Scientific Journal of Impact Factor (SJIF): 4.14
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 3, Issue 3, March -2016

SIMPLIFYING SIX SIGMA METHODOLOGY USING SHAININ D.O.E

Raunak Gupta[1], Dr. P. L. Verma[2], Dr. Ashish Manoria[2], Dr. Lokesh Bajpai[3]
[1]M.Tech Scholar, [2]Associate Professor, [3]Professor & Head
Department of Mechanical Engineering, Samrat Ashok Technological Institute, Vidisha (M.P), India

Abstract— Increased competition in the manufacturing sector for improving the product quality has changed the concept of quality. The quality is related with producing the product right in first attempt. The focus of industries is now shifting from just customer satisfaction to customer delight. To achieve such quality, it is necessary to reduce the variation in the product performance and process specifications. To achieve the tight variability and high process capability, industries are adopting various quality management techniques such as FMEA, BPR, Six Sigma, Design of Experiments etc. Six Sigma is one of the most popular quality management techniques among the all, whose focus is on improving the performance excellence by reducing the process variation. The implementation of six sigma in industries needs rigorous application of various quality tools and great knowledge of statistical tools. Very few studies focus on the successful implementation of six sigma in the small and medium enterprises. The most important reason behind the failure of six sigma is its complex methodology and poor organizational culture. This paper attempts to simplify the methodology used in six sigma using some other tools as used in the much simpler and powerful but less popular Shainin approach to design of experiments. The various simple and powerful tools used in Shainin methodology are Isoplot, Multi-Vari Analysis, Component search, B versus C etc. These tools, when applied along with six sigma methodology, can help in achieving the great success to the organization.

Index Terms— Six sigma, Design of Experiments, Shainin Approach, Isoplot, Multi-Vari Analysis, B versus C.

INTRODUCTION

More and more focus on the quality of the product in the current scenario is leading to the high competition. Industries are trying to delight their customers with extra features in their product as well as the smooth functioning at the competitive cost. According to Juran the assurance of quality in any industry is governed by three groups of activities;

1. Quality Planning
2. Quality Control
3. Quality Improvement

Quality planning is concerned with the process of ensuring quality at every developmental stage to satisfy the level of quality according to the customer expectation. Quality plan can be considered as a document which consists of various standards, specifications, features, resources and particularly set of activities which assures the specified quality to the customer. Quality planning is done at the pre-production stage.

Quality control is concerned with controlling all the activities required to achieve the specified features and specifications in a product to satisfy the customer. It also concerns that the product is adhering to the industry standards.

Quality improvement is concerned with focusing the approach towards the analysis of the current process and product and making the systematic efforts to improve its performance to maintain the competitive advantage. The focus of quality improvement is always towards facilitating the customers for their delight. The various models and tools used for quality improvement are Deming cycle, FMEA, fault tree analysis, Quality function deployment, Six sigma, Design of experiments etc.

The activities of quality improvement always focus on reducing the process variation and thus making the process stable and capable. This reduction in process variation can be achieved by identifying the root cause with the help of problem solving methodology. Process variation can be reduced in two ways [1];

1. To identify and control the root cause
2. To decrease the sensitivity of the process to the source of variation

The most popular strategy for reducing the process variation is six sigma. It has been applied by many industries successfully since its inception. Along with its successful implementation, there are various studies which show the failure of six sigma in small and medium enterprises.

SIX SIGMA

Six sigma can be defined as: "an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates [2]."

The basic aim of six sigma methodology is to reduce the process variation by centering the process mean to the target value. This helps in making the process stable as well as capable to meet the need of customer. The approach of six sigma is to collect and analyze the data in order to find out the root cause and thus implementation of corrective measures to eliminate them. It involves the application of various statistical tools for measuring and analyzing the data. It features virtually all relevant tools and techniques that have been developed in industrial statistics, from control charting to design of experiments, and from robust design to tolerance design [3].

