

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

Submitted in partial fulfillment of the requirements for the award of

**MASTER OF BUSINESS ADMINISTRATION**

by

**ASHOK.R**

**Register No.40410025**



**SCHOOL OF MANAGEMENT STUDIES**

**SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY  
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE  
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

**APRIL 2022**



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## **SCHOOL OF MANAGEMENT STUDIES**

### **BONAFIDE CERTIFICATE**

This is to certify that this Project Report is the Bonafede work of ASHOK R (40410025) who has done the Project work entitled **"A STUDY ON CONTINUOUS PROCESS IMPROVEMENT USING SIX SIGMA APPROACH AT POWERICA LIMITED, CHENNAI"** under my supervision from January 2022 to March 2022.

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## **DECLARATION**

I **ASHOK R (40410025)**. Hereby declare that the Project Report entitled “**A STUDY ON CONTINUOUS PROCESS IMPROVEMENT USING SIX SIGMA APPROACH AT POWERICA LIMITED, CHENNAI**” done by me under the guidance of Dr.TR KALAI LAKSHMI, School of Business Administration is submitted in partial fulfillment of the requirements for the award of Master of Business Administration degree.

**DATE:**

**PLACE:**

**ASHOK R**

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ASHOK R

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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. The study helps to concentrate on weak areas and to define gap and to find measures to build the gap.

The company management conducted brain storming sessions to the team so as to find out all the possible causes for manufacturing defects and rejections. In this session each member in the team gave their views regarding the problem and all those points were noted without seeing its relevancy. These are known as possible causes of the problem. The data collected during observation stage are considered in this session and all the other facts related to the problem are taken in to account for developing this report

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 INTRODUCTION TO THE STUDY**

In the existing competitive world every customer seeks best and customized products from suppliers in the stipulated time with low cost. In this current economic situation all sectors are shaken by global meltdown and crisis. This has led industries to take hard decisions like cutting off production owing to the lowered demand. Hence improving productivity, quality, on time delivery with reduced costs became the need of the hour. So to 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. This results in the pressure on the manufacturing units to improve productivity, Quality and reduce cost for survival. Many leading manufacturing units are gradually transforming their production operations from their traditional methods to technologically oriented methods.

The globalization of firms that produce manufactured goods has forced firms to re-evaluate the goals and the expectations of their managerial teams. Modern manufacturing facilities are faced with escalating challenges in the world market. The proper flow of materials through processes allows firms to generate and maintain a competitive edge. This edge is the ability to meet customer demand for on time delivery, generating good customer satisfaction. One area that is of increasing concern in manufacturing is material handling. As the need to meet growing demand and greater customer expectation drives organizations, the need to monitor and manage the flow of materials through processes becomes increasingly important. The proper selection of material handling systems and manufacturing concepts such as Six-Sigma (Hobbs, 2004) help to facilitate meeting management goal, specifically increases in productivity. It is the responsibility of higher level management to define the tools and concepts that operational management can use to address such problems, but it is not the responsibility of this level of management to provide a road map or specific

