Improve Productivity and Product Quality by Using Six Sigma

Pramod Kumar Nagar[*1], Mr. Om Prakash Patel[*2]

Research Scholar Department of Mechanical Engineering, SSSCE, RKDF University, Bhopal
Assistance Professor, Department of Mechanical Engineering, SSSCE, RKDF University, Bhopal

[1]pk.nagar12@gmail.com

[2] omprakashpies@gmail.com

Abstract

Quality Management Systems (QMSs), Quality Circles (QCs), benchmarking, and Total Quality Management (TQM). Quality engineers presently support the simplification of performance evaluation in an effort to boost the efficiency of the industry. The utilisation of quality and process tools exhibits variability within the contemporary industrial landscape characterised by volatility, competition, and change.

Keywords:-Productivity, Product Quality, six sigma.

1. Introduction

Acknowledging the intrinsic variability of production processes, these differences are classified into two categories: those attributable to internal or natural factors, and those attributable to exceptional circumstances. The former, referred to as inevitable causes, produce a generally predictable and typical distribution of values. The latter have distinct effects on the process or environment, as they are induced by distinctive external causes. However, in order to ensure the survival and economic viability of companies, especially in quickly emerging nations confronted with obstacles such as inflation, population expansion, and volatile GDP, it is imperative to improve manufacturability. While striving to enhance efficiency and capacity utilisation, industries also prioritise intangible objectives such as community service and customer pleasure. Leverage of resources is employed to accomplish these aims. Utilizing statistical instruments and data analysis, the Six Sigma technique discovers and regulates the fundamental causes of quality problems. This approach is not limited to the manufacturing sector but is applicable to a wide range of corporate activities.

Continuous Improvement (CI), which originated in the 19th century, is a strategic approach adopted by organisations to augment profitability and efficiency while preserving brand value, customer confidence, and market share over extended time periods. CI strategies involve the modification and innovation of pre-existing models. Progressive strategies like as artificial intelligence, fuzzy logic, just-in-time (JIT), Six Sigma, and Total Productive Maintenance (TPM) are merged with conventional approaches including lean, kanban, TQM, and just-in- time (JIT). Combining traditional and contemporary approaches is regarded as the most efficient option for fulfilling operational requirements. The application of Lean, Six Sigma, and the Theory of Limitations (TOL), either in isolation or in conjunction, has demonstrated substantial enhancements. Particularly, lean concepts emphasise the elimination of hidden waste in manufacturing systems by detecting and resolving inefficiencies in transportation and overproduction.

Six Sigma, abbreviated as 6∫, is a systematic methodology that optimises manufacturing and business processes through the implementation of particular tools and processes. The concept was first introduced by Bill Smith and Mikel J Harry in conjunction with Motorola in 1986. It

garnered considerable attention and support when Jack Welch integrated it into the operational strategy of General Electric in 1995. This approach is widely recognised for its ability to enhance quality and reduce process variation. By identifying and correcting faults, as well as suggesting alternate techniques for manufacturing and business operations, it endeavours to increase the output of processes.

2. Application of Six Sigma

The Six Sigma framework comprises a sequence of activities comprising statistical approaches, quality control processes, and empirical methodologies. These components are organised according to five phases of guidance that pertain to the management of system resources. Each Six Sigma project inside an organisation is structured to adhere to these procedural phases, with each step having its own unique value objectives. The principal objectives of Six Sigma implementation are the reduction of costs and variability, the enhancement of customer happiness and profitability, and the decrease in operation cycle times. Six Sigma, a term that was formally registered as a trademark by Motorola on December 28, 1993, originated from the field of statistical analysis. As indicated by the sigma level, it gives a metric for assessing the quality and efficiency of manufacturing. The objective of Six Sigma's manufacturing process adoption is to achieve an almost flawless accuracy rate of 99.99966 precent, permitting a maximum of 3.4 errors per million items. The initial benchmark of 3.4 faults per million, established by Motorola for its subsidiaries, swiftly evolved into a criterion for excellence in quality management.

