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Implementation Of Six Sigma Methodologies In Service Industry

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Our work was inspired from the interest generated from the field of Industrial management and its flexibility to apply in various fields. The subject of six sigma has always been an interesting concept for us and was one of the prime interests which motivated theoretically to understand the existing models and the problems they are used for, to find new opportunities in this fast and dynamic world.

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Abstract

At the present time, companies are faced with an increasingly competitive environment in which the satisfaction and loyalty of customers are crucial factors in the success of any organization. Most of the companies search for management methodologies to improve their products and services, perfecting their processes, decreasing their costs, improving the capital's profitability and customer satisfaction. These require the use of improvement methodologies, such as Six Sigma, which gives an opportunity to the companies to improve customer satisfaction and meet their expectations.

Six Sigma has been widely adopted in a variety of industries in the world and it has become one of the most important subjects of discussion in quality management. Six Sigma is a well-structured methodology that is used to find a root cause of quality problems and to reduce defects and process variability within the business processes using effective application of statistical tools and techniques. Also, it can support a company to achieve expected goals through continuous project improvement.

The Six Sigma process has two methodologies: DMAIC (Define, Measure, Analyze, Improve and Control) and DFSS (Design for Six Sigma). One of the most widely known and applied models of Six Sigma problem solving approach is the methodology of DMAIC. In this study, the phases of DMAIC are explained in detail. This paper presents a case study illustrating the effective use of Six Sigma to identify the Key performance indicators for implementing improvements about the problems faced in a call Centre.

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1. Introduction

In today's testing business world, the opposition has strengthened dramatically. Organizations are attempting to separate their items or administrations to acquire portions of the overall industry. A portion of the organizations are satisfied with their circumstance on the lookout; being endure is sufficient for them, however for some of them aren't. The present circumstance supports a few organizations to increment their benefit. One more explanation of needing to be greater is to make clients more joyful. Quality, cost, and time are three critical components for being more mentioned. Assuming that the assembling system of items and administrations are slowed down for organization, costs of them ought to be higher to take care of its expenses and thus the clients cannot manage these. In addition, the conveyance time is likewise imperative to sell the items or to offer types of assistance immediately. In conclusion, quality is a huge component for the clients, clients can zero in on the particular nature of an item or administrations, or how it separates rivals on the lookout. In the present changing and profoundly aggressive climate it is obligatory that the organizations improve persistently themselves for development and endurance. Nonstop improvement has been assuming a significant part in the quality world. Numerous definitions have been given and a few methods of reasoning have been created to consider for the start, advancement, execution, and the executives of ceaseless improvement. For hundreds of years, organizations have been attempting loads of strategies to get the best degree of value. The Six Sigma strategy is a quality way of thinking that is getting wide acclaim in the business. It has followed the TQM developments to work on quality, conveyance and

decrease costs. The Six Sigma technique is characterized by Lindemann et al. (2003) as a coordinated and orderly technique for vital cycle improvement and new item and administration advancement that depends on measurable strategies and the logical strategy to cause emotional decreases in clients to characterize deformity rates. Numerous associations have revealed huge advantages today because of Six Sigma executions. General Electric and Motorola which fostered this coordinated and efficient philosophy in 198Six are presumably two of the best organizations in carrying out Six Sigma projects. Throughout the long term, many organizations, like Allied Signal, 2 Citibank, Sony, Raytheon, and Delphi Automotive have likewise revealed extraordinary accomplishments from the Six Sigma drive (Schroeder, Linderman, Liedtke, Choo, 2007). Starting in 2014, it is broadly utilized in numerous areas of industry, despite the fact that its utilization isn't without contention. The Six Sigma strategy examination to further develop associations items, administrations and cycles by the method of ceaselessly diminishing imperfections and varieties in the association. It is a business procedure for understanding client prerequisites, business frameworks, usefulness and monetary execution. In fact, the Six Sigma technique implies a degree of imperfections under 3.4 deformities per million freedoms (DPMO) where sigma is the term which is used to show the interaction variety around its mean (Linderman, 2003). The Six Sigma has a profoundly organized technique for information assortment and treatment which was given by the method of utilizing fundamental quality devices, as, histogram, pareto chart, process stream graph and so forth and mix them with the board backing to a huge degree. Utilizing the assets proficiently, playing out the procedure of Six Sigma

thoroughly, characterizing and decreasing the fluctuation about items for normalization give the accomplishment of Six Sigma project. Besides, incorporation of senior administration and a chain of importance of laborers with the required preparation are required to achieve Six Sigma strategy. The Six Sigma technique has the capability of disposing of fluctuation from cycles and items by utilizing a persistent improvement philosophy (DMAIC) or a plan/upgrade approach which is otherwise called Design for Six Sigma (DFSS). These procedures follow the accompanying stages: Define (D), Measure (M), Analyze (A), Improve (I) and Control (C). In any case, DFSS utilizes the succession Define (D), Measure (M), Analyze (A), Design (D) and Verify (V), during configuration/overhaul projects. The organizations who are carrying out Six Sigma systems have upgraded their benefits in a critical way which keeps on rising. These constructive outcomes were caused to pick the Six Sigma techniques to compose this proposal. This review is one of the analysts that are about the systems of Six Sigma and the utilizations of Six Sigma in various ventures. The object is to give brief data about the Six Sigma and to give and dissect models about the use of Six Sigma in various businesses. 3 After this presentation part, the writing of Six Sigma participates in the subsequent area. Beginning from the historical backdrop of Six Sigma, successively definition and standards of Six Sigma, Six Sigma association design, advantages and prizes of Six Sigma, explores around Six Sigma, Six Sigma applications in worldwide organizations and in Turkey, basic investigation or revamping of discoveries occur in this part. In the third section, the procedures of Six Sigma participate. The procedures are characterized and every one of the periods of strategies analyzed. What's more, after

the assessment, the periods of DMAIC systems clarified with the model which is about enhancements of the Six Sigma in the inner strategic region. In the fourth section the applications have been put in request to set out in full Six Sigma approaches. There are four contextual investigations; Reduce Waste at Manufacturing Company, Ford Team Project Builds Relationships, Improves Quality, Using Six Sigma to Improve Complaints Handling, Delivering Record Products without Delays. After clarification of contextual investigations, the distinctions of the applications between clarified contextuals were not really settled and showed the reasons for these distinctions. What's more, the likenesses of utilizations between clarified contextual analyses additionally were characterized and explained what the aftereffect of these similitudes. The aftereffects of that were displayed by Tables. In the last section, the finish of the postulation partakes. The overall practices of the directors and the workers about the authoritative issues in Six Sigma applications were examined in this part. The impediment of Six Sigma technique was isolated 3 sections: Issues in system, Issues in authoritative culture and Issues in preparing. Moreover, eventual fate of Six Sigma was referenced in this postulation

2. Literature Review

In this part, Six Sigma is characterized as a technique for taking care of issues. Six Sigma objectives and measurements are examined with regards to this part. History of Six Sigma is to contact, and Six Sigma carried positive outcomes with models communicated.

2.1 Overview of Six sigma

Six Sigma is a focused, information driven methodology and strategy comprising devices and strategies to get freed of imperfections in any interaction from assembling to value-based and item to support. Six Sigma is a quality program that, regardless, further develops your clients experience, brings down your expenses, and constructs better pioneers. - Jack Welch. Jack Welch carried out Six Sigma as a focal business methodology and benefited $2.5 billion every year at General Electric and Motorola, Honeywell, ABB, Bombardier, Sony and so on from the enormous rundown. Coming to support associations this amazing methodology was embraced by large associations like JP Morgan, American Express, Lloyds TSB, City Bank, Egg, Zurich Financial Services, BT, and so on despite the fact that uses of Six Sigma are as yet restricted. In the majority of the associations, six sigma is a proportion of value for those who constantly put in endeavors to arrive at flawlessness. Six Sigma was first presented by Bill Smith while working as a senior specialist and researcher in correspondence division, as an answer for the issues of high guarantee claims at Motorola in 1986. This helped Motorola with accomplishing Six sigma quality level as well as, the emphasis was on diminishing

deformity rate in the process with assistance of amazing, down to earth and measurable devices and methods. This prompts better efficiency, consumer loyalty, better nature of administration, diminished the cost of tasks and expenses of low quality and so forth M Harry once is certified with the advancement of the Six sigma idea in the last part of the 1980s (Maguire, 1999). Motorola was respected with the Malcolm Baldrige Award in 1988. Motorola had spent $170 million on laborers schooling and preparing and saved $2.2 billion as far as expenses of low quality (Antony and Banuelas,2002). General Electric is the effective practitioner of the Six sigma tasks. According to the Chairman of the Board and CEO of GE (Jeffrey R. Immelt), “It has become a permanent initiative – Six sigma is the way we work”