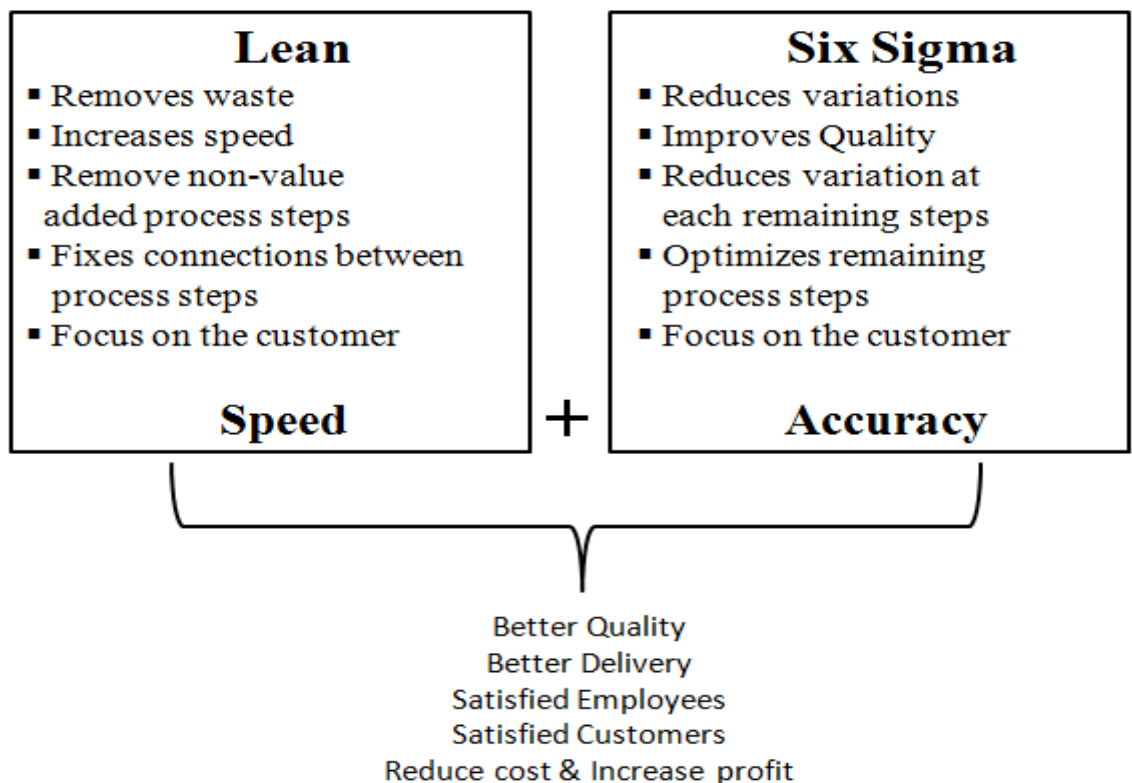
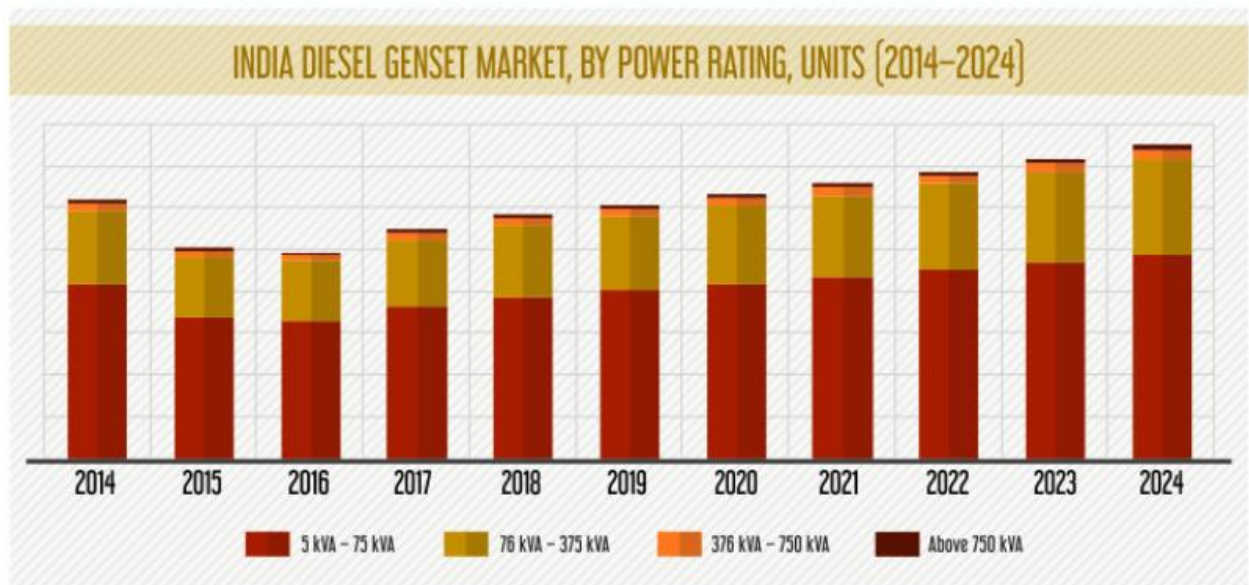
methodology to deploy these tools. Nor is it their responsibility to define what the specific goal of individual work cells will be. The problem addressed by this research is defining operations management objectives of implementing Six-Sigma to material handling systems of a petroleum drill bit manufacturing company. The implementation of Six-Sigma has been mandated by higher level management as a tool that will be used to assist in waste reduction. Operational management must define what the goals of Six-Sigma will be when deployed to specific work cells. Converting the culture of an organization to Six-Sigma and lean thinking in general is a large task. A best practice of Six-Sigma implementations is to approach the event slowly by implementing in a single pilot cell and then continue to spread to other areas of the organization.