Scholars and professionals throughout the world have acknowledged Six Sigma as a unique and very successful approach to quality improvement. Its focused approach to process quality control, thorough analysis, and empirical decision-making distinguish it from other quality programmes. Its increasing adoption by organisations across the globe, representing diverse industries and backgrounds, serves as evidence of its efficacy. In business organisations, Six Sigma is seen as a crucial approach for obtaining high levels of efficiency and productivity. As time has progressed, academics hailing from many nations have re-evaluated Six Sigma, contributing varied viewpoints regarding its execution and consequences, thereby

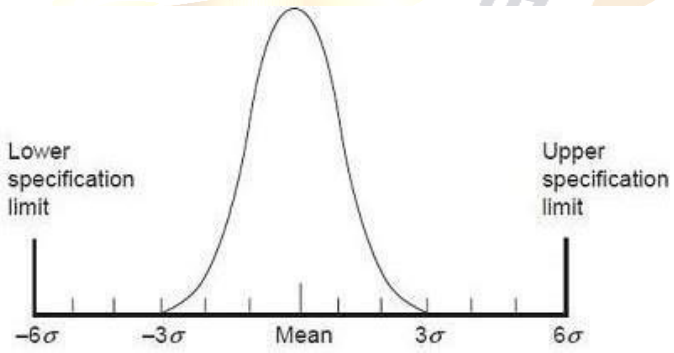


Figure 1 3-sigma and 6-sigma definitions

expanding the methodology's range and practicality.

Step-I: Application of Statistics for implementation of Six Sigma Six Sigma is defined as an estimatory parameter that possesses a quantifiable foundation. Sigma quantifies the capacity of a cycle to execute or produce work that is devoid of imperfections. Six Sigma is further defined as an information- driven process that relies on a high level of performance in the first driver analysis of business- related problems and subsequently identifies solutions for them. GE defines Six Sigma as a metrics-driven methodology that tracks deviations from achieving perfection

for a given cycle.

According to **[1]**, statistically speaking, Six Sigma refers to a process in which the difference between the mean quality of the process and the nearest specification limit is no more than six times the process's standard deviation (SD). **[2[** posits that the Six Sigma concept is predicated on insights and aids in sequentially defining the problem, granting access to tools for estimating and analysing the influencing factors, and ultimately acknowledging the quantity of implemented enhancements that must be maintained in operational mode with a controlling cycle in order to sustain the improvements over an extended period of time. **[3]** assert that Six Sigma places significant emphasis on financial achievements that are achieved via the total elimination of defects in products and processes. **[4]** asserts that Six Sigma is seen as a lean technique that is structured with the needs of the organisation in mind. Six Sigma is a methodical and structured concept that places its trust in enhancing cycle capability with a focus on customer requirements [5]. This method is overly exhaustive in quality control for firms who are still striving to achieve three-sigma performance [6]. This method has reportedly generated enormous financial gains with the aid of tools employing advanced information analysis, by emphasising customer service, and by implementing tools/a strategy for operating the board [7]. Sigma, according to **[8]**, is a term originating from Greek that is applied to several types. Six Sigma is a highly structured programme whose primary objective is to enhance business processes through the reduction of variations and omissions in separate production processes. Six Sigma is defined by a surrender rate of 3.4 per million openings (DPMO) [9]. Six Sigma is an exceedingly precise factual approach that relies on the utilisation of pre-existing data with the objective of eliminating defects within a certain cycle or item [10]. A deformity is defined as any condition that is not under the control of the client

Phase Two: Six Sigma from a managerial standpoint Six Sigma with the combined impact of Steps I and II in Step III It is recommended that all Six Sigma initiatives adhere to two sets of procedural approaches that draw inspiration from Deming's "Plan-Do-Check-Act" Cycle. Instructions for each module comprise the subsequent five stages that comprise these approaches.

- Control, Define, Measure, Analyze, and Enhance (DMAIC)
- Design, Define, Measure, Analyze, and Confirm (DMADV)

DMAIC, a structured approach used in process improvement, consists of five

critical stages: Define, Measure, Analyze, Improve, and Control.

In the Define phase, the focus is on comprehending the current operational processes, capturing the customer's voice, and understanding their key requirements and expectations. The Measure phase involves identifying the essential aspects of the current process, collecting relevant data, and assessing the process's existing capability. During the Analyze phase, the emphasis is on thorough data examination to establish the link between inputs and outputs in the system. This phase includes data processing, analysis, and interpretation, aiming to identify the primary causes of variances and errors within the system. The Improve phase is dedicated to enhancing the current processes based on the insights gained from data analysis. This involves designing experiments, establishing standardized workflow procedures, and planning

the future state of the process to achieve better results. The Control phase is about maintaining the improvements and ensuring the process remains consistent to deliver the desired outcomes. This phase involves implementing robust monitoring mechanisms, such as statistical analysis, visual inspections, and automated checks, to maintain process integrity. The control measures are iteratively applied and adjusted until optimal quality is consistently achieved.

