Six Sigma - An Innovative Human Resource Practice for Business and Operational Excellence

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1. Introduction

Six Sigma (**6σ**) is a set of practices and tools for process enhancement. It was introduced by engineer Bill Smith while working at Motorola in 1980. Jack Welch made it central to his business strategy at General Electric in 1995. A six sigma is a statistical process and one in which opportunities are prevailing to produce feature of a part which is free of defects.

Six Sigma strategies strive to progress the quality of the output of a process by identifying and removing the causes of shortcomings and restraining contradiction in manufacturing and business processes. It practices a set of quality management techniques, mainly empirical, statistical methods, and generates a distinct reinforcement of people within the organization who are professionals in these techniques. Each Six Sigma project conceded out within an organization follows a divergent order of phases and has precise value targets, for example: decrease progression phase time, decrease effluence, reduce outlays, surge customer satisfaction, and escalate profits.

Organizations prerequisite to regulate an pertinent sigma level for each of their most significant practices and strive to accomplish these. As a result of this goal, it is vital on management of the organization to prioritize areas of development."Six Sigma" was enumerated June 11, 1991 as U.S. Service Mark 1,647,704. In 2005 Motorola accredited over US$17 billion in savings to Six Sigma. Other early adopters of Six Sigma include Honeywell and General Electric, where Jack Welch introduced the method. By the late 1990s, Nearly two-thirds of the Fortune 500 organizations in the late 1990s, had instigated Six Sigma initiatives with the determination of reducing costs and quality excellence.

In present years, Six Sigma ideas have been conglomerated with lean manufacturing to generate a methodology named Lean Six Sigma. The Lean Six Sigma procedure views lean manufacturing, which discourses process flow and waste issues, and Six Sigma, with its focus on disparity and design, as balancing disciplines aimed at promoting "business and operational excellence".

The International Organization for Standardization (ISO) has published in 2011 the first standard "ISO 13053:2011" defining a Six Sigma process. Other "standards" are determined mostly by universities or companies, which acquainted certification programs for Six Sigma. Bill Smith and Bob Galvin acquainted the Six Sigma quality advancement process in 1986. Six Sigma enhanced to improve quality so that the number of defects becomes so few that they are statistically insignificant Lean Six Sigma is simply a process for solving a problem. The Six Sigma DMAIC process (define, measure, analyze, improve, control) is an development system for prevailing procedures deteriorating below specification and beholding for incremental improvement

2.1 Review on literature

Al-Mishari & Suliman (2008) suggested three possible 'on-ramps' or approaches an organisation can take to implement Six Sigma. The first is through a business transformation approach where an organisation undergoes complete change to convert its traditional method of working in order to regain lost customers or to overcome the heavy losses. The second is the strategic mprovement approach limited to one or two critical business needs focusing on major opportunities and weaknesses. The third is a problem-solving approach which focuses only on persistent problems

Roy Andersen, Henrik Eriksson, and Hakan Tortensson (2006) published the findings of a study on Six Sigma. During their research, the authors found that TQM, Six Sigma and Lean have many similarities, they differ in some areas. But, because they are complementary concepts, if combined, an organization can gain a lot. The study points out that Six Sigma and Lean work like road maps for organizations. They can be used separately or combined with the values of TQM.

Tjahjon Ball, A.Srivastava and S.Srivastava elucidated that the enabler of six sigma is top management Commitment that can promote effective training to the employees and reduces and prevents the defect which affect the quality of both product and processes.

Selim Ahmed 2018 investigated applications of Six Sigma methodology in Malaysian private hospitals. It measures Six Sigma initiatives of the private hospitals based on demographics such as gender, position and working experience and used stratified random sampling to collect data from eight selected hospitals in Peninsular Malaysia. The descriptive analysis, independent samples *t*-test and one-way ANOVA were undertaken using SPSS version 23. The findings of the study indicates that male respondents have better perception on four aspects of Six Sigma applications such as process improvement tools, process improvement methods, manage quality improvement activities and formal planning process compared to female respondents. The research findings also indicates that doctors have better perception regarding process improvement tools to measure quality improvement process, leadership to continuous improvement processes, training in process improvement tools for employees' skill improvement compared to nurses, pharmacists, medical laboratory technologists.