2.2 History of Six Sigma

The underlying foundations of Six Sigma, estimation standard is on Carl Friedrich Gauss (1777-1855), which can be followed presented the idea of the ordinary bend. Six Sigma as an estimation standard in item class variety can return to 1920, when Walter Shewhart showed that three sigmas from the mean worth is where interaction requires remedy. Barney and McCarthy (2003) by Motorola University to decide the names in their book "The New Six Sigma"; "Large numbers of estimation principles (CPK, zero deformities, and so on) later came on the scene, however the credit for authoring the expression "Six Sigma" goes to Motorola engineer named Bill Smith. (As it turns out, the "Six Sigma" is a governmentally enrolled brand name Motorola)". Six Sigma is first upheld by Motorola in the mid 1990s, a business drive. Current Six Sigma examples of

overcoming adversity, particularly from any semblance of General Electric, Sony, Motorola and 5 AlliedSignal, the consideration of Wall Street have recorded and advanced the utilization of this business procedure (George, 2002). Motorola had laid down a good foundation for itself as the world innovator in the field of remote interchanges items in the mid 1970s. Soon after Japanese producers were contending in front of an audience in the intense economic situations. These hardships were outlined in 1973, when Motorola acknowledged, itself is not fit to contend. In 1979, a re-establishment and development organization started under the administration of CEO Bob Galvin. As per the VPs were clear, to clarify the circumstance: "Our quality smells." Work on the nature of the 10X goal was driven by chose pioneers in every specialty unit. In any case, it was distinctly on the creation work isn't not difficult to Figure out the fundamental wellsprings of issues. In view of a story written in the organization Motorola University, Motorola Manufacturing Establishment was established in 1984 (MMI) and started to organize instructive projects. Fast fulfillment of top administration, "Plan for Manufacturability" (DFM) and "Six Steps to Six " an educational program that was utilized for all specialized staff throughout the planet. Another Motorola Engineer Craig Fullerton created and instructed "Six Sigma Design Methodology" (SSDM - Today as Design for Six Sigma and DFSS from many different organizations). Motorola’s chiefs put out a more forceful objective of 10X to 100X improvement after Six Sigma's achievement. A one-day course called "Understanding Six Sigma" was then evolved around the world for all non-specialized faculty and Six Sigma began to use it on everything from estimating preparing deformities to monetary

viability at Motorola (Breyfogle, 1999). The endeavors prompted Motorola getting the main Malcolm Baldrige National Quality Award in 1988. Motorola endeavored to accomplish Six Sigma in all that they did in 1990, however it appeared to be stuck at 5.4 sigma (Barney and McCarty, 2003). Six Sigma has advanced over the long haul. It's something other than a quality framework, like TQM or ISO. Six Sigma is a method of working together.

2.2.1 Some Six Sigma Success Stories

“Six Sigma has forever changed GE. Everyone- from the Six Sigma zealots emerging from their Black Belt tours to the engineers, the auditors, and the scientists, to the senior leadership that will take this Company into the new millennium-is a true believer in Six Sigma, the way this Company now works.”- GE Chairman John F. Welch. At General Electric, passion and drive for Six Sigma have achieved some very positive results. From the first year accelerated payback: $ 750 million by the end 1998, an estimated $ 1.5 billion by the end of 1999. The financial "big picture", but this is just a reflection of the numerous individual successes GE has achieved as part of its initiative Six Sigma. Some of the 1998 annual report of GE's shareholders based on the bottom.

• Team Six Sigma at GE lighting fixture repair problems in its accounts as one of its top client Wal-Mart cutting errors invoices and disputes by 98 percent, faster payments and increased productivity for both companies.

・GE Medical Systems design methods used Six Sigma to create a breakthrough in medical technology scanning. Now patients can have a full body scan in half a minute to increase in comparison with their use of devices and reduce the cost per scan.

· A group of employees of the lawyer through Six Sigma team leaders in a service business GE Capital led a simplified contract review, which led to more rapid completion of the proposals, in other words, the service response customers and annual savings of $ 1 million (Pande, 2000).

・GE reported an improvement in capacity of 12% -18% increase in operating margin to 16.7%, and 750 million in savings.

・Since July 1996, GE Plastics Singapore team, has decreased discoloration of plastic articles. The team has raised the quality of two sigma to 4.9 sigma at four months $ 400,000 per year at the plant.

・GE Plastics Singapore team, starting in July 1996, reduced color variation in plastic products. The team raised quality from two Sigma to 4,9 Sigma over four months at $400.000 a year for one plant.

· The first-year deployment of Six Sigma scored a GE Plastics benefit of $ 20 million. It's very impressive in 1996, as the first year of training costs are much higher than a year's costs (Keller, 2001).

AlliedSignal / Honeywell began its activities to improve the quality improvement measures in the early 1990s to 1999 and saved more than $ 600 million a year, thanks to

the wide staff training and the application of the principles of Six Sigma. The company says Six Sigma increased 6 percent performance in 1998 and with its record profits by 13 percent. Because Six Sigma efforts began in the fiscal year scopy market value of the company has risen 27 percent per year in 1998 (Pande, 2000).

George (2002) had an article in USA Today (1998) about the difference of opinion about the value of Six Sigma in "Firms Air for Six Sigma Efficiency" in his book. Some of the quotes from the article as follows:

· "Six Sigma is expensive to implement. That's why it has been a large company trend. About 30 companies have embraced Six Sigma including Bombardier, ABB (Asea Brown Boveri) and Lockheed Martin."

· "Raytheon Figures it spends 25% of each sales dollar fixing problems when it operates at four sigma, a lower level of efficiency. But if it raises its quality and efficiency to Six Sigma, it will reduce spending on fixes to 1%."

· "Lockheed Martin used to spend an average of 200 work-hours trying to get a part that covers the landing gear to fit. For years, employees had brainstorming sessions, which resulted in seemingly logical solutions. None worked. The statistical discipline of Six Sigma discovered a part that deviated by one thousandth of an inch. The company saves $14.000 a jet after correction."

· "Lockheed Martin took a stab at Six Sigma in the early 1990s, but the attempt so foundered that it now calls its trainees "program managers." Instead of black belts to

prevent in-house jokes of skepticism...Six Sigma is a success this time around. The company has saved $64 million with its first 40 projects".

Keller (2001) has given the following list of companies for Six Sigma; IBM, Bombardier, Asea Brown Boveri, DuPont, Kodak, Boeing, Compaq and Texas Instruments. As with GE, Motorola and Allied Signal, further examples of implementations-based services include GMAC Mortgage, Citibank, JP Morgan and Cendant Mortgage.

2.3 What is Six Sigma?

There are many different opinions about what Six Sigma is. The most famous description for the matter concerned is that Six Sigma is one of the engineers and statisticians used to fine-tune 8 the quality of products or processes, technical processes. Statistics and measures are important components of the methodology Six Sigma.

Furthermore, Pyzdek (1999) describes Six Sigma as Quality Digest and declares " Six Sigma is such a drastic extension of the old idea of statistical control as to be an entirely different subject." Other descriptions are about its goal of near perfection in meeting customer requirements based on the assumptions.

Six Sigma is a statistically derived performance target of operating with only 3.4 defects per million opportunities or activities suppressed. Motorola, which is one of the leaders of the world, is still trying to achieve this goal. At the same time, another explanation for its striking effect cultural change can take place.

Six Sigma is a company's commitment at firms such as Motorola or General Electric. Therefore, cultural change at issue is absolutely a valid way to describe Six Sigma. All these perspectives can be collected in one description for Six Sigma. Pande, Neumann & Cavanagh (2000) defined Six Sigma as "a comprehensive and flexible system for achieving, sustaining and maximizing business success".

Six Sigma is uniquely due to the understanding of the needs of customers in a detailed manner, disciplined use of facts, data, statistical analysis, management, improvement and rethinking business processes in detail, and careful manner. Mikel J. Harry, one of the developers of Six Sigma at Motorola, has calculated that the average company is considered suitable to the level of 4-sigma in the western world business culture, while the 6 Sigma is not uncommon in Japan (Harry, 2000). Harrold (1999) compares sigma level in accordance with the industry and the type of treatment:

• Internal Revenue Service (IRS) phone-in tax advice – 2.2 σ

· Restaurant bills, doctor's prescription writing, and payroll processing – 2.9 σ

• Average company – 3.0 σ • Airline baggage handling – 3.2 σ

· Best in the class companies – 5.7 σ

• U.S. Navy aircraft accidents – 5.7 σ

• Airline industry fatality rate – 6.2 σ

Sigma is a universal scale. This is a scale such as a balance measurement ounce or measuring temperature thermometer. Universal scales such as temperature, weight and

length allow us to compare very dissimilar objects. The scale of the sigma makes it possible to compare completely different business processes in terms of the ability of the process to stay within the quality limits established for the process in question as well. Six Sigma is not just an "improvement methodology". It is

· To achieve a permanent control system of corporate governance and creating maximum performance for business and its customers, employees and shareholder's benefit.

· A measure of the ability of each process definition.

· A target for improvement, which reaches about perfection (George, 2002). Pyzdek (2003) defined the system using its tools and effects, "Six Sigma is a rigorous, focused and highly effective implementation of proven quality principles and techniques. Incorporating elements from the work of many quality pioneers, Six Sigma aims for virtually error free business performance. "

2.4 Principles of six sigma

Six Sigma is a systematic, data-driven approach with define, measure, analyze, improve and control process (DMAIC) (Kwak, & Anbari, 2006) and makes the following principles:

2.4.1 Increasing customer satisfaction

Customers are the priority of Six Sigma. Therefore, Six Sigma begins to review the performance of customer satisfaction. The success of Six Sigma has an impact on customer satisfaction and ratings.

