



# A STUDY ON CONTINUOUS PROCESS IMPROVEMENT USING SIX SIGMA APPROACH AT POWERICA LIMITED, CHENNAI

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## ABSTRACT

Six-Sigma is based on the elimination of waste from the processes, both value added and non-value added, used to produce goods and services. There are five primary elements to consider while implementing Six-Sigma holistically; manufacturing flow, organization, process control, metrics and logistics. Regardless of industry, one of the key processes of manufacturers is material handling. A great deal of waste can often be found in the material handling processes of manufacturers. The operational management teams of firms are often tasked with the hurdle of reducing this waste to meet business goals and meet customer demand. Many times, techniques such as Six-Sigma are mandated as the methods by which operational groups must reduce this waste and create improvement opportunities, but a specific roadmap to define the objectives of the operational group is not provided. The goal of this research is to develop a methodology that will provide management groups with a tool to assist in defining the objectives of Six-Sigma implementations at Powerica Ltd. The central focus of the methodology is to identify waste and prioritize solutions based on the business goals of the organization.

This report thereby seeks to encapsulate the learning derived from the internship period. This report is an attempt to analyze and study the seven wastes of lean materials and the ways to reduce these wastes at Six-Sigma. There are many issues found in the manufacturing process of products at Six-Sigma. This study speaks about few issues and explains how solutions were arrived with the adoption of lean methodologies. The lean methodology is being adopted in the company for previous 5 years.

## INTRODUCTION

### 1.1 INTRODUCTION TO THE STUDY

In the existing competitive world every customer is seeks best and customized products from suppliers in the stipulated of time with low cost. In this current economic situation is all sectors are shaken by global meltdown and crisis. This has led industries to the take hard of decisions like cutting off production in owing to the lowered demand. Hence there is improving productivity, quality, on time delivery with reduced costs became the need of the hour. So it become competitive focus should be on cost reduction to minute details and building quality and to gain agility focus should be given on removing manufacturing constraints and making manufacturing process smoother. Nowadays customers want improvement in Quality, Cost reduction and Prompt delivery.

## 1.2 INDUSTRY PROFILE

The Indian diesel genset market estimated to value \$1,039.7 million in 2018 is projected to reach \$1,518.1 million by 2024, demonstrating a CAGR of 6.5% during the forecast period. This growth is expected to be driven by the high demand and adoption of medium- and high-horsepower diesel gensets across the country.

## 1.3 COMPANY PROFILE



A PROMISE FOR POWER

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power applications.

Powerica Limited was established in the year 1984 under the dynamic leadership of visionary Mr. Naresh Oberoi. It is also promoted by Bharat Naresh Oberoi and Kharatiram Kharak Puri, who have been involved in the diesel generator set business for several decades. Powerica has evolved to become a leading end-to-end power solution provider in conventional diesel-based, standby and prime

### MISSION

*"Engineer excellence in product quality and services to provide end-to-end power solutions across all segments"*

### VISION

- ✓ Powerica endeavors to create a global impact across all verticals of power production
- ✓ To design a new definition of customer satisfaction

### ASSOCIATIONS

Powerica enjoys strong alliances with technical partners who are renowned global pioneers in their fields. Cummins, Hyundai and Vestas are among the global leaders in their particular market segments. Powerica continues to explore opportunities to expand the scope of their relationship with them.

### DIESEL GENERATOR SETS

Our three-decade long associate, Cummins India Ltd. are global leaders in all aspects and areas associated with design, manufacture and servicing of diesel engine. They hold a 33.9% market share in India in 2017. For the financial year 2017-18, Powerica has the highest market share in India of 42.8% of these diesel generator sets powered by Cummins engines.

### MEDIUM SPEED LARGE GENERATORS

In 1996, Powerica made its foray into the MSLG line of slow speed captive power plants. We established a significant presence with 149 installed power plants with an estimated output of 500 MW.

### WIND ENERGY

In 2008, we began our association with M/s. Vestas, the Global leader in Wind Turbine Technology. We currently have 9 wind farms in India with an installed capacity of 147 MW with Vestas turbines. We have signed a joint venture with M/s. Vestas for the development of 750 MW of wind farms over the next five years in different states of India and a special Co-Development agreement (CDA) of 750 MW.