Carlos Abraham Mayo 2018 proposed an assessment approach to evaluate the organizational capabilities to deploy a Lean Six Sigma (LSS) strategy.. The case studies show that this approach allows SMEs to understand their strengths and weaknesses and thus better prepare the implementation of LSS. The proposed methodology will help managers and practitioners to evaluate the readiness level of a company to implement LSS. Then, they could estimate the effort required to achieve the LSS deployment.

Nandakumar Mishra 2018 explored the application of analytics and Six Sigma in the manufacturing processes for iron foundries. The study aims to establish a causal relationship between chemical composition and the quality of the iron casting to achieve the global benchmark quality level. The analytics helps in achieving the statistically significant business goals. The design includes Six Sigma DMAIC (Define – Measure – Analyze – Improve and Control) approach, benchmarking, historical data analysis, literature survey and experiments for the data collection. The data analysis is done through stratification and process capability analysis. The logistic regression-based analytics helps in prediction model building and simulations. The application of prediction model helped in quick root cause analysis and reduction of rejection by over 99 per cent saving over INR6.6m per year. This has also enhanced the reliability of the production line and supply chain with on-time delivery of 99.78 per cent, which earlier was 80 per cent. The analytics with Six Sigma DMAIC approach can quickly and easily be applied in manufacturing domain as well

Need for the Study

Six Sigma is a procedure that helps to advance corporate procedures by using statistical analysis. It is a data-driven and highly well-ordered methodology and approach that ensures elimination of defects in any type of business or organizational process. Instigating Six Sigma is important as it will help organizations in several ways like Mapping or flowcharting of processes are often used towards making improvement suggestion like employee roles and decision points in overall work performance required for meeting specific client needs. Six Sigma techniques can be used for elimination of waste and discrepancy in business processes. Six Sigma processes have the required tools and skills to identify problem or bottleneck areas that camps down production or performance. This procedure helps employees to ascertain areas of improvement and work towards it constantly. At the end, it aids in enlightening prevailing facilities or products and supports with expansion of new high quality products.

2.1.Objectives of the Study

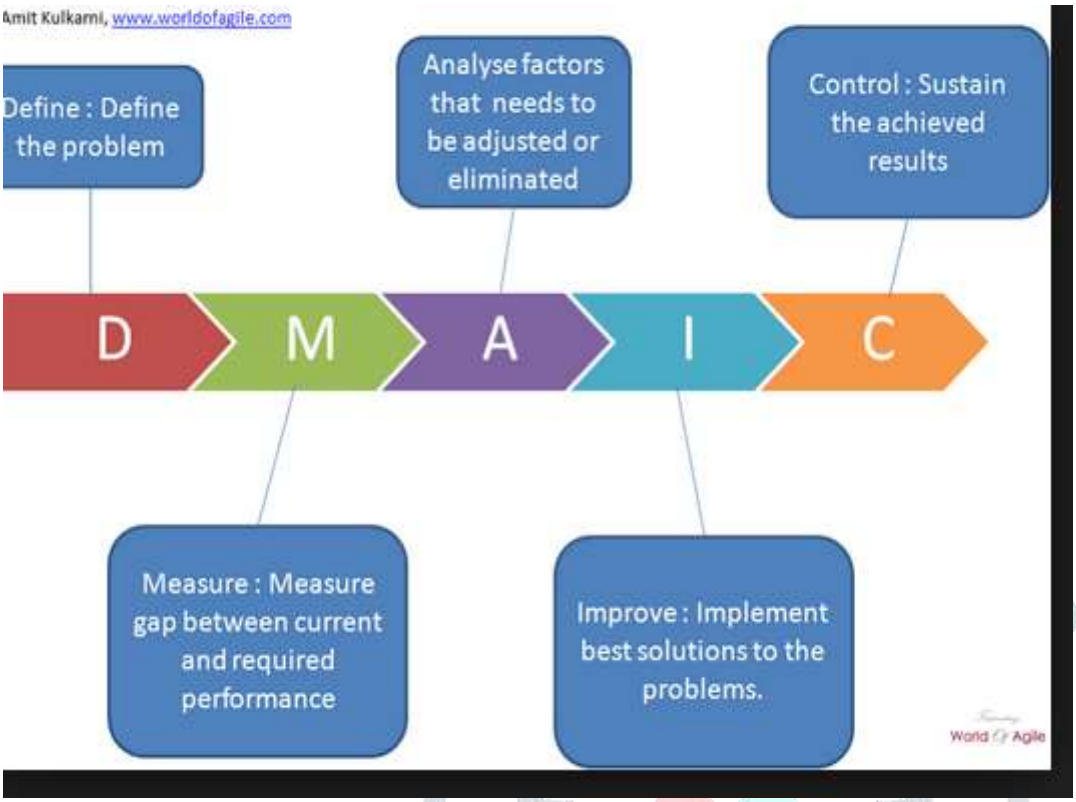
- To comprehend the importance of six sigma Practices in various industries.
- To ascertain the factors influencing the six sigma human resources practices.
- To Evaluate the impact of six sigma and its insights in business.

