Reduction in Repair Rate of Welding Processes by using DMAIC

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Abstract

Six Sigma is being Implemented all over the world as a successful quality improvement methodology. Many companies are now days are using Six Sigma as an approach towards zero defects. This article provides a practical case study regarding the implementation of Six Sigma project in a welding facility and discusses the statistical analysis performed for bringing the welding processes in the desired sigma Limits. DMAIC was chosen as potential Six Sigma methodology with the help of findings of this methodology, First identified the critical factors affecting the process yield and then certain improvement measures were taken to improve the capability of individual welding processes and also of overall welding facility.This is an exploratory research. The research methodology incorporated qualitative & quantitative research instruments. A comparison is done between various process excellence initiatives. An integrated methodology using the tools, techniques and skills from lean principles and Six Sigma is necessary to optimize business process.

Keywords— *Six Sigma, Pareto charts, Standard deviation, Critical to Quality (CTQ), Analysis of Variance (ANOVA), DMAIC.Introduction .*

I. INTRODUCTION

All over the world many companies are adopting six sigma methodology as process excellence tool. GE, Motorola, ABB, Citi Bank, Ford is few of them. Some Asian companies are also have been implemented six sigma. Toshiba, Honda, Sony and Samsung are few of them. Six Sigma is data driven method to achieve near perfect quality. It was started by Bill Smith in mid of 1980.It is the set of practices originally developed by Motorola to systematically improve process by eliminating defects. Defect is defined as nonconformity of a product or service to its specification. A new and improved quality improvement approach called Six Sigma is also becoming popular in controlling the defect rate and managing the quality as overall process function. The term Six Sigma refers to a highly capable process that can produce products within specifications. Process that achieves Six Sigma levels produces only 3.4 defective products per million opportunities. Main focus of Six Sigma is to improve all key processes of manufacturing setup and takes quality as a function of Process Capability to produce items with in specification.

Table 1 : Sigma Level

Sigma level	DPMO
2	308537
3	66807
4	6210
5	233
6	3.4

The basic element of six sigma like , statistical process control , Failure mode effect analysis , ANOVA results , pareto charts and other tools that have been on reduction of rejects and enhancing the quality .Six Sigma provides a framework in which all these tools can be performed with management support. Applying six sigma technique on reduction in repair rate of welding process by using DMAIC. DMAIC is more focused on reacting, on detecting and resolving problems, while DFSS tends to be more proactive, a means a preventing problem DMAIC is for product or services that the organization offers currently, DFSS is for the design of new product or services and processes. DMAIC is based on manufacturing or transactional processes and DFSS is focused on marketing, R& D and design. Dollar benefits obtained from DMAIC can be quantified rather quickly , while the benefits from DFSS are more difficult to quantity and tend to be much more long term .It can take six to twelve months after the launch of new product before you will obtain proper accounting on the impact of a DFSS initiative.

II. LITERATURE REVIEW

A data driven method to achieve near perfect quality is said to be a Six Sigma strategy. This strategy was used by many companies.Factors critical to the success of quality program and their influence on performance indicators in some of Lebanese hospitals which reduce the turn- around time of in patients.

Continuous improvement of knowledge management system using Six Sigma methodology.In Indonesia,

many housing constructors are using asbestos as roofing which is partly supplied by PT BBI among many other suppliers. By implementing six sigma methodologies, the team found that this condition was mainly caused by side flat as its dominant defect type due to speeding up the curing time without simultaneously increasing its temperature.

MahaYusr, Abdul Rahim Othman, Sany Sanuri Mohd Mokhtar assessing the relationship among Absorptive Capacity, Innovation Performance and six sigma . Although six sigma focuses on internal process improvements to achieve the zero-defect target, it insists on understanding the requirements of customers. Hence, companies which apply six sigma give attention to the external activities to be in touch with their environment (Lee & Choi, 2006).While six sigma is increasingly implemented in industry, little academic research has been done on six sigma and its influence on quality management theory and application. There is a criticism that six sigma simply puts traditional quality management practices in a new package. To investigate this issue and the role of six sigma in quality management, this study reviewed both the traditional quality management and six sigma literatures and identified three new practices that are critical for implementing six sigma's concept and method in an organization. These practices are referred to as: six sigma role structure, six sigma structured improvement procedure and six sigma focus on metrics.