## 1.4 STATEMENT OF THE PROBLEM

This study speaks about the intervention of Six Sigma and reduction of wastages and it also explains how solutions were arrived with the adoption of six sigma methodologies as a process improvement.

## 1.5 NEED OF THE STUDY

During the recent years manufacturing sector witnessed a tremendous growth. Meanwhile there is increasing pressure from markets found. It is important to find methods that would make manufacturing process more efficient.

## 1.6 OBJECTIVES OF THE STUDY

### Primary Objective

**To study the process improvement techniques using six-sigma methodologies at Powerica**

### Secondary Objectives

- To identify and analyze issues and common industrial challenges or problems after implementing Six-Sigma at Powerica
- To understand the level of integration of various functions in the company's Six-Sigma.
- To understand and know about the reasons for using Six-Sigma.
- To know the benefits and obstacles in implementation of Six-Sigma.
- To give suggestions to improve the Six-Sigma operations in the organization.

## 1.7 SCOPE OF THE STUDY

Today organizations are using different tools and techniques to improve and sustain in the market. Currently, Six Sigma of tools and Lean Management are recognized as most popular and continuous improvement initiatives and companies are using them widely.

## REVIEW OF LITERATURE

### 2.1 LITERATURE REVIEW

**1. J. Muraliraj, Suhaiza Zailani, S. Kuppusamy, C. Santha, (2018) "Annotated methodological review of Lean Six Sigma", International Journal of Lean Six Sigma, Vol. 9 Issue: 1, pp.2-49**

**Purpose** – Literature reviews are a pervasive aspect in research. An ever mounting field such as Lean Six Sigma requires a perpetual touch on the subject to accentuate insights that can be researched about. The purpose of this paper is to address the published literatures in the field of Lean Six Sigma through multiple criterion for an enhanced understanding of the subject matter through summarizing its current trends, uncovering existing literature gaps and revealing opportunities for future research in the field.

**2.Pramod Kumar Shrivastava (2017) International Journal of Business Administration and Management. ISSN 2278-3660 Volume 7, Number 1 (2017)**

In this paper we provide an exploration and analysis of implementing Lean Six Sigma (LSS) as a strategy in manufacturing small- and medium-sized enterprises (SMEs). Critical factors are identified and analysed. Exploratory evidences about LSS implementation in SMEs were collected from a survey study.

**3. Rajesh Kumar Mehta, D.Mehta, Naveen K. Mehta, 2016, Six-sigma Practices: Problems and Prospects, Faculty Of Engineering - Hunedoara, Romania, International journal of Engineering**

According to **Rajesh, ehta and Naveen (2012)**, lean is about generating more values for buyers by removing activities that are regarded waste. Any activity or process that consume resources, adds cost or time without creating value becomes the target for elimination. Six-sigma is an efficient way to identifying and eliminating waste through incessant improvement. Lean is about doing things in less time, inventory, space, people, and money. The core objective of Six-sigma is elimination of waste in production, maintaining customer relations, product design, supply chain and factory management.

**4. Mahmoud Dehghan Nayeri and Malihe Rostami (2016), Effectiveness of Six Sigma Methodology through BSC in Banking industry, Asian Economic and Social Society ISSN (E): 2225-4226 Volume 6, Issue 1, 2016, pp. 13-21**

This paper aims to discuss the effectiveness of Six Sigma through balanced scorecard in banking industry. Six-Sigma is a powerful analytical technique which yields a dramatic reduction in defects, errors, or mistakes in production and service processes. So it can be useful to find defectives in financial institutions and banks while it can accompany with BSC to approach all organization aspects. Reaching this aim, this paper tries to survey the effectiveness of Six Sigma through balanced scorecard aspects in one of Iranian pioneer banks in deploying aforementioned methodologies.