Customer satisfaction is defined as a customer's overall evaluation of the performance of an offering to date (Gustafsson, Johnson, & Roos, 2005). The empirical results indicate a significant relationship between customer satisfaction and cost-effectiveness but less is known about how the satisfaction of companies' customers translates into securities pricing and investment returns, and virtually nothing is known about the associated risks (Fornell, Mithas, Morgenson III, & Krishnan, 2006).

Today the necessary steps to ensure and improve customer satisfaction can be ordered as follows:

· Identification of the products and services which are provided by any person or department. · Identification of clients for each product and services · Identification required to meet customer needs.

· Identification of processes.

· Frame of processes.

· Providing continuous improvement by measuring, analyzing and controlling improved processes. On the way to success, increasing customer satisfaction is one of the principles of Six Sigma, because Six Sigma is a guide to success.

2.4.2 Data- Based Management

In recent years, despite the importance of the data, the measurement process, information management, information technology and so on, most of the business decisions are still based on the ideas and assumptions. The data-based approach to make decisions consistent with the objectives of applied behavior analysis (Pfadt, & Wheeler, 1995).

The first step is the application of Six Sigma is necessary to define indicators to measure key business performance.

Later, these criteria are applied to understand the critical variables and optimize results. Six Sigma helps managers to answer two questions for basic support-based solutions and solutions of data:

- The data / information, how can I use it to the best advantage?
- What is the data / information that is necessary?

2.4.3 Process-Oriented

Six Sigma is a methodology of innovation management to produce virtually all products, which are defect free, based on the process data. Activities for Six Sigma are not limited to process level or less to reduce the work at all levels of the company and produce high quality products.

Activities for Six Sigma are not limited to process level but extended to all levels of the company to produce high quality products and reduce cost (Han, & Lee, 2002).

To perform a successful process:

- Goals should be clearly defined.
- It must be clear what the problem is.
- Key processes of the organization must be clearly defined, classified and mapped.
- Improving the skills to be developed in the organization.
- Improvements should be able to continue in the organization.
- Calculability should be in the organization.

2.4.4 Limitless Operations

This expression is one of the words of John Welch, who is a Six Sigma guru of boundless business success. Cooperation with other companies with significant opportunities with their suppliers and customers or employees.

Large amounts of time, waste of money and effort caused by disconnection or competition between groups, the need to work to add value for customers together.

Six Sigma provides real needs and processes to enhance the value of the client to determine. And it helps to understand where the employee is in this formation.

2.4.5 Target to perfect and tolerate to failure

It's not just for perfection without risks. If employees are afraid to take risks, or they are afraid of the results of their efforts, the required improvement cannot be provided. Therefore, the mentality should be communicated to employees and the requirements established for the quality of "Do not fear the results of their own efforts."

Six Sigma has risk management. Therefore, purposes may lead to failure of success, but that risk management should always be in the business strategy to perfection.

2.5 Six sigma Organization structure

Six Sigma has its own organizational structure, which consists of a belt system. Each belt has a job description based on education. Generally, this organizational structure is a yellow belt, green belt, master black belt and champion belt. Furthermore, there is hierarchical coordination with each other.

I. Yellow belt

• He is a part-time team member.

• Provides supporting roles.

• Helps in data collection, validation, monitoring and effectiveness.

• Basic understanding of analytical tools.

II. Green belt

• Part time team member.

• Drives fewer complex projects.

• Understand basic working knowledge for the Lean 6 Sigma project.

• Works under the guidance of black belt, trained to analyze & solve quality problems.

III. Black belt

• Generally full-time person for lean 6 Sigma projects and drives complex projects.

• Train and educate green/yellow belts, understanding team dynamics and assigning responsibilities to the team members

. • Communicate with the champion.

IV. Master black belt

• Assistant and advisor to champions

• Support black belts • Monitors and removes bottlenecks

• Spread expertise about lean 6 Sigma in the organization.

V. Champion

• Leader of the organization

• Sponsor of the projects

• Promotes and supports projects with resources.

• Take decisions on bottlenecks.

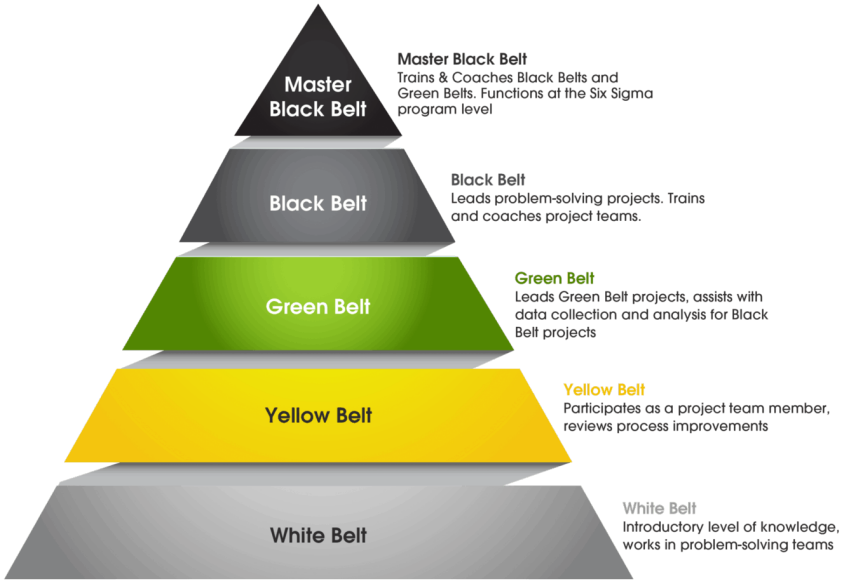

Figure 1: Six Sigma belt Organization Structure

2.6 Six sigma Logic

The term sigma is a measure indicating the deviation in the performance characteristic of a service from its mean performance. The basic goal of a six-sigma strategy is to reduce variation within the tolerance or specification limits of a service performance characteristic. In order to improve the quality of a typical service, it is imperative to measure or quantify variation and then develop potential strategies to reduce variation. Assume a process where the output, say, the time taken to process an insurance claim

(Y), is desired to be not more than a specification limit (SLupper) or upper specification limit. If the distance between process means and the SLipper is about six standard deviations, the process is said to then achieve a “six sigma " quality level. If the process drift factor is taken into account due to various sources of external uncontrollable influences (fluctuations of emotional conditions of staff members) over a period of time, then the defect rate is about 3.4 parts per million. In essence, six sigma quality level relates to 3.4 defects per million opportunities (DPMO). The primary means to achieving six sigma quality level is to eliminate the causes of quality or process related problems before they are transformed into defects. The focus of “six sigma" is not on counting the defects in processes, but the number of opportunities within a process that could result in defects. For instance, consider a call or contact center and for any given call from a customer to the contact center, the following opportunities might lead to defects, which ultimately causes customer dissatisfaction and hence lost customers:

- the manner in which the customer is greeted by the customer service agent or customer service representative.
- the accuracy of information provided by the agent to the customer; the queuing time before the customer gets hold of an available agent.
- the number of rings before an agent responds to the call
- the accuracy of the data entry of customer identity to retrieve past data; the listening, speaking and interpretive skills of the agent.
- the accuracy of data entry if a fault or problem has been reported by the customer; the time taken to restore the service if a fault has been reported.

- the manner in which the call is ended, and the timely arrival of any requested follow-up material, etc.

The objective of a six-sigma strategy in the above case is to understand the process within the call center which creates the defects and devise process improvement methods to reduce the occurrence of such defects which improve the overall customer experience. The focus must be on four issues:

- What is the nature of the defects which are occurring in the process?
- Why are such defects occurring and at what frequency?
- What is the impact of defects on customers?
- How can these defects be measured and what strategies should be implemented to prevent the occurrence of such defects?

2.7 Why is six sigma required in the service industry?

Research has shown that most of the service processes like payroll processing, billing, invoicing, shipping, order entry, response to service requests, baggage handling, etc. are performing at less than 3.5 sigma quality level with a defect rate of over 23,000 ppm or yield 97.7 per cent (Yilmaz and Chatterjee, 2000). If we improve the sigma quality level of any of the above-mentioned service processes to four sigma quality level, the defect rate will be dropped significantly to 6,210 ppm. This clearly indicates a 3.5-fold improvement in process performance. The process yield will be increased to 99.38 per cent. This would bring significant financial returns to the bottom-line of any organizations (due to reduced defect rate, reduced number of customer complaints,

improved customer satisfaction, etc.) engaged in powerful business process improvement methodologies such as six sigma.

Many service-oriented companies still conform to the notion that six sigma is confined just to manufacturing companies. The best way to convince a service-oriented company to initiate, develop and implement a six sigma strategy is through the three rudimentary principles of statistical thinking advocated by Hoerl and Snee (2002). These are:

(1) all work occurs in a system of interconnected processes;

(2) all processes exhibit variability; and

(3) all processes create data that explains variability and it is our responsibility to understand the sources of variability and devise effective strategies to reduce or eliminate variability.