2.2 Importance of the Study

Six Sigma aims to ascertain strategy and lessen the amount of inconsistency in business processes. The key concepts in the Six Sigma practices is its prerequisite that a business focus on critical-to-quality attributes -- which comprise of the most significant customer specifications -- and how the process delivers them.

Scenarios in Six Sigma application are important because they aid a valuable forecasting tool and benefit businesses envisage quality and practice measures will occur given various circumstances

3.1 DMAIC in Six Sigma



3.2 Tools of Six Sigma

The 5 S is a method of organizing workplace materials for quicker access and better maintenance. This system is essential for eliminating waste that is produced by poor workstations and tools in poor condition.

The 5 S's are:

- **Seiri (Sort)** eliminates all unnecessary items of current production, leaving only what is necessary.
- **Seiton (Set In Order)** unifies remaining items and label them accordingly.
- **Seiso (Shine)** cleans and inspects work area and everything in it every day.
- **Seiketsu (Standardize)** writes out standards for the Sort, Set In Order, and Shine steps above.
- **Shitsuke (Sustain)** applies the standards set for company and make them habits for everyone in organization.

Value Stream Mapping

Value stream mapping tool used in the phase of DMAIC as well as in Six Sigma

A value stream map illustrates the flow of materials and eliminate non-value adding activities. It reduces time lag between consecutive steps in processes information. Value stream mapping helps to identify:

- Value-enabling activities
- Value-adding activities
- Non-value adding activities

Regression Analysis

A regression analysis is a statistical process for estimating and understanding the relationship between variables. It is used to define the mathematical relationship between an output variable (y) and any number of input variables (x1, x2, etc.) Graphing these inputs and outputs helps to visualize patterns or abnormality from desired pattern work flow

- When the error term in one time period is positively correlated with the error term in the previous time period, you'll encounter the problem of (positive first-order) **autocorrelation**

Pareto Chart

The Pareto chart graphically shows the variances between groups of data, allowing Lean Six Sigma teams to identify the largest issues facing the process.The y-axis signifies a cumulative percentage and a defect frequency, while the x-axis signifies the groups of response

variables revealed as bars, such as machine design or machine parts.This chart is often acclaimed as one of the most significant tools in the Lean Six Sigma toolbox for facilitating teams uncover the 20% of sources that grounds 80% of glitches in their practices.

FMEA

Failure Modes and Effects Analysis (FMEA) helps businesses ascertain and eliminate weak points in the early stages of any product or process.

Established in the 1950s, FMEA is used to review components, assemblies, and subsystems to ascertain failure modes and their grounds and special effects.

Lean Six Sigma practitioners use FMEA to increase the quality of their procedures, services, and products by perceiving and setting complications before they occur.

Kaizen (Continuous Improvement)

Kaizen is the exercise of persistently discerning, categorizing, and instigating incremental developments in the manufacturing process.

It encourages all managers and employees to be involved in the process of manufacturing developments.

Kaizen ensures that waste will be progressively abridged through the combined talents and acquaintance of everyone in the concern working together to transform the smallest inadequacies everyday.