**5. MehulMayatra , Mr. N.D. Chauhan , Mr. ParthivTrivedi, 2015, A literature review on implementation of Six-sigma Techniques, Mayatra et al, International Journal of Advance Research, Ideas and Innovations in Technology, Volume 1, Issue 4**

According to **Mehul, Chuhanand Parthiv (2015)**, in competitive environment Six-sigma is necessary in every industry. Six-sigma is a standard manufacturing mode of the 21st century. Six-sigma have various synonyms like lean management, Six-sigma, It is very use full techniques for reduce the flow of non-value added time. Six-sigma is a philosophy to reduce the time between customer order and products are ready for the delivery by eliminating waste. Waste (muda) is a serious problem in to the industry it is creates a non-value added services and poor quality of the product.

## **RESEARCH METHODOLOGY**

### **3.1 RESEARCH DESIGN**

Research can be defined as a systematic and objective process of gathering, recording and analyzing data to guide decision making. It is mainly used to reduce the uncertainty of decisions.

### **3.2. SAMPLING TECHNIQUE**

This study adopts simple random sampling method for samples collection. A **Random sampling** is the purest form of probability sampling. Each member of the population has an equal and known chance of being selected.

### **3.3 DATA REQUIREMENTS**

**Primary Data:** This report majorly concentrates on primary data collection. The instrument used for data collection is questionnaire. Primary data is considered as a fresh handed data collected by the researcher freshly.

**Secondary Data:** The secondary data for this study is collected by referring various journals, articles, magazines, internet publications and books

### **3.4 RESEARCH INSTRUMENTS TO BE USED:**

Questionnaire is the research instrument. Personal interviews and observation methods are used to collect primary data

### **3.5 SAMPLING DESIGN**

**Sample Size:** More than 100 respondents

**Sample Location:** Chennai

**Sample Targeted People:** Employees of Powerica Ltd., in Chennai

**Period of Study:** 3 months from December 2021 till February 2022

### **3.6 TOOLS FOR ANALYSIS**

#### **3.6.1 Descriptive Analysis**

#### **3.6.2 Hypothesis Analytical Tools**

- Chi square test
- ANOVA
- Correlation
- Regression
- Independent T test

### **3.7 HYPOTHESIS**

**Null Hypothesis:  $H_0$**  = There is no statistically significant relationship between gender of the respondents and their opinion on performance skill gap found on learning new things each and every time.

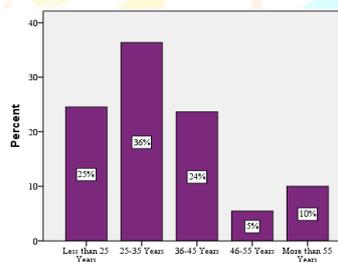
**Alternate Hypothesis:  $H_1$**  = There is a statistically significant relationship between gender of the respondents and their opinion on performance skill gap found on learning new things each and every time.

**4.1 PERCENTAGE ANALYSIS**

**TABLE 1: AGE OF THE RESPONDENTS**

Options	No.of Respondents	Percentage
Less than 25 Years	27	25%
25-35 Years	40	36%
36-45 Years	26	24%
46-55 Years	6	5%
More than 55 Years	11	10%
<b>Total</b>	<b>110</b>	<b>100%</b>

**CHART 1: AGE OF THE RESPONDENTS**



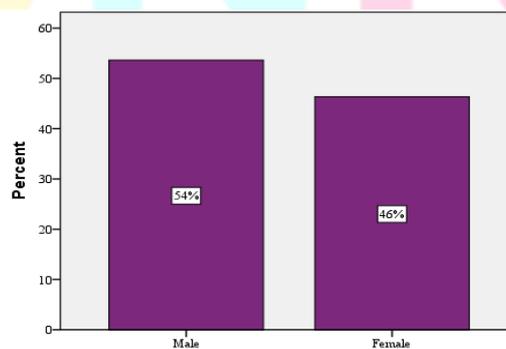
**INTERPRETATION**

25% of the respondents are less than 25 years old, 36% of them are 25-35 years old, 24% of them are in the age group of 36-45 years, 5% of them are in the age group of 46-55 Years and rest 5% respondents are more than 55 years old

**TABLE 2: GENDER OF THE RESPONDENTS**

Options	No.of Respondents	Percentage
Male	59	54%
Female	51	46%
<b>Total</b>	<b>110</b>	<b>100%</b>

