC vs. DFSS

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

**Measure:** Identifying key measures of effectiveness and efficiency and translating them into the concept of sigma. Measure phase detail Data collection plan is prepared.

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

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

**Control:** Ensuring that improvement sustains over time. The process is standardized in the control phase and procedures are documented.

### Lean Six Sigma DMAIC    Lean Six Sigma DFSS

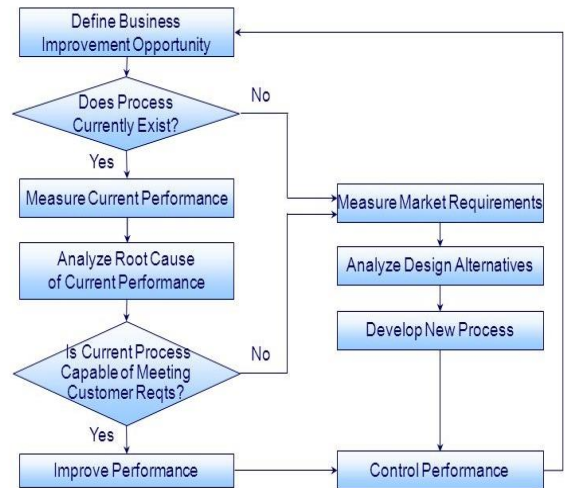


Fig. 5: DMAIC vs. DFSS

### 4.2 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.

### 4.3 The DMAIC project methodology has five phases

Define the system, the voice of the customer and their requirements, the project goals, specifically. Measure key aspects of the current process and collect relevant data. Analyze the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out the root cause of the defect under investigation. Improve or optimize the current process based upon data analysis using techniques such as the design of experiments, poka yoke or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish process capability. Control the future state process to ensure that any deviations from target are corrected before they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process. Some organizations add a Recognize step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology. DMADV or DFSS The DMADV project methodology, known as DFSS ("Design For Six Sigma"), features five phases: Define design goals that are consistent with customer demands and the enterprise strategy. Measure and identify CTQs (characteristics that are Critical to Quality), product capabilities, production process capability, and risks. Analyze to develop and design alternatives Design an improved alternative, best suited per analysis in the previous step Verify the design, set up pilot runs, implement the production process and hand it over to the process owner.

First off, DMADV and DFSS are essentially the same processes. DFSS stands for "Design for Six Sigma," and is just another name for DMADV. DMAIC is the more well-known and most-used Lean Six Sigma project methodology and is focused on improving an existing process, rather than creating a new product or process like DMADV.

Dollar benefits obtained from DMAIC can be quantified rather quickly, while the benefits from DFSS are more difficult to quantify and tend to be the much more long term. It can take six to twelve months after the launch of a 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.

### 4.4 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 ensures that at design level it self-product meets Six Sigma quality requirement.

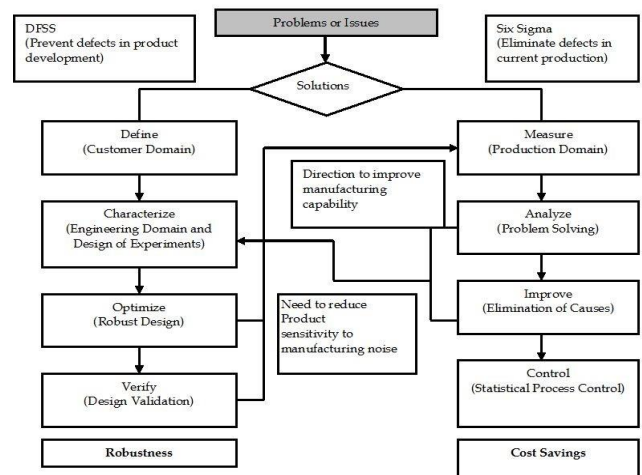


Fig. 6: Design for six sigma

#### 4.5 The LEAN approach of Process excellence

Taiichi Ohno, founder of Toyota Production System (TPS), said that “All we are doing is looking at the timeline 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. The 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 the customer. This very nature of Lean shows that we can extend it to manufacturing and service sector.