Poka-yoke (Mistake Proofing)

Yoke is a Japanese term that means mistake proofing. It's a procedure by which employees work to ascertain and eradicate the grounds of human errors throughout the manufacture and production procedures. For example, a poka-yoke could be altering the phrasing on machine buttons to eradicate worker confusion or it could be totaling a safety brake to mobile equipment to prevent accidents.

3.3 Principles of Six Sigma

Six Sigma success is based on five key **principles**: Converging on customer requirements. Expending wide-ranging dimension and statistical investigation to comprehend how work gets done and to ascertain the root cause of problems (variations) Being pre-emptive in eradicating variation and continually improving the process.

SIPOC

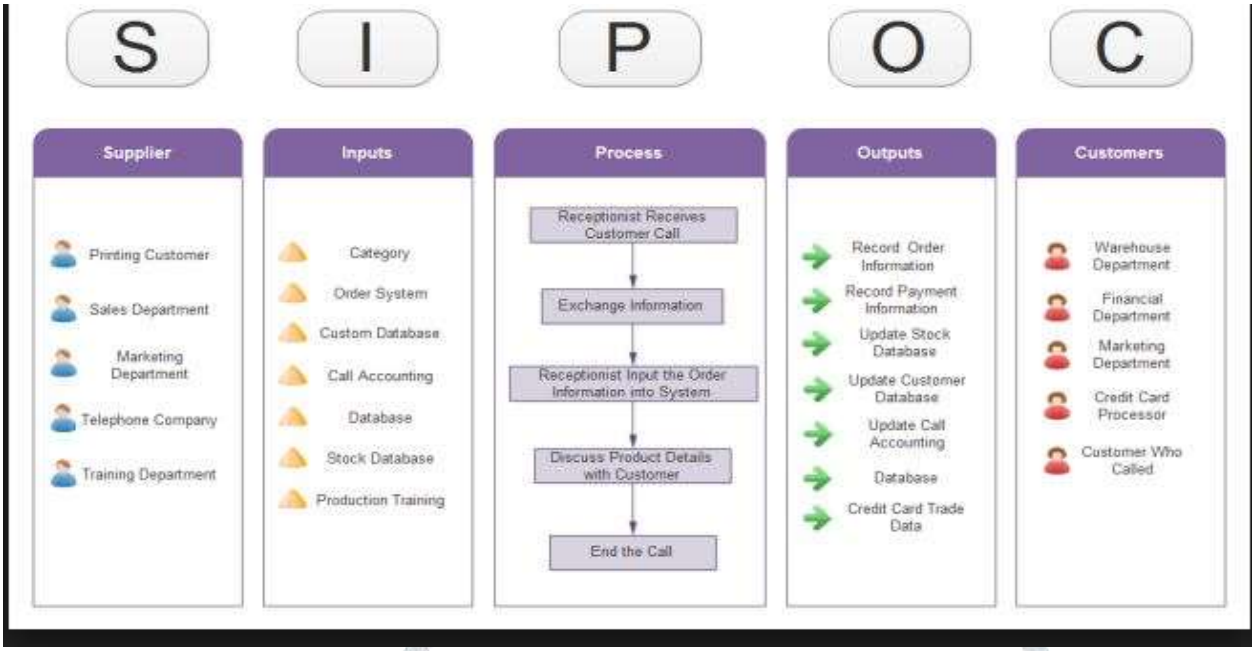
SIPOC (**COPIS**) is a tool that précises the inputs and outputs of one or more practices in table form. The contraction SIPOC stands for **s**uppliers, **i**nputs, **p**rocess, **o**utputs, and **c**ustomers which form the columns of the table. It was in use at least as early as the total quality management series of the late 1980s and continues to be used today in Six Sigma, lean manufacturing, and business process management. To underline driving the needs of the customer foremost, the tool is sometimes called COPIS and the practice material is filled in preparatory with the customer and operational upstream to the supplier.