The methodological approach while implementing six sigma is in form of DMAIC approach for improving the existing process or product and in form of DMADV approach for designing a new process or product. The key activities of each step in DMAIC

approach are as given in table 1. The key activities of the first three steps in DMADV are similar to the DMAIC approach. The key activities of the remaining two steps are to design the new process and verify it to suit the requirements of the customer. It is also popularly known as Design for Six Sigma (DFSS).

Table 1

S. No.	Step	Purpose
1	Define	Define the problem by identifying the customer requirements and create a project charter. This step also deals with forming the teams for six sigma implementation.
2	Measure	Measure the existing defined process and identifying the metrics by collecting data related to the process.
3	Analyze	Analyze the data obtained in previous step to identify the root cause of the problem.
4	Improve	Improve the process by conducting various experiments with the help of statistical tools and design of experiments.
5	Control	Measure the new process capability and documenting the improved process. This step also deals with maintaining the improved process.

Six sigma utilizes the application of various quantitative metrics such as process variation measurement, process capability measurement, critical to quality, critical to process, cost of poor quality, defect parts per million opportunities etc.

SHAININ D.O.E

Shainin methodology of Design of experiments was developed by the Dorian Shainin from 1950 to 1990s. It is also known as Shainin Systems (SS).There is a saying in Motorola, "Without Deming, the US would not have had a quality philosophy; without Juran, it would not have had a quality direction; without Shainin, it would not have solved quality problems!"[4]. It sums up the power of Shainin in solving the quality problems. It helps in solving various chronic quality problems.

The basic approach of Shainin D.O.E in problem solving methodology is that the variation in any product or process is caused by a maximum of 3 to 4 factors. The principle behind the Shainin system is that 80% of the variation in any product or process is caused by the 20% of the factors. The need is to identify these critical factors correctly and thus finding the interaction effect among them. These factors are represented by various colors coding in the Shainin system for better understanding.

Green Y represents the process variation problem statement in Shainin system. This output is the contribution of many input factors. The input factor, which affects the Green Y most, is termed as Red X. It signifies that elimination or control of Red X can help in reduction of variation to a large extent. The other two factors in terms of contribution to the Green Y can be represented by Pink X and Pale Pink X. The most dominant cause Red X can be a single variable or the interaction between the separate variables.