Six Sigma is a methodology that relies on a collaborative team effort to improve performance by systematically removing waste combining lean manufacturing/lean enterprise and Six Sigma to eliminate the eight kinds of waste (muda): Time, Inventory, Motion, Waiting, Over production, Over processing, Defects, and Skills. A Lean Culture is the foundation of Lean process improvement. When a Lean Culture exists, improvement is exponentially more likely to be sustained and an environment for continuous improvement is created. It is a combination of defining customer value, aligning around a common purpose, striving for perfection while at the same time respecting and developing employees.

## 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. Furthermore, macroeconomic growth, coupled with revival in infrastructure, growth in manufacturing, and increase in commercial construction projects, is expected to boost the demand for these gensets for meeting prime and auxiliary power requirements in several facilities and plants in the coming years. A diesel genset or a diesel generator set is an integrated system comprising a diesel engine and an electric generator that work in conjunction to produce electricity. The electricity produced by the genset is used for

meeting power requirements.



On the basis of power rating, the market is classified into 5 kVA–75 kVA, 76 kVA–375 kVA, 376 kVA–750 kVA, and above 750 kVA diesel gensets. In terms of volume, the category of 5 kVA–75 kVA gensets is estimated to hold the largest share in the Indian diesel genset market in 2018. These gensets are employed in high volumes at residential and small commercial installations, construction projects, and telecom towers. Besides, since these generators are manufactured by a large number of market players in both organized and unorganized sectors, they are generally competitively priced.

Besides, factors such as investments in the telecom sector and growing installation of tower towers for connectivity in remote locations, coupled with improvements in current network capabilities, are expected to support the demand for these gensets in the Indian diesel genset market. The Indian diesel genset market is also categorized into commercial, industrial, and residential applications. Of these, gensets for commercial application are estimated to contribute the largest revenue to the market in 2018. This can be mainly attributed to the high demand for diesel generators in telecom towers, commercial offices, hospitals, and hotels. Additionally, growing cloud adoption by public and public players, increasing focus of telecom companies toward high-speed services, and construction of captive and colocation data centers are expected to drive the demand for these gensets during the forecast period. In terms of volume, nearly half of the demand in the Indian diesel genset market is estimated to be generated by Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, and Uttar Pradesh in 2018. This can be mainly attributed to the high regional demand for these gensets in various application areas, including telecom towers, residential facilities, construction projects, and manufacturing plants, for meeting prime and auxiliary power requirements.

## India Diesel Genset Market Dynamics

### Trend

The implementation of Bharat Stage VI (BS-VI) emission standards for internal combustion engines in 2016 and their nationwide rollout expected by 2020 can be viewed as a major trend observed in the Indian diesel genset market.

Under the proposed guidelines, diesel gensets of different power ratings are expected to comply with the smoke limit and other criteria laid out for particulate matter (PM) and gaseous emissions. From a manufacturing standpoint, this is expected to lead to structural reforms and significant technological overhaul in manufacturing and final product configurations. However, the transition is expected to be smooth due to the pre-existing production of standard-compliant products for export markets.