First introduced in 1996 to LG Electronics and Samsung SDI in Korea. Since then many world-class companies in Korea, such as Samsung electronics, Hyundai automobile, POSCO and Korea heavy industries and Construction Company have adopted six sigma as their management strategy, and they have been quite successful in six sigma implementation. Korea heavy industries and Construction Company changed its name to Doosan Heavy Industries & Construction Company in 2001. It will be referred to as 'Doosan' from now on. Six sigma is the favorite management innovation strategy in Korea now, and more and more companies are becoming interested in six sigma. It is believed that six sigma is one of the reasons why some companies in Korea have become world-class companies and have a competitive edge. The national quality prize for six sigma was introduced in Korea in 2000. The first recipients of the prize were LG Electronics and Samsung SDI. Their six sigma stories can be found in the books of LG Electronics (2000) and Samsung SDI (2000). The following improvement project was a case study at Doosan on the reduction of short shelf life material (SSLM). This was a typical non-manufacturing application which helped to develop an efficient computerized control system. The DMAIC (Define–Measure–Analyze–Improve–Control) methodology was applied in the project. Doosan learned Six Sigma management skills from General Electric in 1997, and started six sigma to achieve management innovation. In early 2002, the company published a book called six sigma best practices in which 15 six sigma project activities were published. The long-term vision of the company is to become a 'competitive world-class company of 21st century with the best quality and technology.' To achieve this vision, they made four strategies which were global company, best quality, best technology and competitiveness. In order to realize these strategies, they made their own management action plans (MAP), with which critical success themes (CSTs) were selected for quality and productivity innovation.

III. RESEARCH METHODOLOGY

DMAIC methodology which consists of sequential identification and controlling of root Causes of Problem to bring the process under control and in desired quality level. The head manufacturing at KSE workshop was not satisfied from the current welding repair rate.

A. Define

Define the problem: Define phase is first phase of six sigma that is leader of project and create map on reduction in repair rate of welding process in KS engineering workshop. Define phase of the project helps to identify the problem according to the demand of customers. In this phase of Project Quality Problems and future roadmap for the project are defined.. By decreasing the welding repair rate overall project quality and productivity would be improved. Project goal is to reduce repair rate up to 0.25 %.

B. Measure

Map out the current process: Collecting the data in order to measure Project outputs in more detail and from different angles. The Measure Phase now focuses to get a bit more information about the welding processes by measuring the Yield of different projects performed in past and calculating current sigma levels. This will help to identify areas of improvement and bench mark the quality levels to be achieved by bringing improvements. Some Tools of Measure Phase are given in the following- Cause and effect, Pareto chart , Gathering data and measuring the current problem.Data was collected for all the projects Slag inclusions and porosity are the most frequently occurring defects so efforts will be made to minimize these defects.Shielded metal arc welding and flux cored arc welding are the processes with lowest sigma values so these processes are selected for further analysis.

Sr.no.	Welding technique	Weld length(cm)	Repair defect(cm)	Defect%	DPMO	Yeild	Sigma	Cpk
1	SMAW	17531	703	4.01	40100	95.22	3.2	1.083
2	GTAW	223076	290	0.13	1300	99.28	4.5	1.500
3	FCAW	2489	80	3.21	32140	96.56	3.3	1.125
4	SAW	12195	25	0.20	2050	99.79	4.4	1.459
5	GMAW	100000	60	0.06	600	99.90	4.7	1.583
	total	355291	1158	0.32	3259	99.28	4.1	1.375