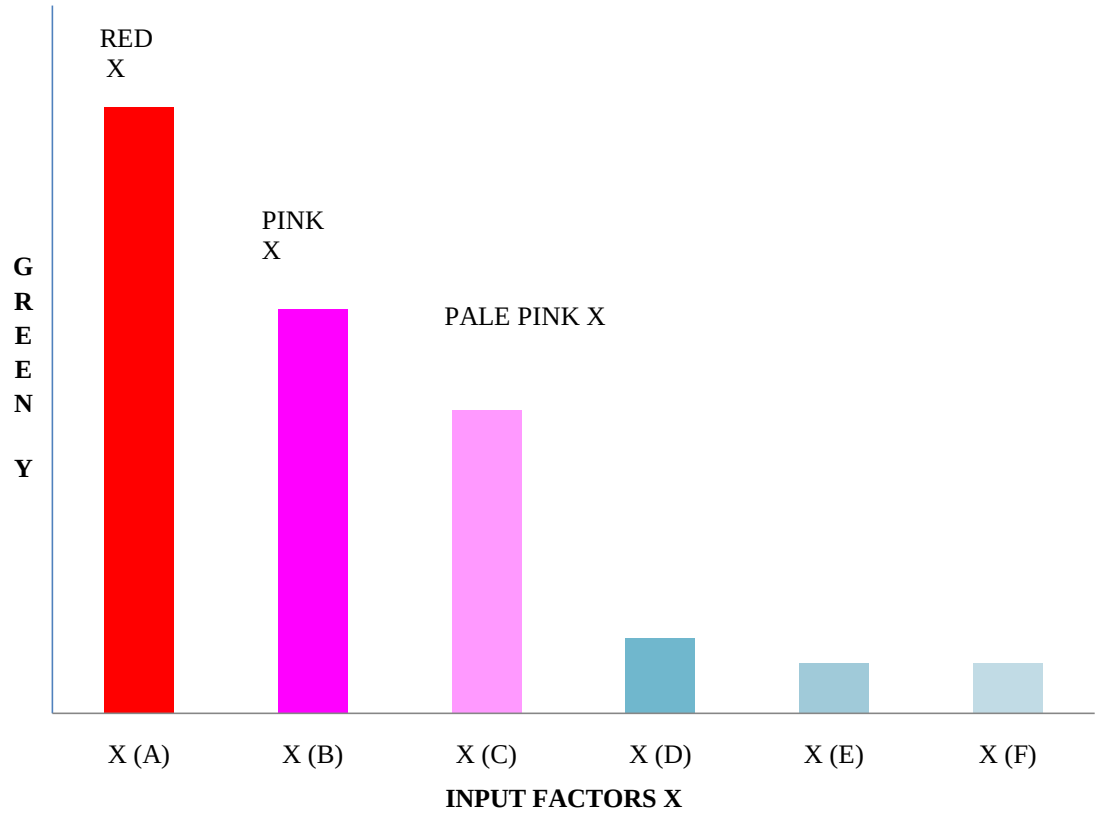

Fig. 1: *Color coding for various input factors*

The basic aim behind representing the dominant causes as color coding is giving proper attention to these causes in terms of their contribution to the Green Y or the Output variation.

The various powerful tools being used in Shainin system are such as Isoplot, Multi-Vari analysis, Concentration Chart, Component search, Paired comparison, Product/Process search, Variable search, Full factorial, B versus C etc. The Shainin system never applies the theoretical and less effective tools such as Brainstorming and Fish bone diagrams.

The basic methodology while implementing Shainin system is in the form of FACTUAL approach. The purpose of each step in this approach is as given in table 2.

The philosophy of Shainin can be understood by the statement "Don't let the engineers do the guessing; let the parts do the talking."[5]. The Shainin system always focus on understanding the machine or parts problem through the knowledge environment with powerful techniques rather than guessing.

Any problem solving methodology consists of two phases as diagnostic and remedial phase. Diagnostic phase is concerned with measuring and analyzing the current process performance while the remedial phase consists of various corrective actions taken to improve the process and monitoring the new procedure to make it a culture. Fig. 2 shows the comparison between the six sigma and Shainin methodological approach.

Table 2

S. No.	Step	Purpose
1	Focus	Converting the business opportunity in a technical project and defining it
2	Approach	Identification of Green Y, developing strategy, verifying the measurement system
3	Coverage	Identifying Red X, comparing the

		best and worst case
4	Test	Confirmation of Red X by DOE/Trial, Risk measurement
5	Understand	Understanding the relation between Red X and Green Y, Interaction between factors, Converting customer requirements in the limits
6	Apply	Corrective action implemented and validated, Updating of procedures, Monitoring of Process (Green Y)
7	Leverage	Achieved benefits

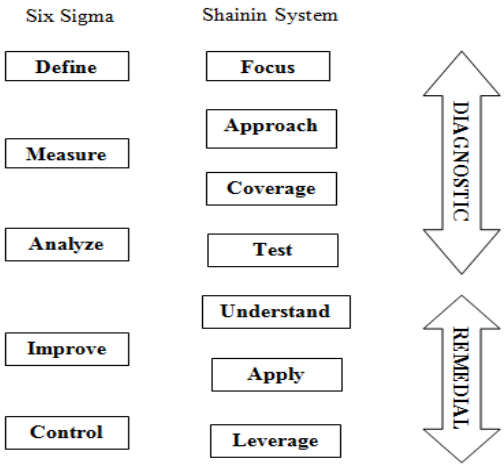

Fig. 2: *Diagnostic and Remedial Phase*

SHAININ TOOLS

The various tools used in Shainin methodology are so powerful that they can solve any chronic quality problem dramatically in a very easy way. These tools can be applied in association with six sigma methodology to make it simple and easy to implement. The two important tools being discussed here are Isoplot and Multi-Vari.