The SIPOC is often presented at the outset of practice upgrading efforts such as Kaizen events or during the "define" phase of the DMAIC process. It has three typical uses depending on the audience:

- To provide people who are unacquainted with a procedure a preeminent overview
- To reacquaint individuals whose acquaintance with a procedure has distressed or become out-of-date due to process changes
- To aid individuals in defining a new process

Several aspects of the SIPOC that may not be readily apparent are:

- Suppliers and customers may be internal or external to the organization that performs the process.
- Inputs and outputs may be materials, services, or information.
- The emphasis is on apprehending the set of efforts and productions rather than the individual steps in the progression



3.4 Applications of Six Sigma in Different Sector

Six Sigma mostly finds application in large organizations. An important factor in the spread of Six Sigma was GE's 1998 announcement of $350 million in savings thanks to Six Sigma, a figure that later grew to more than $1 billion. According to industry consultants like Thomas Pyzdek and John Kullmann, companies with fewer than 500 employees are less suited to Six Sigma implementation or need to adapt the standard approach to make it work for them. Six Sigma however contains a large number of tools and techniques that work well in small to mid-size organizations. The fact that an organization is not big enough to be able to afford Black Belts does not diminish its abilities to make improvements using this set of tools and techniques. The infrastructure described as necessary to support Six Sigma is a result of the size of the organization rather than a requirement of Six Sigma itself.

Although the scope of Six Sigma differs depending on where it is implemented, it can successfully deliver its benefits to different applications.

Manufacturing

After its first application at Motorola in the late 1980s, other internationally recognized firms currently recorded high number of savings after applying Six Sigma. Examples of these are Johnson and Johnson, with $600 million of reported savings, Texas Instruments, which saved over $500 million as well as Telefónica de Espana, which reported €30 million in savings in the first 10 months. On top of this, other organizations like Sony and Boeing achieved large percentages in waste reduction.

Engineering and construction

Although companies have considered common quality control and process improvement strategies, there's still a need for more reasonable and effective methods as all the desired standards and client satisfaction have not always been reached. There is still a need for an essential analysis that can control the factors affecting concrete cracks and slippage between concrete and steel. After conducting a case study on Tinjin Xianyi Construction Technology Co, Ltd., it was found that construction time and construction waste were reduced by 26.2% and 67% accordingly after adopting Six Sigma. Similarly, Six Sigma implementation was studied at one of the largest engineering and construction companies in the world: Bechtel Corporation, where after an initial investment of $30 million in a Six Sigma program that included identifying and preventing rework and defects, over $200 million were saved.

Finance

Six Sigma has played an important role by improving accuracy of allocation of cash to reduce bank charges, automatic payments, improving accuracy of reporting, reducing documentary credits defects, reducing check collection defects, and reducing variation in collector performance. Two of the financial institutions that have reported considerable improvements in their operations are Bank of America and American Express. By 2004 Bank of America increased customer satisfaction by 10.4% and decreased customer issues by 24% by applying Six Sigma tools in their streamline operations. Similarly, American Express successfully eliminated non-received renewal credit cards and improved their overall processes by applying Six Sigma principles. This strategy is also currently being applied by other financial institutions like GE Capital Corp., JP Morgan Chase, and SunTrust Bank, with customer satisfaction being their main objective.

Supply chain

In this field, it is important to ensure that products are delivered to clients at the right time while preserving high-quality standards from the beginning to the end of the supply chain. By changing the schematic diagram for the supply chain, Six Sigma can ensure quality control on products (defect free) and guarantee delivery deadlines, which are the two major issues involved in the supply chain.

H**ealthcare**

This is a sector that has been highly matched with this doctrine for many years because of the nature of zero tolerance for mistakes and potential for reducing medical errors involved in healthcare The goal of Six Sigma in healthcare is broad and includes reducing the inventory of equipment that brings extra costs, altering the process of healthcare delivery in order to make more efficient and refining reimbursements. A study at the University of Texas MD Anderson Cancer Center, which recorded an increase in examinations with no additional machines of 45% and reduction in patients' preparation time of 40 minutes; from 45 minutes to 5 minutes in multiple cases.

Six Sigma and Information Technology

Information technology (IT) organizations increasingly are underneath pressure to develop their service and process capability. In the pursuit for improvement methodologies, organizations often adopt a "pick one" strategy – with Six Sigma being the widely favored choice. However, it is possible to integrate Six Sigma and reap the full benefits that these methodologies can bring to the table.