The implementation of Six Sigma involves a variety of specialized tools, each tailored to facilitate specific stages of the Six Sigma methodology. These tools are essential for extracting valuable insights and outcomes from Six Sigma techniques. In the initial Define step, tools such as Voice of the Customer (VOC) methodologies, process mapping techniques, Project Charters, SIPOC (Suppliers, Inputs, Process, Outputs, Customers) diagrams, Quality Function Deployment (QFD), and benchmarking practices are utilized. These tools assist in clearly defining the project scope, objectives, and customer requirements. During the Measure phase, tools focused on data analysis come into play. This includes methods for data reduction and mining, Pareto Charts for identifying key issues, Run Analysis for process stability, Exploratory Data Analysis for uncovering underlying patterns, and Descriptive Statistics to summarize data characteristics.

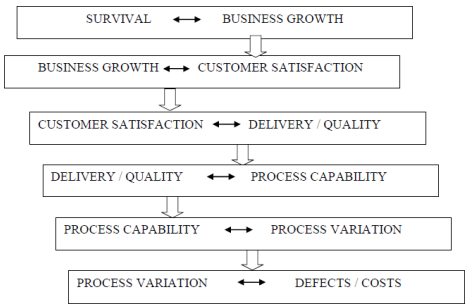
In the Analyze step, more complex tools are employed to delve deeper into process issues. These include the Fishbone Diagram for identifying potential causes of problems, Tree Diagrams for breaking down issues, Design of Experiments (DOE) for testing hypotheses, Enumeration Statistics for detailed data analysis, Failure Modes and Effects Analysis (FMEA) for

risk assessment, and ANOVA (Analysis of Variance) alongside Simulation techniques for further data exploration.

The Improve phase leverages tools like the Force Field Diagram to identify forces affecting a problem, the 7M tools for a comprehensive approach to problem-solving, and Prototype Pilot Studies to test potential solutions. In the Control step, tools such as Statistical Process Control (SPC) to monitor process stability, FMEA for ongoing risk management, and a structured Reporting System are crucial. These tools ensure that the improvements are sustained over time and that the process remains under control. Each association has its own set of deficiencies and strengths. In this particular scenario, the Six Sigma technique proves to be advantageous in aiding an organisation with its own investigation. A substantial proportion of deficiencies will manifest solely during the implementation of Six Sigma as a method of improvement. As stated by Charles Waxer (2004), whenever the simplicity of Six Sigma implementation and organisational requirements are discussed, it is common to observe that small organisations have both advantages and disadvantages. These minor associations are more versatile, adaptable, and light-footed. However, their needs can include limited access to trained belts or considerably less knowledge on Six Sigma in comparison to the vast resources and infrastructure of major organisations. A small organisation possesses a multitude of options for managing the cost of preparation, including the cost of hiring a specialist to conduct preparation and the organisation of many advisors to provide expert guidance on the specific task. Generally, large organisations have implemented Six Sigma planning processes for not just their employees but also their suppliers, customers, and partners. Recently, restricted scope firms have assumed a crucial role in the economy of India. These are playing a substantial role in the technological and financial progress of our nation. These small businesses are a large source of employment age and account for a substantial portion of the nation's fares [10]. Six Sigma was introduced by Motorola, and although it was implemented in multiple production facilities in an incredibly quick period of time, the question of how to implement it in small and medium-sized enterprises remains. The evidence supporting the implementation of Six Sigma in small and medium-sized enterprises is minimal. Only via the implementation of Six Sigma improvement methodology can issues inside organisations be identified and then resolved. [12] asserts that small and medium enterprises (SMEs) are playing a pivotal role in the progress of the nation. Their overall contribution to the country's

GDP is approximately 40 precent, although their contribution to public fares is extremely close to 50 precent. Their contribution to the advancement of the nation and the labour force is substantial, necessitating proactive measures to address this matter.

Small firms bear the brunt of the intense heat caused by financial crises and other prevailing economic challenges that the nation is confronted with. Six Sigma will have a critical responsibility in the future to moderate the numerous problems facing the nation. There was a previous misconception that Six Sigma was exclusive to large organisations; however, this was proven to be unfounded, and it has since been denounced. Small businesses encounter a dearth of resources to implement Six Sigma. In light of evolving corporate objectives and targets, it is imperative for every organisation to employ tools that enable it to face competition and achieve progress in the current cautious era.