Service-oriented companies adopting six sigma will have the following benefits:

- Effective management decisions due to heavy reliance on data and facts instead of gut-feelings and hunches. Hence costs associated with fire-fighting and misdirected problem-solving efforts with no structured or disciplined methodology could be significantly reduced.
- Increased understanding of customer needs and expectations, especially the critical-to-quality service performance characteristics which will have the greatest impact on customer satisfaction and loyalty.

- Efficient and reliable internal operations, leading to greater market share and satisfied shareholders. BPMJ 12,2 236 Downloaded by HERIOT WATT UNIVERSITY At 14:23 11 December 2015 (PT).
- Improved knowledge across the organization on various tools and techniques for problem solving, leading to greater job satisfaction for employees.
- Reduced number of non-value-added operations through systematic elimination, leading to faster delivery of service.
- Reduced variability in service performance, leading to more predictable and consistent level of service.
- Transformation of organizational culture from being reactive to proactive thinking or mindset.
- Improved cross-functional teamwork across the entire organization.

3. Methodologies of Six Sigma

Six Sigma uses two different types of methodologies, DMAIC and DMADV which aim to analyze complementary aspects of business processes. Differences between these methodologies are aimed at reaching different business sectors concurrently but focusing them differently. In spite of a single difference, they match up with each other during the analyzing processes and aim at the same goal which is improvement of business processes. Both of these methodologies have their own guidelines and goals which are targeted at improving business processes by way of using data collection and statistical tools. Although the methodologies are targeted the same thing, there are significant differences between them which should be regarded by professionals in business environments (Mast, Lokkerbol,2012).

3.1 DMAIC Model

The DMAIC Model is one of the most important development models for the Six Sigma approach which is the most feasible to the production part of a product or services.

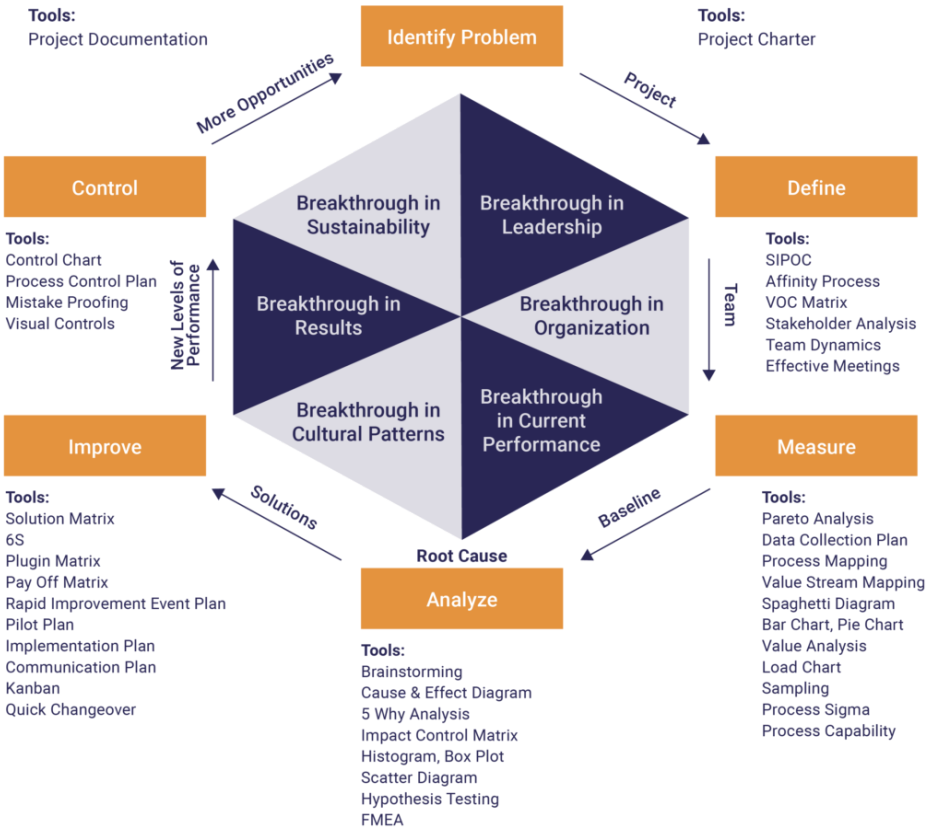

Figure 2: DMAIC Model

This methodology consists of following five steps:

Define the problem and customer requirements

Measure process performance and defects

Analyze the data collected and process map to determine root causes of defects and opportunities for improvement

Improve the process by designing creative solutions to fix and prevent problems.

Control the improvements to keep the processes on the new course (Lin, Chen, Wan, Chen, Kuriger, 2013).

Phase	Description
Define	Identify, evaluate and select projects; prepare the mission; and select and launch the team
Measure	Measure the size of the problem, document the process, identify key customer requirements, determine key product characteristics and process parameters, document potential failure modes and effects; theorize on the cause or determinants of performance
Analyze	Plan for data collection; analyze the data and establish and confirm the 'Vital few' determinants of performance
Improve	Design and carry out experiments to determine the mathematical cause effect relationships and optimize the process
Control	Design controls: make improvements, implement and monitor

Table 1: DMAIC Methodology (Chua 2001)

Six Sigma steps	Key processes
Define	Define the requirement and expectations of the customer Define the project boundaries Define the process by mapping the business flow
Measure	Measure the process to satisfy customer's needs, develop a data collection plan Collect and compare data to determine issues and shortfalls
Analyze	Analyze the cause of defects and sources of variation, Determine the variations in the process Prioritize opportunities for future improvement
Improve	Analyze the cause of defects and sources of variation, Determine the variations in the process Prioritize opportunities for future improvement
Control	Design controls: make improvements, implement and monitor

Table 2: Key Steps of Six Sigma Using DMAIC Process(McClusky, 2000)

Steps of the DMAIC Model are explained below

3.1.1 Define Phase (D)

The objective of the Define phase of DMAIC is to define the opportunities of the project and to confirm or validate that it represents potential improvement. It is requested that a project be important to both the business and customers which means voice of customer (VOC). Who works in the process (stakeholders) and process' downstream customers need to agree on the potential suitability of the project (Montgomery, Woodall, 2008).

A project charter is one of the first items which should be completed in the defined phase. This is typically about up to two or three pages which consist of description of project, project's scope, project's deadline, preliminary description of primary and secondary metrics which will be used to evaluate success and regulate business unit, aims of corporate, the potential benefits of customer, the potential financial benefits of organization, milestones which should be complete successfully in the project, the team members and their roles and any useful additional resources to complete the project.

Normally in developing project charter the project sponsors play a remarkable role and they can use draft charter which basically consist of organization structure of the team and to assign responsibility to team members. It provides complete projects unerringly.

Generally, a project charter should be able to be completed in 2- 4 working days by team but if it takes longer time; the project scope may be more detailed. In addition, a

project charter should consist of identifying the customer's critical-to-quality characteristics (CTQs) that are impacted by the project. In the defined phase, graphics are also useful to catch the details about the project. The most common ones used involve flowcharts and process maps, value stream maps and SIPOC diagrams which stand for Supplier/ Input/ Process/ Output/ Customer. Whereby these tools, what needs to be changed or improved in the process are much more visual and understanding details are more effortless. Especially in the nonmanufacturing environments are taken into account these diagrams such as banks, financial institutions, accounting firms, e-commerce, hospitals, governmental agencies and service organizations, where the opinions of a process, system and thinking process are misunderstanding.

An action plan to proceed with other DMAIC phases will be needed to prepare by the team. This will consist of individual work assignments and temporal deadlines. Other significant

matters being attention to the measure phase, as it will be performed next. Finally, the team also should focus on the following to prepare tollgate review of define phase: (Montgomery, Woodall, 2008)

- Are the symptoms at the center of the problem statement? On the other hand, does the problem statement focus not on possible causes or solutions?

・Are all the key stakeholders identified?

・Does the potential financial effect positively impact the project?

・Has the scope of the project been affirmed to make sure that it is neither too small nor too large?

・Has the team completed a high-level process map?

・Have any obvious obstacles which are prevented to complete the project been ignored?

・Is the action plan of the team for measuring phase of DMAIC admissible?

3.1.2 Measure Phase (M)

The objective of the Measure phase of DMAIC is to apprise and comprehend process state. This phase consists of collecting data on measures of quality, cost and throughput/cycle time. In this phase, developing a list of all of the key process input variables (KPIV) and the key process output variables (KPOV) are important tasks. On the other hand, the KPIV and KPOV may have been determined transiently at least during the defined phase of DMAIC. Nevertheless, identifying and measuring KPIV and KPOV also should be so important in the measurement phase. Significant factors may be spending time performing various work activities and waiting for additional processing. Deciding and collecting what and how much data, which should be useful data to make possible a thorough analysis and understanding of current process performance to adapt to the key metrics, are important tasks in this phase. During the measure phase, collecting data may be made widely known in lots of ways such as stem-and-leaf

diagrams, scatter diagrams, histograms, run charts and Pareto charts. Data could be collected by reaching historical records, but this way sometimes may be unsatisfactory because of incomplete history or the methods of record keeping. The methods of record keeping can have changed day by day. In addition, the desired information is set at naught in many cases. Briefly, it is mostly necessary to collect current data by way of observational study or it may be done by sampling from the relevant data streams. In the system, using sampling methods may come easier and more useful to many workers. In a specific organization such as transactional/ service businesses, it may be necessary to develop a convenient measurement and measurement system to record the information. This is the main difference between service and manufacturing systems. In manufacturing, the methods of measurement and system performance's data are usually already found, whereas the background information is often clearer in manufacturing than in services. The data collected are used as the basis for determining the current state or basic process performance. Moreover, the capability of the measurement system must be evaluated because the team should know that they are trying to solve a real problem in which the performance of the process is fine, but the system of measurement is chapped. Additionally, the team needs exact data to solve the problem currently. A formal gauge capability study may be used to make measurement system analysis, in other words a designed experiment may be used to quantify the accuracy and variation of the measurement process (Montgomery, Woodall, 2008).