#### Drivers

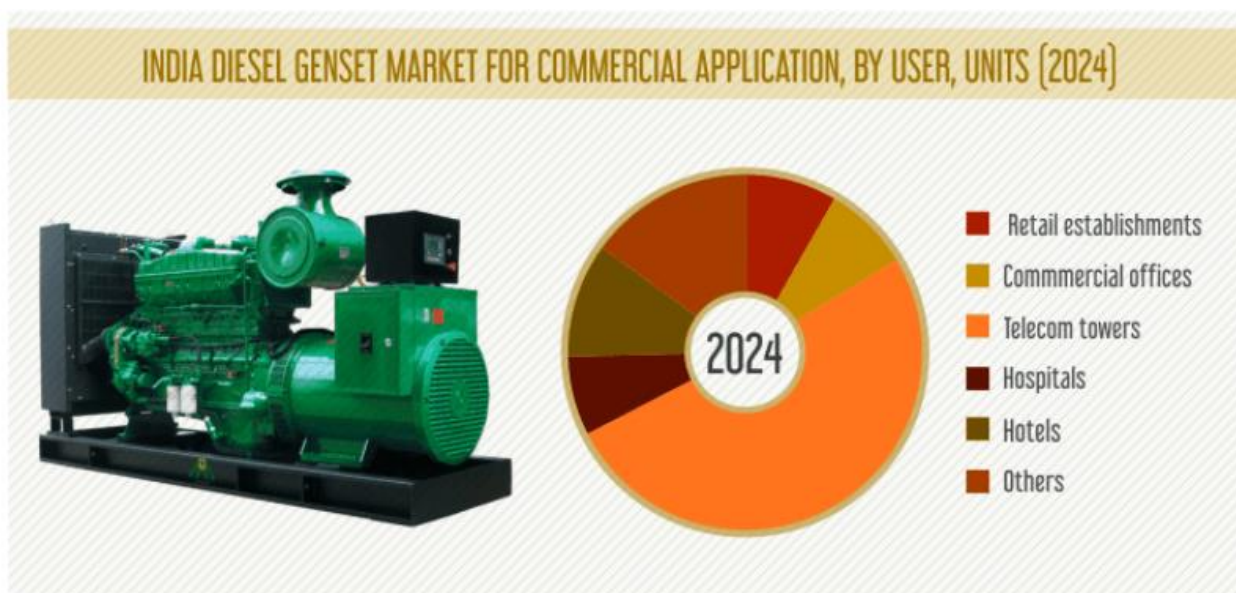
Growth in end-use industries such as manufacturing and construction is expected to result in the generation of a high-volume demand for diesel generators for commercial applications, thereby driving the Indian diesel genset market.

The Indian manufacturing industry is poised for growth on account of private and public investments, government schemes, development of special economic zones, and improvement in transportation and logistics network. Diesel generators are widely employed in manufacturing facilities owing to uncertainty, power-intensive production lines, and the need for a reliable backup power source. Thus, growth in the manufacturing industry during the forecast period is expected to drive the demand for diesel generators in the country. Besides, growth in the residential and commercial real estate market of India has picked up in recent years, on account of increased transparency, rapid urbanization, and development in the IT/ITeS sector. Increased customer confidence in residential real estate, in coherence with growth in commercial construction projects such as commercial offices, hotels, metros, and telecom towers, is expected to translate into the widespread adoption of diesel generators to meet prime and backup power requirements in the country. Furthermore, construction and localization of data centers is anticipated to act as an inflection point for the generation of a high demand for these generators, thereby positively impacting the Indian diesel genset market.

## Restraints

Increasing penetration of electricity grids and growing implementation of laws and regulations aimed at curbing environmental emissions are expected to hinder the growth of the Indian diesel genset market in the near future.

In recent years, the regulatory agencies in India have adopted stringent regulations for diesel generators owing to the detrimental environmental impact and carcinogenic nature of these gensets. Additionally, the country has made significant progress in energy generation, with its grid capacity increasing from 199.9 GW in 2012 to 344.0 GW in 2018, complemented by electrification of over 16.7 million areas during the same period. This shift toward power generation through electricity grids has lowered the traditional dependency on diesel gensets across several regions in the country, thus hampering the growth of the Indian diesel genset market.