The objective is to employ the Six Sigma DMAIC methodology, which stands for Define, Measure, Analyze, Improve, and Control, in order to address the particular concern of oil leakage in heavy-duty transformers produced by small-scale enterprises located in Jaipur. This requires a data-driven and methodical examination in order to enhance the manufacturing process.

Conducting a comprehensive investigation and identification of the fundamental root issues that contribute to oil leaks in transformers. This include the analysis of design elements, operational procedures, material quality, and production processes.

Solve and Test Problems: Formulate, execute, and comprehensively evaluate efficacious resolutions with the objective of reducing or entirely eradicating oil leakage concerns. This target comprises enhancements to both processes and technical solutions.

Assess the Effects of Process Improvements: In order to determine how the made modifications affected the transformers' quality. This entails quantifying the decline in defect rates and assessing enhancements in the overall quality and dependability of the product.

Conclusions

In order to guarantee the implementation of durable and efficacious quality control protocols that effectively avert the reoccurrence of oil leakage flaws. This includes the development of quality inspections and standard operating procedures that may be incorporated into

the normal manufacturing process. In order to optimise resource utilisation, minimise rework, and reduce waste, the operational efficiency of small-scale transformer manufacturing units shall be increased via the implementation of Six Sigma principles.

REFERENCES

[1] Guide Jr, VDR, Srivastava R. Recoverable manufacturing systems: A framework for analysis. In: Proc. 1997 Portland Int. Conf. on Management of Engineering and Technology (PICMET 97) Portland OR, 1997; 675–8.

[2] Lund R. Remanufacturing: An American resource. In: Proc. Fifth Int. Congress on Environmentally Conscious Design and Manufacturing. Rochester, NY: Rochester Institute of Technology, 1998, in press.

[3] Lund R. Remanufacturing: United States Experience and Implications for Developing Nations. Washington, DC: The World Bank, 1983.

[4] Stahel W. The utilization-focused service economy: Resource efficiency and product-life extension. In: Allenby B, Richards D, editors. The Greening of Industrial Ecosystems. Washington DC: National Academy Press, 1994.

[5] Thierry M, Salomon M, Nunen van J, Van Wassenhove L. Strategic issues in product recovery management. California Mgmt Rev 1995;37:114–35.

[6] Vandermerwe S, Oli M. Corporate challenge for an age of reconsumption. Columbia J World Business 1991;27:7–25.

[7] Ayres R, Ferrer G, Van Leynseele T. Eco-e$ciency, asset recovery and remanufacturing. Eur Mgmt J 1997;15:557–74.

[8] Ferrer G. The economics of personal computer remanufacturing. Res Conservation Recycling 1997; 21:79–108.

[9] Alam Md Tawqueer and Gangil Manish "Effect of Carburization on the Mechanical Properties & Wear Properties SAE 1020 Steel" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 3, Issue 2, June 2020.

[10] Alam Md Tawqueer and Gangil Manish cc Employees Skills Inventory using Deep Learning for Human Resource Management" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 4, December 2019.

[11] Shantilal Sonar Prashant and Gangil Manish "Warehouse Sales Forecasting using Ensemble Techniques" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 4, December 2019.

[12] 4Shantilal Sonar Prashant and Gangil Manish "A Review of Optimization-associated examine of Electrical Discharge Machining Aluminum Metal Matrix Composites" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 3, September 2019.

[13] Kumar Hemant Dave Kush and Gangil Manish "An Approach to Design of Conveyor Belt using Natural Fibres Composite" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 3, September 2019.

[14] 6. Kumar Hemant Dave Kush and Gangil Manish "An Assessment of Duplex stainless Steel pipe for Oil and Gas Application" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 3, September 2019.

[15] Sah Ram Balak and Gangil Manish "Optimization Design of EDM Machining Parameter for Carbon Fibre Nano Composite" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 3, September 2019.

[16] Kantilal Patel Bhaumik and Gangil Manish "Scope for Structural Strength Improvement of Compressor Base Frame Skid" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 2, June 2019.

[17] Kantilal Patel Bhaurnik and Gangil Manish "Recent Innovations for Structural Performance Improvement of Cotter Joint" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 2, June 2019.

[18] Tanel Hirenkumar Vishnubhai and

Gangil Manish "Recent Innovations for Structural Performance Improvement of Plummer Block" Research Journal of engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 2, June 2019.