The process cycle time also can be divided into value-added and non-value-added activities. It is more useful to evaluate an estimate of process cycle time efficiency were

$$Process\ Cycle\ Efficiency = Value - Add\ Time\ /Process\ Cycle\ Time$$

The amount of time actually spent in the process to transform the form, fit, or function of a product or service is termed the value-added time. The result of the value-added time activities, the stuff which the customer is willing to pay for, occurred.

A direct measure of how efficiently the process is converting the completed products or services is termed process cycle efficiency. Process cycle time is also related to the amount of work which is in-process through Little's Law:

$$Process\ Cycle\ Time = Work - in - Proces\ /Average\ Completion\ Rate$$

The average completion rate means that the output of the process over a defined time period, which also is a measure of the capacity.

At the final step of the measure phase, if necessary, the project charter should be updated by the team. Updating means reevaluating the project goals and scope and reexamining the structure of the team. Moreover, the members of downstream or upstream business units may be expanded by the team, if activities of measure phase show that these individuals will be useful in following DMAIC phases. All of the issues and concerns which impact the success of a project should be 28 documented and shared with the project owner or sponsor. On the other hand, the team may be making immediate recommendations to improve the process, such as elimination of

non-value-added activities or removing an unwanted variability source (Montgomery, Woodall, 2008).

3.1.3 Analyze Phase (A)

The objective of the Analyze phase of DMAIC is to use the data from the Measure phase to start to designate the cause-and-effect relationships in the process and to comprehend the different sources of variability. In addition, the objective of this phase is to establish the potential causes of the defects, quality problems, cycle time and throughput problems, customer issues or waste and inefficiency which motivated the project. Separating the source of variability into common and assignable causes is also an important task in the Analyze phase. Process is changed to remove a common cause of variability during removing assignable cause which often includes eliminating a specific problem. Insufficient training of personnel processing insurance claims is a common cause of variability; concurrently a tool failure on a machine is an assignable cause (Montgomery, Woodall, 2008). Historical data or the data collected in the Measure phase are used by the Analyze phase tools.

These data are usually very important in providing tips about potential causes of the problems which the process is experiencing. Progressions and actually defined specific improvements are the result of these clues.

In most cases, tips to the factors affecting performance are already available from define and measure phase. The team may be demonstrating the problem though isolating to one group and that group is using older equipment. Either they may have analyzed the process map and they have revealed some fairly apparent sources of inefficiency and retardation in the process. Anyway, depending on these two reasons it is insufficient to say that is the cause of the problem. One of the reasons, uncertainties and hypotheses should be confirmed with information in all phases of DMAIC. It is not just enough that the team affirm these factors are present; the team also must confirm that changes in these factors largely impact the outcome. The other objective of the Analyze phase is to identify root causes, which has to be deeper. There are some techniques to determine potential root causes. One of them is brainstorming, which is used between team members. While brainstorming, all of the team members prepare a large list of factors which could reasonably affect performance. This list consists of any factors that were revealed in the measure phase. Another popular technique is the 5 Whys. This technique includes repeatedly asking “why?” until it no longer makes sense to do so.

In most cases, the aim of the Analyze phase is to find out and comprehend tentative relationships between process variables and developing insight about potential process improvements. A list of specific root causes and opportunities should be prepared because these are worked up for action in the Improve phase where strategy of improvement will be enhanced and tested.

Statistical tools are also potentially useful in the Analyze phase. Some of the statistical tools are graphical data displays, control charts, hypothesis testing and confidence interval estimation, regression analysis, designed experiments, failure modes and effects analysis. Another powerful tool is discrete event digital simulation in the Analyze phase. Although use of it is not contained to those types of operations, it could be particularly used in service or transactional business. In factories, many successful applications of discrete event simulation in studying scheduling problems are used to improve cycle time and throughput performance. In this simulation model, a computer model is used to simulate a process in an organization. For example, what happens when a home mortgage loan application enters a bank could be simulated by a computer model. In this example, a discrete event is each loan application. The random variables are arrival rates, processing times and application's route by way of the bank's process. The specific substantiation of these random variables impress applications which accumulate at the different steps of the process. Other random variables can be identified to formalize the effect of incomplete applications, defective information, different types of defects and errors, delays in procurement information from outside sources, like as histories of credit. By using the simulation model for loans, it can be easier to make reliable estimates of cycle time, throughput, and other quantities of interest (Montgomery, Woodall, 2008).

While the team is preparing tollgate review of Analyze phase, they should be focused on following issues and potential questions:

- Which opportunities will be targeted for research in the Improve phase
- What data and analysis promotes that researching the targeted opportunities and improving or eliminating them will have the requested outcome on the KPOVs and customer CTQs which were the main focus of the project?
- Are there other opportunities which will not be further evaluated?
- Is the project still going well with being careful of time and expected outcomes? Are there any additional resources required?

3.1.4 Improvement Phase (I)

The team determines which KPIVs and KPOVs to study, decides what data to gather and how to display and research them, defines potential sources of variability, and decides how to explain the data they procured in the Measure and Analyze phases. In the Improve phase, they give way to creative consideration about specific alteration which may be in the process and other staff which may be done desirable to effect on performance of the process (Montgomery, Woodall, 2008).

In the first step of the Improve phase, importantly people who are involved in the performing process should be involved. The project team should not complete this phase alone. Actually, maintaining communication with people who take part in the process makes sense along any Six Sigma quality improvement project. There are lots of techniques to brainstorm potential solutions to controvert the determined root causes in the Analyze phase. It is very effective to encourage the participants to go against rules and assumptions, pretext and think like children. Normally, more structured

brainstorming exercises are preferable between participants and usually participants can prepare a significant list of ideas on their own.

In this phase, ideas are never judged and removed. Just because, firstly one idea could seem nonsensical but after it can lead to a related idea which can be an ideal solution. Similarly, assumptions about what can or cannot be completed successfully should not be confirmed without confirmation.

In the Improve phase, there are many various tools to use. By using flow charts and value stream maps, the process is redesigned to improve workflow and reduce bottlenecks and work-in-process. Sometimes, an operation will be useful if error-proofing designing operation is used only the right way. The most important statistical tool is design experiments in the Improve phase. Design experiments can be performed to an actual physical process or to a computer simulation model of the process. Which factors influence the outcome of a process, and the optimal combination of factor settings can be determined by using designed experiments.

To improve a solution to the problem and to pilot test the solution are the other objectives of the Improve phase. The pilot test means a form of a confirmation experiment and the aims of it to appraise and document the solution includes the project goals. The pilot test's outcome is caused by repetitive activities which are the original solution being refined, revised and improved lots of times (Montgomery, Woodall, 2008).

During preparation tollgate review of Improve phase, it should be focus on the following:

· Sufficient documentation which includes that explains the way the problem solution is done. · Alternative solutions' documentation was being taken into account.

· Results for the pilot test are completely analyzed.

· The pilot test results literally are implemented to the plan. It should also consist of any regulatory requirements, legal issues, personal concerns or the effect on other business standard practices.

· Convenient risk management plans and any risk of practicing the solution are analyzed.

3.1.5 Control Phase (C)

The objectives of the Control phase are to finish all unfinished work on the project and to transfer the improved process with a process control plan to the owners of process and other required procedures to be sure that the earning from the project is going to be institutionalized. The goal is to be sure that the gains will be helped to the process and the improvements could be implemented in different but similar processes in the business. The owners of processes should ensure the past and present data of process-on-process metrics, documents of training, operations and current process maps. It is necessary to quantify the financial benefits of a project. The process control

plan should be prepared like a system to pursue the implemented solution which involves methods and metrics for periodic controlling. In the Control phase, an important statistical tool is control charts which include lots of process control plans on critical process metrics. Process owners also should be ensured the transition plan which involves a validation, and it should be checked several months after completing the process. Another important requirement is to make sure that original results are still accessible and stable. This way the positive financial impact will be sustained. It is usual to encounter a problem in the transition to the improved process. The plan should include the talent to respond quickly to unexpected defects (Montgomery, Woodall, 2008).

Defects are mostly happening in the weak links of the procedure and if they can be followed carefully, they may be prevented and fixed before continuing the process. Responding to a defect means to avoid a little fault before becoming a defect. Reducing defects to almost zero is in the best designed systems and Six Sigma can be reached.