Wipro is one of the largest IT services and product engineering companies in the world. It has more than 100,000+ employees and 70+ delivery centers in 55+ countries. In fact, Wipro, an Indian IT giant, successfully decoded the Six sigma practices, implemented and then, upgraded six sigma practices for their Global IT Consulting services. Followed by Wipro, Six sigma practices were implemented by TCS, Infosys and HCL, etc.

Six Sigma implementation offers IT process the following benefits:

- Progress competence and efficacy of the business and IT processes
- Decrease overall operational costs
- Improve customer experience
- Provide quicker results with business value
- Progress workforce productivity
- Improve quality of performance of products and services
- Enabled service proficiency and solidity with operative efficiency and control

Six Sigma and Aviation

Efficiency is the goal of a continuous process improvement effort. That involves eliminating whatsoever that does not add value for customers. It also prominences on quality and performance progression.

Six Sigma emphases on defects in both prevailing processes and designing new-fangled ones as error-proof as possible. The goal is to eliminate variation, add flexibility and set up systems that maximize the use of human talent. It gives an organization more control over the quality of the final product or service.

The aviation industry comprises a series of intertwining procedures, each with its own challenges. In addition to the issue of safety, airlines aim to improve passenger satisfaction. There are many areas where this can go wrong, from delayed flights, missed connections, long layovers, lost luggage or, worst of all, cancelled flights.

The meteorological a role in some of these issues, and definitely that is beyond an airline's control. However, as McKinsey & Company reported, airlines also have delays at gates after airplanes land, under-utilized aircrafts and other expensive equipment and staff that remains idle for long periods of time.

Six Sigma and Health Care

To help reduce waste and improve quality care, many hospitals and healthcare practices have adopted Six Sigma management tools to help achieve goals. Employing Six Sigma principles in healthcare settings can help eliminate defects and variations in processes, and it can help make procedures more streamlined, less costly and help improve patient care.

In healthcare environments, a shortcoming is defined as a factor that leads to patient dissatisfaction. Examples of defects range from the provoking kind, such as a long wait to see a doctor, to the serious kind, such as an incorrect diagnosis or treatment.

Patients can access more information on healthcare providers than ever before, and quality of care has been seen as an important factor in deciding which provider patients choose. Healthcare organizations are increasingly regarding patient reviews and perceptions as essential factors for quality improvement, and Six Sigma as the approach to measure and improve these factors.

Six Sigma and Manufacturing Industry

Six Sigma identifies and removes defect-causing elements along with reducing the changeability of the business and manufacturing processes to improve the quality of outputs from a manufacturing process. In this methodology, an organization follows a defined set of steps to quantify the targeted value of the project. An application of Six Sigma in manufacturing can help an organization reduce

pollution, reduce time cycle of one or more processes, and reduce cost of production for increasing profits and satisfaction level of its customers.

Motorola reported some astonishing facts about the benefits Six Sigma had for its organization after registering its service mark: they disclosed they had saved more than $17 billion by the end of 2006 with the help of quality improvement processes offered by this unique system.

4 Conclusion

The present study is restrained to Six Sigma and its insights on academic excellence in different industries. Six Sigma is a rigid, intensive and immensely operative implementation of proven quality ideologies and techniques. Integrating basics from the exertion of many eminence innovators, Six Sigma aims for practically error free business performance. A company's performance is restrained by the sigma level of their business processes. Traditionally companies accepted three or four sigma performance levels as the norm, despite the fact that these processes created between 6,200 and 67,000 problems per million opportunities. The Six Sigma standard of 3.4 problems per million opportunities is a response to the increasing prospects of customers and the augmented complexity of modern products and processes.

Six Sigma's magic isn't in statistical or high-tech systems. Six Sigma convictions on experimental methods that have been around for decades. In fact, Six Sigma consfiscates great deal of the complexity that characterized Total Quality Management (TQM), which the Air Force used in the beginning of 1990s but failed to sustain the initial motivation. By one expert's count, there were over 400 TQM tools and techniques. Six Sigma takes a handful of proven methods and trains a small cadre of in-house technical leaders, known as Six Sigma Black Belts, to a high level of proficiency in the application of these techniques. To be sure, some of the methods used by Black Belts use are highly advanced including the use of up-to-date computer technology

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