Table 2 : Collection of Data

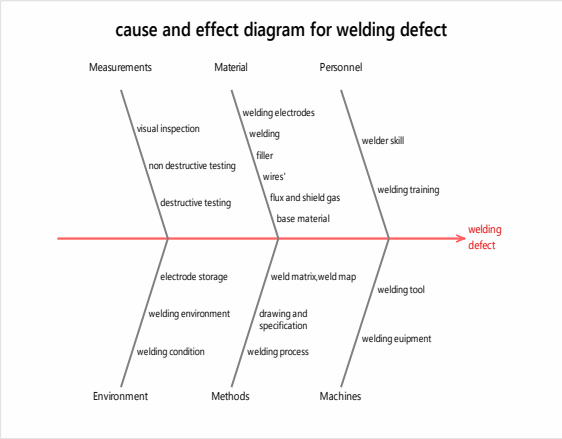

Fig. 1 . Cause And Effect Diagram For Welding Defect

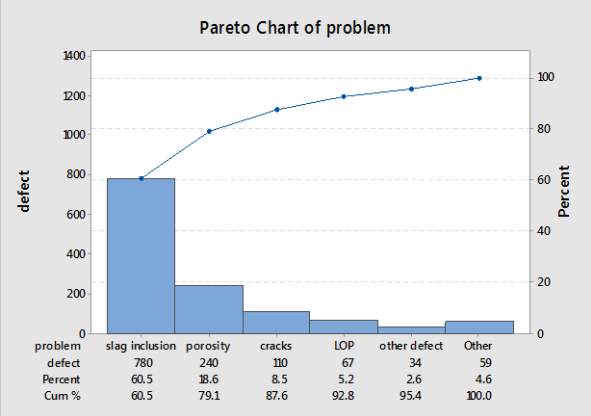

Fig.2. Pareto Chart of Defect Type

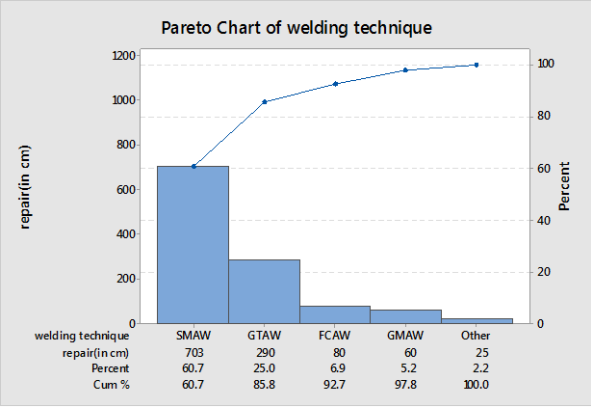

Fig.3. Pareto Chart of Welding Technique

C. Analysis

Identify the cause of problem:Establishing the baseline and target level, the team analyzed the causal relationships in detail. This phase involved identifying and validating possible X's and prepare for the design of experiment for the improve phase.The findings of measure phase show that two welding processes i.e. shielded metal arc welding and flux cored arc welding have the low sigma values of 3.2 and 3.3 consecutively and data table shows that FCAW technique is used to weld only 2489 cm of welding length. So the decision here is to remove flux cored arc welding from the investigation list and focus of improvement will now be on shielded metal arc welding due to its lowest sigma values and high repair rate. Screening experiment was done and results shown on ANOVA i.e. Analysis of variance is of P value which is less than 0.05 for electrode diameter and arc length .

D. Improve

Implement and verify the solution:This phase involves identifying solutions, select best choice, and carrying out experimentations to validate solutions and relations between the effects and causes.

Table 3 : Screening Effect

Shift	Electrode composition	Heating time (in hrs.)	Defect (%)
Evening	Low	5	0.10
Evening	High	3	0.90
Morning	Low	3	0.19
Morning	High	5	0.28
Morning	Low	5	0.12
Morning	High	3	0.87
Evening	High	5	0.30
Evening	Low	3	0.20

Electrode and heating timings of electrode in oven have P values of 0.007 and 0.009 respectively, so conclusion can be drawn that both of these factors have significant effect on the defect rate. Interaction effect of both these factors is significant because p value of 0.012 is much lesser then the alpha value of 0.05.From all these results it can be conclude that using low flux deposition electrode along with the more heating time will be set as final setting for the SMAW.

Table 4 : Data Collection for New Project

Project no.	Weld length(cm)	Slag(cm)	Porosity(cm)	Repair defect(cm)	Defect%	DPMO	Sigma
1	5055	7	3	10	0.20	1978	4.3
2	4233	5	3	08	0.19	1890	4.3
Total	7065	13	6	19	0.27 (improved)	2689	4.3

E. Control

Maintain the solution: Control phase is a mini version of process management .It is the last process In DMAIC methodology. In this phase check the market value of product and launch the product. All process and technique apply on the welding technique and then to control the process.

IV. RESULTS

The results from two of the recently completed Jobs by Shielded Metal Arc Welding Process. Slag Inclusions and Porosity were taken as Responses variable to be calculated.It is clear that SMAW process has improved from 3.2 sigma to 4.3 sigma which has also improved combined Sigma Value of overall Facility from 4.1 to 4.3 sigma Level.The defect percent before applying six sigma startegy is 0.32 % , after using DMAIC methodology with different tools defect percent reduced to 0.27% as shown in the table 4.

V. CONCLUSION

KSE is the welding facility that is equipped with modern and up to date welding technologies. A quality of welds being produced in the facility are the prime concern for the upper management of the company, because that defines the overall quality of welding facility and also explains how reliable are the welds. From the past one year this company is facing quality defects in its welding projects, due to which a six sigma project was selected for implementation. The five phases of six sigma were implemented and results were obtained to bring quality improvement in welding processes. Shielded metal arc welding was found to be at lowest sigma level so efforts were made to analyze source of variation for SMAW process. After obtaining optimum process settings for SMAW process these were implemented and results were analyzed.

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