Isoplot

It is an important tool used in the Shainin methodology. An Isoplot is used to compare the relative size of the process and measurement system families of variation. In its simplest form, 30 units are selected, and each unit is measured twice [6]. This method is used to analyze that the resulting variation in the process is either due to the process or the measurement system. Fig. 3 shows an example of Isoplot.

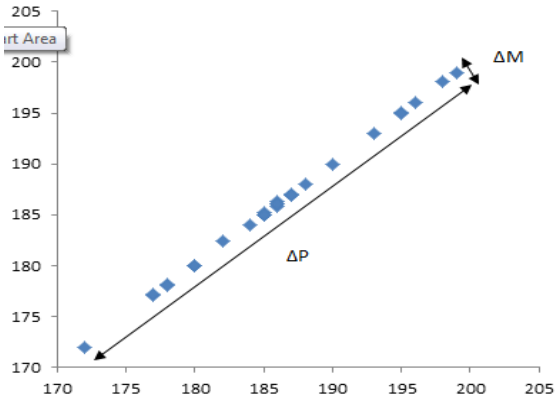

Fig. 3: *An example of Isoplot*

In the above fig. two sets of measurement are plotted against each other. Horizontal axis represents the first set of measurement and the vertical axis represents the second set of measurement. If all the points of measurement lie near to the 45^0 line, it can be said that the variation due to measurement system is very small. It means that we need to proceed with the process control to reduce the variation.

In other way we can calculate the discrimination ratio by the following formula;

$$\text{Discrimination ratio} = \Delta P/\Delta M$$

If the value of this ratio is less than 6, it means that the variation due to measurement system is large while if the value of this ratio is more than 6, it means that the variation due to the process is large. If the variation due to measurement system is large then there is need to perform full measurement system analysis (MSA) study. This technique can be used at the initial phase.

Multi-Vari Analysis

In a Multi-Vari analysis, we systematically take samples from the process to observe the causes of variation due to the various subfamilies such as time to time, unit to unit, machine to machine, with in unit etc. This technique is useful for determining that the dominant cause belongs to which family of variation. Fig. 4 shows an example of Multi-Vari analysis. This example shows the measurement of shaft diameter every hour at different locations.

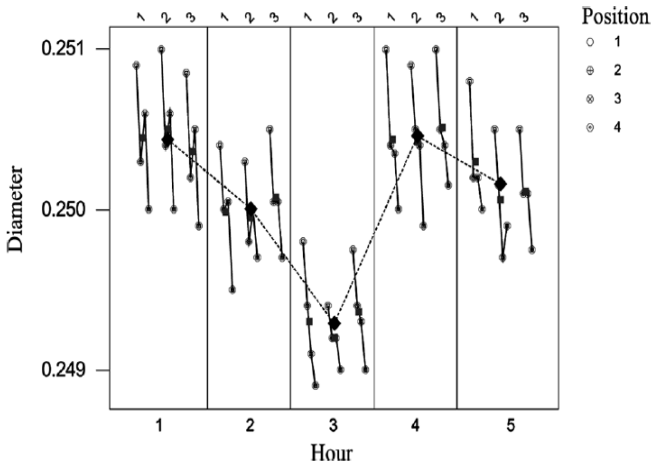

Fig. 4: *Multi-Vari Analysis*

To conduct the Multi-Vari analysis following steps can be followed;

1. If the Green Y is an attribute, convert it into the variable using Likert Scale.
2. Check that the variation due to measurement system is negligible.
3. Identify the number of families for variation.
4. Draw a family tree.
5. Calculate the number of samples required for time to time variation.
6. Calculate the number of samples required for unit to unit family from the process
7. Calculate the number of samples for each subfamily of within unit families; e.g., the number of locations, machines, cavities, heads etc.
8. Multiply the quantities in steps 3, 4, and 5 to determine the total number of units to be studied.
9. Design a table to facilitate the collection of the Multi-Vari data.