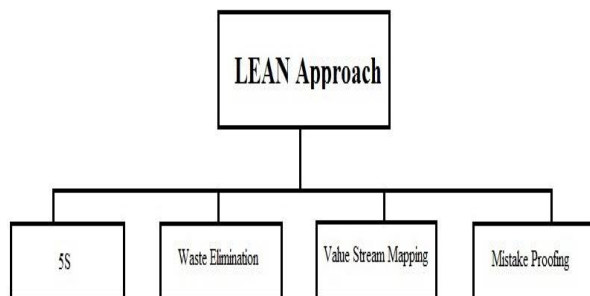


Fig. 7 : LEAN approach and Lean Tool

#### Lean tools:

- (i) 5S
- (ii) Waste Elimination
- (iii) Value stream mapping
- (iv) Poka-yoke ( Mistake proofing )

### 5. SIX SIGMA IMPLEMENTATION MODEL DEVELOPMENT AND APPLICATION

#### 5.1 An Approach context to Indian organizations

Six Sigma is a methodology that provides us with an insight into the products/process or in case necessary, to redesign these products/process. All these Products/ Processes are selected based on the issue in the result of increasing market penetration or improving organizational speed or reducing the 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 mistake, 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 the 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 the structure and formats of so-called Six Sigma implementation are getting precedence over the core essence of it. Also in India people protest any new initiatives initially unless properly and systematically convinced of them. This requires carefully developed Implementation model exclusively for Indian organization. A step by step approach is more effective than any other approach.

#### 5.1 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.

#### 5.2 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.

#### 5.3 Implementation plan development

Considering the 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

#### 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. The 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 a large number of operations

#### 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, a 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.

### 6. CONCLUSIONS AND FUTURE SCOPE

Previous chapters we have analyzed the implementation process for Six Sigma in Larsen & Toubro Limited, Mumbai. We have also evolved a model for Implementation of Six Sigma. Based on this study for Indian Organizations, a model for Six Sigma project implementation also developed

#### 6.1 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 the 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 an internal resource base is most important for any organization. The pool of Black and Green belts carry on Six Sigma revolution, in an organization after a consultant role is over.

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

### **6.1 Research contribution**

The summary of the major contribution of this study are listed as follows:

- The literature review compared the critical factors in six sigma implementation as viewed by different authors.
- Various Process excellence initiatives compared along with their history in the industry.
- Cultural aspects studied with reference to India. A representative organization is studied in detail for its employee's cultural and social aspects.
- The study also gives the importance of resource development, training & recognition for successful implementation of Six Sigma.
- The study also indicates that implementation will be more effective if commitment by senior management is present. The organization under study demonstrated this.

The sustenance of six sigma is possible only through the continuous evaluation process. This is proved by i) Line Managers rating ii) Operation manager rating in this study.

### **6.2 Limitation of research findings**

- 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 a broad sense it is applicable to all Indian organizations.
- As the 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.
- Six Sigma in India is only 10-12 years old and very few organizations have implemented it. Choosing more organizations for the larger study surely fine-tune the models.

### **6.3 The implication for future research**

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

### **6.4 Six Sigma implementation strategy for Indian organizations**

- Implementation strategy should be different in different sizes of the organization.
- The strategy should depend on the organization's existing culture and structure.
- The organization shall not try to import an alien culture just because we have to implement.

### **6.5 Six Sigma in our organization**

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:

- Readiness Assessment: As discussed in detail in earlier chapters, readiness assessment shall be done before starting the implementation process for Six Sigma.
- 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.
- Keep the 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 online and available on the intranet. The organization can usually get one from a qualified implementation partner (a consultant brought in to teach the Six Sigma methodology).

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