The Control phase is a small version of process management. A form of infrastructure has been built along the duration of the project and documentation, which includes exactly how they want to transform that structure onto the participants, is done in the Control phase.

The tollgate review for the Control phase should involve the following:

- The before and after results are in line which means data illustration with the project charter must be convenient. It is important to understand whether the original objectives were accomplished or not.
- Is the plan of process control complete? For monitoring the process, procedures can be used.
- Is all main documentation complete for owners of the process? · The lessons learned from the project should be convenient.
- Opportunities which are stopped following during the life of the project should be listed. This list can be useful for future projects. Inventing potential projects continuously is very important because of the process of improvement.
- Opportunities of results of the project may be used in different parts of the business.

3.2 What is DFSS?

- "Predicting design quality up front and driving quality measurement and predictability improvement during the early design phases "(As Treichler et al. ,2002),
- "A disciplined and rigorous approach to design that ensures that new designs meet customer requirements at launch" (El-Haik and Roy,2005),
- "A data driven methodology based on analytical tools which provide users with the ability to prevent and predict defects in the design of a product or service" (De Feo and Bar-El, 2002),

- “The major focus of the DFSS approach is to look for inventive ways to satisfy and exceed the customer requirements. This can be achieved through optimization of product or service design function and then verifying that the product or service meets the requirements specified by the customer” (Antony and Coronado, 2002)

The set of steps determined are used in Design for Six Sigma, DMADV (define, measure, analyze, design and validate), to ensure reproducibility and continuous improvement. The objective of DFSS is to translate customer requirements qualitatively and quantitatively to specifications of product. DFSS focuses on recommended designs to influence customer scorecards which are defined. The process of DMADV is a redesign process.

DFSS is an attitude for taking the process improvement and reduction of variability philosophy of Six Sigma upstream from manufacturing or production into the design process, where new products, services or service processes are developed and designed. DFSS is replaced by an insufficient available process or product and also is designed as a new product or process. The products or services are maximized during the DFSS period. Another benefit of DFSS is to increase the quality and speed of processes inside an organization. DFSS is used by organizations when a process, product or service has to be designed or redesigned. The source of product and service defect is realized from the earliest stages of research and development by force of “designing in " performance of DFSS. Design for Six Sigma teaches people a coordinated approach which includes involving the right people, asking the right questions and using the right appliances

from the very beginning of any design project. All the industry, product or process design methodology use design for Six Sigma. Software design and systems are modernized, and existing performance of products are improved by DSFF (Mital, Desai, 2008).

Shortly, DFSS is a configured and kept under control methodology to commercialize the technology efficiently that results in new processes, products and services. DFSS contain the whole development process from the definition of customer needs to the final release of the new product or services. Customer input is developed by way of voice of customer activities planned to identify what customer really wants, to prioritize on the strength of real customer wants, and to identify if the business can satisfy needs at a competitive price that will make it possible to make a profit. Customer interviews, direct interaction with and survey of the customer by way of focus groups, surveys and analysis of customer satisfaction data generate voice of customer data. The main objective of VOC is to develop a set of critical requirements of quality for the product or services (Hekmatpanah, Sadroddin, Shahbaz, Mokhtori, Fadavinia, 2008).

Characteristically, DMAIC is used to succeed operational perfection; on the other hand, DFSS is focused on improving the results of business by enhancing the revenue of sales produced from new products and services and creating new opportunities of application for available ones. The reduction of development lead time, which means the cycle time for commercializing new technology and getting the resulting new products to market, is a significant gain from DFSS in many cases. Design for Six Sigma is mainly focused on

enhancing value in the organization. Operational Six Sigma also uses lots of the statistical tools in DFSS. Designed experiments are especially useful. Statisticians can make helpful contributions to DFSS by way of experimentation with main examples and models of computers (Montgomery, Woodall, 2008).

A variation of DMAIC, DMADV (Define Measure, Analyze, Design and Verify) is used for DFSS by some organizations. Generally, DFSS provides some specific realization, for example, every design decision is a decision of business and during the design period, performance of product, cost, and manufacturability are identified. Firstly, a product is designed and released to production; it is unfeasible for the organization of production to make it better. In addition, focalization decreasing variability in production only (operational Six Sigma) isn't able to succeed whole business improvement. Customer requirements are the main issue to focus on for DFSS while concurrently process capability is taken into consideration. Especially, consistency process capability and design requirements are fundamental. When inconsistencies between capability of production system and requirements at any level of design system are met, design changes or alternatives of production are considered to solve the conflicts.

De Feo and Bar-El (2002) determine seven elements of DFSS as follows: -

- Drives the customer-oriented design process with Six Sigma capability
- Predicts design quality at the outset
- Matches top-down requirements flow down with capability flow up
- Integrates cross-functional design involvement

- Drives quality measurement and predictability improvement in early design phases
- Uses process capabilities in making final decisions

The differences between DMAIC and DFSS approaches are also mentioned in the literature. Though DFSS involves designing processes to reach Six Sigma levels and is considered as an aggressive approach, it still lacks a single methodology unlike Six Sigma. (Hoerl, 2004)

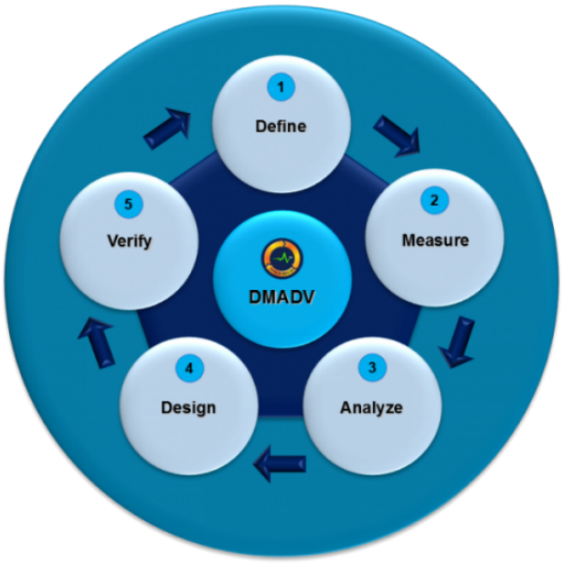

Figure 3: DFSS Model

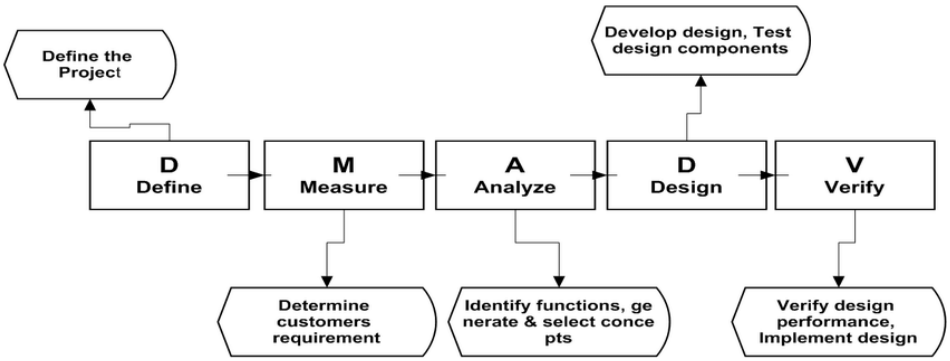

Figure 4: DFSS Methodology

There are different methodologies to use in DFSS as follows (Chakraborty, Tan, 2012).

- IDOV (Identify, Design, Optimize, Validate)
- ICOV (Identify, Characterize, Optimize, Validate)
- DCOV (Define, Characterize, Optimize, Verify)
- DMADO (Define, Measure, Analyze, Design, Optimize)

- DMADV (Define, Measure, Analyze, Design, Verify)
- SMADAV (Define, Measure, Analyze, Design, Optimize, Verify)
- DCCDI (Define, Customer Concept, Design, Implement)
- DMEDI (Define, Measure, Explore, Develop, Implement)

The other differences are:

- Ferryanto explains that DFSS is a methodology that takes into account the issues highlighted by the end customers at the design stage while DMAIC solves operational issues (2005).
- The benefits of DFSS cannot be evaluated easily and are procured in a long time, on the other hand benefits of Six Sigma are stated in financial terms and procured more quickly.
- El-Haik and Roy clarify the differences that "The DMAIC methodology tends to provide incremental improvements in comparison to DFSS where there can be radical improvements (2005).
- "The projects improved through DMAIC methodology are constrained by the assumptions made during the development and design stages, whereas DFSS builds quality into the design by implementing preventive thinking and tools in the products developments process" (Smith,2001)

DFSS methodologies comprise some tools and techniques which are partly different from those of the DMAIC methodology. DFSS involves some tools of innovation like the theory of creative problem solving, axiomatic design, and quality function deployment, which DMAIC does not.