**CHART 2: GENDER OF THE RESPONDENTS**

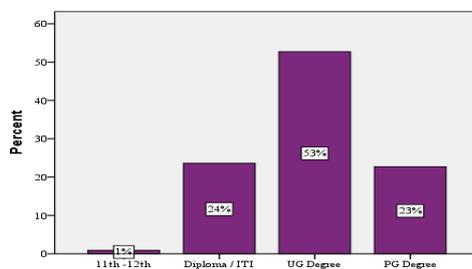


**INTERPRETATION**

54% of the respondents are male and rest 46% of them is female respondents

**TABLE 3: QUALIFICATION OF THE RESPONDENTS**

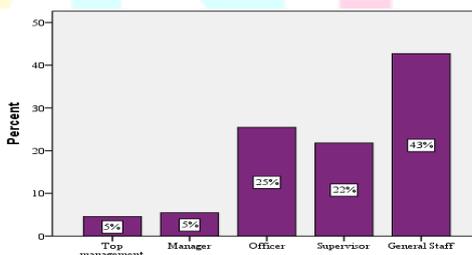
Options	No.of Respondents	Percentage
11th -12th	1	1%
Diploma / ITI	26	24%
UG Degree	58	53%
PG Degree	25	22%
<b>Total</b>	<b>110</b>	<b>100%</b>

**CHART 3: QUALIFICATION OF THE RESPONDENTS****INTERPRETATION**

1% of the respondents are 11<sup>th</sup> to 12<sup>th</sup> standard educated, 24% of them are Diploma / ITI holders, 53% of them are graduates, 23% of them are post graduates

**TABLE 4: DESIGNATION OF THE RESPONDENTS**

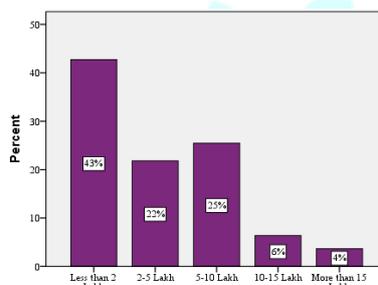
Options	No.of Respondents	Percentage
Top management	5	5%
Manager	6	5%
Officer	28	26%
Supervisor	24	22%
General Staff	47	42%
<b>Total</b>	<b>110</b>	<b>100%</b>

**CHART 4: DESIGNATION OF THE RESPONDENTS****INTERPRETATION**

5% of the respondents are from the top management of the organization, 5% of them are managers, 25% of the respondents are officer cadre employees, 22% of them are supervisors and rest 43% of them are general staff of the organization

**TABLE 5: ANNUAL INCOME OF THE RESPONDENTS**

Options	No.of Respondents	Percentage
Less than 2 Lakh	47	43%
2-5 Lakh	24	22%
5-10 Lakh	28	26%
10-15 Lakh	7	6%
More than 15 Lakh	4	3%
<b>Total</b>	<b>110</b>	<b>100%</b>

**CHART 5: ANNUAL INCOME OF THE RESPONDENTS****INTERPRETATION**

43% of the respondents are earning less than 2 Lakh per annum, 22% of them earn 2-5 lakh, 26% of them are earning 5-10 lakh per annum, 6% of them are earning 10-15 Lakh and rest 3% of them are earning more than 15 lakh per annum.

**4.2 CHISQUARE TEST**

**H<sub>0</sub> (Null hypothesis)** = There is no significant relationship between age of the respondents and their opinion on organizational culture as an issue and common industrial challenge or problem after implementing Six-Sigma

**H<sub>1</sub> (Alternate hypothesis)** = There is a significant relationship between age of the respondents and their opinion on organizational culture as an issue and common industrial challenge or problem after implementing Six-Sigma

		Age * Organizational Crosstabulation					Total
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
21-25 Years	Count	6	16	12	4	0	38
	Expected Count	12.1	15.5	7.6	2.4	.3	38.0
26-30 Years	Count	10	19	8	3	0	40
	Expected Count	12.7	16.4	8.0	2.5	.4	40.0
31-35 Years	Count	14	9	2	0	1	26
	Expected Count	8.3	10.6	5.2	1.7	.2	26.0

More than 35 Years	Count	5	1	0	0	0	6
	Expected Count	1.9	2.5	1.2	.4	.1	6.0
Total	Count	35	45	22	7	1	110
	Expected Count	35.0	45.0	22.0	7.0	1.0	110.0

FORMULA:

$$\text{CHI SQUARE} = \sum [(O-E)^2 / E]$$

O – Observed frequency

E – Expected frequency

(O – E) = Difference between observed frequency and expected frequency.