The data obtained through Multi-Vari can be analyzed after getting the most dominant family of variation. The causes for this family of variation can then be analyzed through other tools such as concentration chart, progressive search etc.

CONCLUSION

Implementation of six sigma methodology for reducing process variation is need of the hour for industries to maintain the competitive advantage. It is necessary to understand the various statistical tools and techniques being applied in the DMAIC approach of six sigma. The problem with the small and medium scale industries in implementing six sigma is their poor knowledge of statistics behind the quality improvement.

For these industries Shainin tool box comprises of various easy to understand and powerful tools to help them in improving their quality. Various studies and literature [7, 8, 9, 10, and 11] explores the successful implementation of Shainin system in the small and medium scale industries. The positive fact about the Shainin methodology is that it requires the good technical

knowledge of the process rather than guessing without any proper clue. It is the beauty of Shainin system that it goes through a structured fashion to solve any chronic quality problem. The problem with the Shainin system is the less availability of its literature. Bhote and Bhote [4] explain the Shainin method in detail. They explain the method in such a hypothesized way that it can give the dramatic success within weeks. This requires the more and more exploration of Shainin method to understand its application.

REFERENCES

1. Jan Kosina., (2015), "Shainin Methodology: An Alternative or an Effective Complement to Six Sigma?", Quality Innovation Prosperity 19/2, pp. 18-31.
2. K. Linderman, R. G. Schroeder, S. Zaheer, A. S. Choo., (2003), "Six Sigma: a goal-theoretic perspective", Journal of operations management 21, pp. 193-203.
3. Jeroen de Mast., (2004), "A methodological comparison of three strategies for quality improvement", International Journal of Quality &Reliability Management, Vol. 21 No. 2, pp. 198-21.
4. K.R. Bhote, A.K. Bhote., (2000), "World class quality using design of experiments to make it happen – II edition", AMACOM.
5. Anand K. Bewoor, Maruti S. Pawar., (2010), "Use of Shainin Tools for Simplifying Six Sigma Implementation in QMS/ISO Certified Environment– An Indian SME Case Study", Journal of Engineering Research and Studies, Vol. I, Issue II, pp. 177-194.
6. Stefan H. Steiner, R. Jock MacKay, John S. Ramberg., (2008), "An overview of the Shainin system™ for Quality Improvement", Quality Engineering 20, pp. 6-19.
7. A.K. Verma, A. Srividya, A.V. Mannika, V.A. Pankhawala, K.J. Rathanraj., (2004), "SHAININ Method: Edge Over Other DOE Techniques", Proceedings of the Engineering Management Conference (18-21 Oct 2004), IEEE International, Vol. 3, pp.1110-1113.
8. Andrew Thomas, Jiju Antony., (2004), "Applying Shainin's variables search methodology in aerospace applications", Assembly Automation, Vol. 24 Issue 2, pp. 184 – 191.
9. Anuj Ghurka, Nilesh Pawar., (2015), "Use of Shainin Design of Experiments to Reduce the Tripping Force of an Air Circuit Breaker", The International Journal Of Engineering And Science (IJES), Vol. 4, Issue 11, pp. 11-18.
10. Nagaraja Reddy K M, Dr. Y S Varadarajan, Raghuveer Prasad., (2014), "Quality Improvement during Cam Shaft Keyway Tightening using Shainin Approach", International Journal of Scientific and Research Publications, Volume 4, Issue 7, pp. 1-5.
11. Steven Cox, John Garside, Apostolos Kotsialos., (2013), "Concise process improvement definition with case studies", International Journal of Quality & Reliability Management, Vol. 30, No. 9, pp. 970-990.