3.3 Project selection process within six sigma programs

The selection of right projects in a six-sigma program is a major factor in the early success and long-term acceptance within any organization. This factor becomes even more critical in a small and medium enterprise. If you do not have a rigorous and disciplined approach to selecting projects, there is a high probability that your efforts will flounder. According to Adams (2003), "doing black belt training before project identification is the classic – getting the cart before the horse". The project selection process should be listening to three important voices: the voice of the process, the voice of the customer and the voice of the strategic business goals. The following guidelines may be used to select six sigma projects:

- Linkage to strategic business plan and organizational goals.
- Sense of urgency – how important is the proposed project for improving your overall business performance (both financial improvement and service process performance improvement)?
- Select projects which are doable in less than six months. If the project scope is broader, the time to completion increases, the cost of the project deployment will increase. This would lead to frustration among the key players due to lack of progress, diversion of manpower away from other activities, delay in realization of financial benefits, etc.
- Project objectives must be clear, succinct, specific, achievable, realistic and measurable.

- Establish project selection criteria – the following criteria may be considered during the project selection process: impact on customer needs and expectations; financial impact on the bottom-line; duration of the projects considered; resources required for projects under consideration; expertise and skills required to carry out the projects; probability of success of projects under consideration; and risk involved in projects, etc.
- Projects have the support and approval of senior management.
- Define project deliverables in terms of their impact on one or more critical characteristics in the service such as critical-to-quality, critical-to-cost or critical-to-delivery.
- Projects must be selected based on realistic and good metrics (DPMO, sigma quality level, capability indices, etc.).

The type of projects and their criteria will vary from business to business and project to project. However, typical service six sigma projects could have the following general and specific goals:

- Improved business value by removing non-value-added processes, reducing errors in processes, reducing cycle time of critical processes, etc.
- Improved customer value by providing faster delivery to customers, reducing hassle for customers, providing consistent and reliable service every time, building better customer relationships, etc.

- Improved employee value by building employee relationships, creating opportunities for employees to acquire new skills and expertise, building employee pride and confidence, etc.

Project reviews must be carried out on a regularly scheduled basis to drive the projects to a successful completion and closure. Six sigma champions or sponsors should view the project review process as a mechanism to identify stumbling blocks (if any) present in the system and the milestones ahead and to obtain a clear picture of what progress has been made by the team.

3.4 What makes six sigma different from other quality improvement initiatives?

I personally have seen that senior management in many organizations view six sigma as another quality improvement initiative or flavor of the month in their list. I am often told by many engineers and managers in small and big companies that there is nothing really new in six sigma compared to other quality initiatives we have seen in the past. In response, I often ask a simple question to people in organizations who practice TQM, "what do you understand by the term TQM?". I often get many varying answers to this question. However, if I ask a bunch of six sigma practitioners, "what do you know of the term six sigma?", I often get an answer which means more or less the same thing that I

would have expected. The following aspects of the six-sigma strategy is not accentuated in previous quality improvement initiatives:

- Six sigma strategy places a clear focus on achieving measurable and quantifiable financial returns to the bottom-line of an organization.
- Six sigma strategy places an unprecedented importance on strong and passionate leadership and the support required for its successful deployment.
- Six sigma methodologies of problem solving integrate the human elements (culture change, customer focus, belt system infrastructure, etc.) and process elements (process management, statistical analysis of process data, measurement system analysis, etc.) of improvement.
- Six sigma methodology utilizes the tools and techniques for fixing problems in business processes in a sequential and disciplined fashion. Each tool and technique within the six-sigma methodology has a role to play and when, where, why and how these tools or techniques should be applied is the difference between success and failure of a six-sigma project.
- Six sigma creates an infrastructure of champions, master black belts, black belts and green belts that lead, deploy and implement the approach.
- Six sigma emphasizes the importance of data and decision-making based on facts and data rather than assumptions and hunches!
- Six sigma utilizes the concept of statistical thinking and encourages the application of well-proven statistical tools and techniques for defect reduction

through process variability reduction methods (e.g., statistical process control and design of experiments).

3.5 Limitations of Six sigma

Just like any other quality improvement initiatives we have seen in the past; six sigma has its own limitations. The following are some of the limitations of six sigma and thus creates opportunities for future research:

- The challenge of having quality data available, especially in processes where no data is available to begin with (sometimes this task could take the largest proportion of the project time).
- In some cases, there is frustration as the solutions driven by the data are expensive and only a small part of the solution is implemented at the end.
- The prioritization of projects in many service-oriented companies is still based on pure subjective judgement. Very few tools are available for prioritizing projects although selecting the right projects is one of the critical success factors of six sigma implementation.
- The statistical definition of six sigma is 3.4 defects or failures per million opportunities. In service processes, a defect may be defined as anything which does not meet customer needs or expectations. It would be illogical to assume that all defects are equally good when we calculate the sigma capability level of a process. For instance, a defect in a hospital could be a wrong admission

procedure, lack of training required by a staff member, misbehavior of staff members, unwillingness to help patients when they have specific queries, etc.

- Owing to dynamic market demands, the CTQs of today would not necessarily be a meaningful one tomorrow. All CTQs should be critically always examined and refined as necessary (Goh, 2002).
- Assumption of 1.5 sigma shift for all service processes does not make much sense. This issue should be the major thrust for future research as a small shift in sigma could lead to erroneous defect calculations.
- Non-standardization procedures in the certification process of black belts, green belts, etc. This means not all black belts or green belts are equally capable. The capability of black belts or green belts vary enormously across the service organizations, depending a great deal on the certification body. For more information on this aspect, readers are advised to refer to Hoerl (2001).
- The start-up cost for institutionalizing six sigma into a corporate culture can be a significant investment. This feature would discourage many small and medium size enterprises from the introduction, development and implementation of six sigma strategy.

4. Six sigma methodology for service processes

As a problem-solving methodology or process improvement framework, six sigma strategy makes use of a series of well-defined steps. This includes definition of the problem (D), measurement (M) of the problem (i.e., defects which are responsible for the problem), data analysis (A) to discover the root causes of the problem (i.e., analysis of defects), improvement (I) of processes to remove the root causes of defects and controlling (C) or monitoring processes to prevent the perennial problem. The six-sigma methodology for service processes

Define phase: -

The following steps must be carried out in the define phase:

- Define the problem (as a project) both succinctly and specifically.
- Identify stakeholders. Understand the link between the problem at hand and the criticality of the problem from the perspective of the customers.
- Carry out a simple mapping of the processes both up- and down-stream to determine where the problem lies.
- Establish the process inputs, outputs and various controls of the processes.
- Form a six-sigma project charter which clearly illustrates the roles of people and their responsibilities for the project. Define the resources required for the project and allow a timeframe for the project at hand. The charter should also reveal the

scope of the project, the project boundaries and the key benefits to internal or external customers.

- Identify the project sponsor and stakeholders and determine whether this project is worth an effort using cost-benefit analysis.
- Identify all customers (both internal and external) and justify how this problem is linked to customer satisfaction

Measure phase: -

The following items should be considered during the measurement phase of the six-sigma methodology:

- determine the current performance of the service process (process yield, DPMO, short-term and long-term capability).
- decide what to measure (critical-to-quality characteristic – CTQ) and how to measure; establish a simple measurement system study (if applicable).
- determine how well our process is performing compared to others through benchmarking exercise; and
- identify the strengths and weaknesses and determine the gaps for improvement.

Analysis phase: -

The following salient points must be looked at during this phase:

- uncover the root causes of defects in processes.
- understand the root causes of variability which lead to defects and priorities them for further investigation.
- understand the nature of data and the distribution or patterns of data.
- determine the key service process variables that may be linked to defects; and
- financially quantify the improvement opportunity (i.e., estimate of potential financial benefits).

Improve phase: -

The improvement phase of the methodology encompasses the following issues:

- Develop potential solutions to fix the problems and prevent them from recurring.
- Evaluate the impact of each potential solution using a criteria-decision matrix. Solutions that have a high impact on customer satisfaction and bottom-line savings to the organization need to be examined to determine how much time, effort and capital will need to be expended for implementation.
- Assess risks associated with potential solutions.
- Validate improvement (i.e., reduce defect rate or improve sigma quality level of the process) by pilot studies.
- Re-evaluate the impact of chosen potential solutions.

Control phase:-

The control phase of the methodology should comprise of the following items:

- develop corrective actions to sustain the improved level of service process performance. develop new standards and procedures to ensure long-term gains.
- implement process control plans and determine the capability of the process.
- identify a process owner and establish his/her role, verify benefits, cost savings/avoidance.
- document the new methods.
- close project, finalize documentation and share key lessons learned from the project; and
- publish the results internally (monthly bulletins) or externally (conferences or journals) and recognize the contribution made by the team members.