(O – E) = Square of the difference

$$\text{Degree of freedom} = (R-1) (C-1)$$

$$= (4-1) (5-1)$$

$$= 12$$

significance and df (12) the table value is 26.273

Calculated value At 5% level of = 0.010

Table value > calculated value

H<sub>0</sub> is accepted.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.273 <sup>a</sup>	12	.010
Likelihood Ratio	27.960	12	.006
Linear-by-Linear Association	14.372	1	.000
N of Valid Cases	110		
a. 11 cells (55.0%) have expected count less than 5. The minimum expected count is .05.			

**Inference:**

Hence, there is no relationship between age of the respondents and their opinion on organizational culture as an issue and common industrial challenge or problem after implementing Six-Sigma

**4.4: CORRELATION CO-EFFICIENT**

A Pearson product-moment correlation was run to determine the relationship between experience of the respondents and their opinion on lack of know-how to implement six-sigma as an obstacle

**Null Hypothesis:** Ho = There is no statistically significant relationship between experience of the respondents and their opinion on lack of know-how to implement six-sigma as an obstacle

**Alternate Hypothesis:** H<sub>1</sub> = There is a statistically significant relationship between experience of the respondents and their opinion on lack of know-how to implement six-sigma as an obstacle

Correlations			
		Experienc e	Knowho w
Experienc e	Pearson Correlation	1	.080
	Sig. (2-tailed)		.406
	N	110	110
Knowhow	Pearson Correlation	.080	1
	Sig. (2-tailed)	.406	
	N	110	110

## INTERPRETATION

The data showed no violation of normality, linearity or homoscedasticity. There was a positive correlation between experience of the respondents and their opinion on lack of know-how to implement six-sigma as an obstacle, which was statistically significant ( $r = 0.080$ ,  $n = 110$ ,  $p = 1$ ). The Pearson correlation coefficient,  $r$ , is 0.080 and that is statistically significant

## FINDINGS, SUGGESTIONS AND CONCLUSION

### 5.1 FINDINGS OF THE STUDY

- ✓ 25% of the respondents are less than 25 years old, 36% of them are 25-35 years old, 24% of them are in the age group of 36-45 years, 5% of them are in the age group of 46-55 Years and rest 5% respondents are more than 55 years old
- ✓ 54% of the respondents are male and rest 46% of them is female respondents
- ✓ 1% of the respondents are 11<sup>th</sup> to 12<sup>th</sup> standard educated, 24% of them are Diploma / ITI holders, 53% of them are graduates, 23% of them are post graduates
- ✓ 5% of the respondents are from the top management of the organization, 5% of them are managers, 25% of the respondents are officer cadre employees, 22% of them are supervisors and rest 43% of them are general staff of the organization
- ✓ 43% of the respondents are earning less than 2 Lakh per annum, 22% of them earn 2-5 lakh, 25% of them are earning 5-10 lakh per annum, 6% of them are earning 10-15 Lakh and rest 4% of them are earning more than 15 lakh per annum

### 5.2 SUGGESTIONS AND RECOMMENDATIONS

- ✓ Situation appraisal to be made to identify concerns, set priorities, and plan the next steps.
- ✓ Problem analysis should to precisely describe the problem, identify and evaluate the causes and confirm the true cause to remove seven wastages.
- ✓ Decision analysis to be made to clarify purpose, evaluates alternatives, and assesses the risks of each option and to make a final decision.
- ✓ Potential problem analysis is being identified for safety degradation that might be introduced by the corrective action
- ✓ Identify the likely causes of the problems, take preventive action and plan contingent action against seven wastages

### 5.3 CONCLUSION

The major contribution of this research is the development of a systematic methodology to implement lean manufacturing against seven wastages. The primary idea of this research is to help the company to take new initiatives such as lean manufacturing in order to become more cost-competitive in today's global market. The methodology developed for the company can be readily extended to other application areas within the continuous manufacturing industry.

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