4.1 Tools and techniques for service process performance improvement

Tools and techniques are practical methods, skills, means or mechanisms that can be applied to particular tasks which foster positive change and improvements (McQuater et al., 1995). A tool has a clearly defined role and is often narrow in focus. Examples of service process performance tools include process maps, cause and effect analysis, affinity diagrams, run charts, etc. In contrast, a technique has a wider application and

requires specific skills, creativity and training. Statistical process control (SPC) is a technique as it utilizes various tools (e.g., control charts, histograms, root cause analysis, etc.) within it. The successful implementation of six sigma requires stringent application of tools and techniques at different stages of the methodology. Although the tools and techniques are not new, they have been brought together to provide a well-stocked toolbox. It was interesting to observe that many service organizations are gaining significant benefits through the application of basic tools of six sigma (e.g., Pareto analysis, root cause analysis or cause-and-effect analysis, process mapping or flowcharting of processes, etc.). This would align itself with Ishikawa's (1986) view that the basic tools of quality control would be able to tackle more than 80 per cent of quality or process related problems. The purpose of this section is to look at the commonly and widely used tools and techniques of six sigma within the service industry. These tools and techniques are generally employed by project teams and specially trained black belts with technical expertise to tackle process or quality related problems (Pande et al., 2000). The following six sigma tools and techniques grid (Table II) provides some guidelines for people in the service sector regarding what tools and techniques for service performance improvement should be used and at what stage in the six-sigma methodology they should be applied. It is important to note that the effective application of tools and techniques in a service environment is heavily dependent on effective and planned training, uncompromising support from senior management, a co-operative environment, etc. Some of the tools and techniques are relevant to more than one stage of the six-sigma methodology.

4.2 Six sigma performance metrics commonly used by service industries

The key performance indicators (KPIs) vary from process to process, and from company to company. Nevertheless, there are some commonly and widely used KPIS or performance metrics of six sigma, across a number of service industries. The following are some of the commonly used six sigma performance indicators (KPIs) within service sector:

- cost of poor quality (COPQ).
- DPMO.
- process capability.
- time to respond to customer complaints\
- processing time (mortgage applications, insurance cover, bank loans, etc.).
- delivery time or speed of delivery.
- time to restore customer complaints.
- waiting time to obtain the service.
- service reliability; and
- Accuracy of information provided to customers.

4.3 Success factors for the implementation of six sigma in the service sector

Several authors (Pande et al., 2000; Eckes, 2000; Breyfogle et al., 2001; Antony and Banuelas, 2002) have written about the success factors for implementing six sigma in world class organizations. The identification of success factors will encourage their

consideration when companies are developing an appropriate implementation plan. If any of the critical success factors are missing during the development and implementation stages of a six-sigma program, it would then be the difference between a successful implementation and a waste of resources, effort, time and money. The following success factors have been identified from existing literature:

- strong leadership and management commitment.
- organizational culture change.
- aligning six sigma projects to corporate business objectives.
- selection of team members and teamwork.
- six sigma training.
- Understanding the DMAIC methodology, tools, techniques and key metrics.
- selection of projects and project management skills.
- linking six sigma to customers; and
- accountability (tying results in financial terms to the bottom-line).

4.4 KPI'S of Six sigma in Service Organizations

A Key Performance Indicator (KPI) is a measurable value that determines how effectively a company is achieving key business objectives and the goal of organization should be aligned with the 6Sigma initiative. Organizations use KPIs to evaluate their success at reaching targets. some of the important key performance indicators of 6Sigma in service organization identified from literature review are:

• Efficiency

• Cost reduction

• Time to delivery

• Quality of service

• Employee satisfaction

• Customer satisfaction

• Reduce variation

• Financial benefit

• Cycle time

• Waiting time

• Inventory turnover

• Operational cost

• Productivity

4.5 Case study

Case Study The study done here is about the improvements to the Automated IT call Centre process. As it is an existing process, the DMAIC methodology of six-sigma is applied.

Define Phase: -

The senior leadership of the IT services company completed the important pre-project work and found an area of the business worthy of attention by a DMAIC (Define, Measure, Analyze, Improve, Control) project team. The team then began work on understanding and articulating the project goals, scope and business case.

The DMAIC roadmap called for work in these areas during the Define phase:

D1. Project Charter**:** Spelling out the project's goal statement.

D2. Customer Requirements**:** Identifying all the internal and external customers who depend on the outputs of the process under study, the deliverables and measures connected with those outputs, and the process steps, process inputs and (as appropriate) the suppliers of those inputs.

D3. High Level Process Map**:** Showing the flow of information, materials and resources, from key process inputs, through process steps and decision points, to create the process outputs. The map describes the flow of what happens within the scope of the target process and it defines the boundaries of that scope.

Measure Phase:-

Having developed a good understanding of the project's business case and customer requirements (identifying the Y's), and the as-is process, the Six Sigma project team of the IT services business began to focus on the Measure phase. The team identified the measures and data collection plan for gathering the right amount of the right data to impel their learning about root causes and drivers that impact the project *Y*'s.

M1. Refine the Project ***Is*****:** Getting even clearer about how the project's key outcome measure(s) will be defined, measured and reported.

M2. Define Performance Standards for the ***Y*****'s:** Identifying how performance will be measured – usually somewhere on the continuum from capability measures like Cp and Cpk for "variables" data that is normally distributed to percentile or other capability metrics for "attribute" and other data that may be skewed in distribution.

M3. Identify Segmentation **Factors for** Data **Collection Plan:** Starting with the natural segmentation of project *Y*'s and moving though consideration of prospective driving factors (X's), segmentation suggests the packets of data that should be collected in order compare and contrast segments to shed light on *Y* root causes and drivers.

Analyze Phase:-

A1. Measure Process Capability: Before segmenting the data and "peeling the onion" to look for root causes and drivers, the current performance is compared to standards (established in step M2 of the Measure phase).

A2. Refine Improvement Goals: If the capability assessment shows a significant departure from expectations, some adjustment to the project goals may need to be considered. Any such changes will, of course, be made cautiously, supported with further data, and under full review with the project Champion and sponsors.

A3. Identify Significant Data **Segments and Patterns:** By segmenting the *Y* data based on the factors (X's) identified during the Measure phase – the team looks for patterns that shed light on what may be causing or driving the observed *Y* variation.

Improve Phase:-

I1. Identify Solution Alternatives to Address Critical X's: Consider solution alternatives from the possibilities identified earlier and decide which ones are worth pursuing further.

I2. Verify the Relationships Between X's and Y**'s:** What are the dynamics connecting the process *X*'s (inputs, KPIVs) with the critical outputs (CTQs, KPOVs)?

I3. Select and Tune the Solution: Using predicted performance and net value

I4. Pilot / Implement Solution: If possible, pilot the solution to demonstrate results and to verify no unintended side effects.

Control phase:-

C1. Develop Control Plan**:** Include both management control dashboards that focus on Y(s) and operational control indicators that monitor the most significant process variables, focusing on the x's.

C2. Determine Improved Process Capability**:** Use the same measures from Define and Measure in order to provide comparability and monitor impact in a consistent way.

C3. Implement Process Control**:** Create, modify and use data collection systems and output reports or dashboards consistent with the control plan.

C4. Close Project: Prepare the implementation plan, transfer control to operations, conduct project post-mortem, and archive project results.

By the above measures the company achieved the cost reduction from the support cost baseline then process control was implemented.

Implement Process control: -

The team began by planning the data collection process to be used, including preparing operational definitions for each data element and automated tools whenever possible to minimize expense and effort. Heeding W. Edward Deming's message to "drive out fear," the team was careful to prepare a well-thought-out communication plan to ensure the staff knew how the data was to be used and to address any concerns about punitive uses

of the data. The team recognized that if members of the staff thought the data would be misused, they might be tempted to distort the data.

The team also verified that the process was under procedural control (i.e., standards and documentation were up-to-date and the staff understood and followed the intended process). In preparation for implementing control charts on some of the process variables, the team recognized the segmented some of the data, such as “issue type.” Significant variations were expected across, but not within, issue types (e.g., “problem” versus “question”).

The CTQs identified of the process are:

- User friendliness of the telephone system
- Responsiveness in directing customer to the right source of contact
- Department representatives' responsiveness in answering the query
- Customer service of the call center staff

The KPIs for different types of services, compared are tabulated below.

s.no	Healthcare	Bank	Call center
1	Throughput	Increased Sale revenue	Support cost per call
2	Cost/procedure	Improved service and balance retention	Man-hour*
3	Care	Delighted customers	Cycle time*
4	Wait Time	Reduced cycle time for mortgage application	Customer satisfaction*
5	Service Time	External and internal call backs	Days to close
6	Information Conveyance Time	The credit processes	Wait time
7	Cost per Unit of Service	Cycle time reduction of finance and leasing service	Transfers
8	Labour Productivity		Service time
9	Customer Satisfaction		
10	Clinical Excellence		
11	Patient Safety		
12	Revenue Enhancement		
13	Employee Satisfaction		

Table 3: Comparison of KPI's

The analysis of KPIs for different services shows that though service may be varied, there are several indicators which are common across the services. The common KPIs identified are:

- Efficiency
- Cost
- Time-to-deliver
- Quality of the service
- Customer satisfaction
- Reduced variation

5. Conclusion

This paper makes an attempt to demonstrate the power of six sigma in the service industry. Although six sigma has been successfully implemented in many manufacturing industries, its application in the service sector is still comparatively limited due to various constraints. This paper briefly presents the potential areas where six sigma could be exploited in service functions. The paper also reveals most common six sigma performance metrics commonly used by service industries. The critical success factors which make the successful deployment of six sigma are discussed, followed by providing some guidelines for the six sigma project selection process. The critical differences and commonalities between six sigma and TQM are also highlighted in the paper. This study is based on an investigative approach, future researchers can venture further by following a qualitative approach.

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