## India Diesel Genset Market Competitive Landscape

Some of the major players operating in the Indian diesel genset market are Kirloskar Oil Engines Limited, Ashok Leyland Limited, Greaves Cotton Limited, VE Commercial Vehicles Limited, Mahindra Powerol Ltd., Cummins India Ltd., and Caterpillar Inc.

The Indian diesel genset market is characterized by the presence of several organized and unorganized players. The organized sector of the market is highly concentrated, with Cummins India Ltd., Kirloskar Oil Engines Limited, Mahindra Powerol Ltd., and Caterpillar Inc. operating as key players. These players have strong in-house R&D capabilities and offer differentiated portfolios of diesel generator sets. Besides, the Indian diesel genset industry has witnessed a number of product launches in recent years. For instance, in September 2018, Perkins, a subsidiary of Caterpillar Inc., announced the launch of its six-cylinder, 23-liter 4006 electronic engine. The genset is electronically controlled, is compatible with Perkins EST diagnostic tool, and generates 750 kVA of prime power. The product is manufactured at the company's Aurangabad facility in Maharashtra and is expected to serve a vast customer base in the country in the coming years.

### 1.3 COMPANY PROFILE



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 power applications. Dynamic growth across verticals has also led Powerica to have a strong footprint in renewable energy projects. Powerica's power solutions are provided through its expertise in manufacturing, marketing, installation, commissioning, after-sales servicing & maintenance contracts. All auxiliary systems - acoustic enclosures, fuel & exhaust systems and power & control systems that are required for a complete diesel generator set are manufactured in our factories.

Since its inception, Powerica formed a strong alliance with Cummins, a global pioneer in engine manufacturing. Powerica executes an estimated 1200 MW power with Cummins Diesel Engines annually with the supply & commissioning of over 7,000 DG

Sets. Currently, Powerica markets the complete range of engines manufactured by Cummins from 7.5kVA to 2750kVA in diesel.

Our relationship with Cummins India Ltd. defines us to be the exclusive after-sales service providers. This includes the sale of spare parts for all diesel generator sets powered by Cummins engines installed across the Indian states of Karnataka, Maharashtra, Andhra Pradesh, Pondicherry and Tamil Nadu. These services are also available for all non-DG set applications powered by Cummins engines. Powerica also has a lineage of pre-purchase consultancy, design engineering, sale, installation, lease, operation and maintenance of Medium Speed Large Generator (MSLG) sets. After 22 years of vast power provision, Powerica set forth to spread its wings in the renewable energy sector in 2006. With its roots set in using elite technology, Powerica opted to work with Vestas – the global leaders in wind energy. In 2008 Powerica commissioned its first Wind Power project becoming an Independent Power Producer (IPP). We commenced our EPC business for in-house Powerica IPP projects in 2012. Starting 2015, Powerica has emerged to become an Engineering Procurement and Construction (EPC) developer for other IPP customers.

#### 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
- ✓ With constantly evolving technological advancements being the heart of our focus, we aim to positively steer the renewable energy program in sync with the National Climate Change Green Energy.
- ✓ Having built a concrete foundation through conservative values, Powerica aims to dynamically improve the quality of life of all stakeholders of the company.

## 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. Through these associations, we are now established as market leaders for the diesel generating set business and have further expanded in related power generation and distribution businesses with MSLG and Wind Power.

## 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. We have strengthened our association through a dealership agreement to provide after sales services for the supply of spare parts and service support of engine and alternators during and post warranty in the states of Karnataka, Maharashtra and Tamil Nadu.

## 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. Extensive experience leading to strong project expertise in the generating set business enables us to provide end to end power solutions from concept to commissioning on a turnkey basis. We are associated with Hyundai Heavy Industries since 2014. We expect to continue to grow our emergency diesel generator set and base load applications business with them in the years to come. Our MSLG Power Plants, powered by engines from M/s HHI are being supplied to our domestic and international clients

## 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. Powerica is a focused industrial leader that's earned its unmatched scale and diversity. With unshakable ethical codes, the company has been committed to the industry, and its stakeholder and shareholders. Constantly evolving with the age, Powerica has diversified to become a trusted institution to manage high-value critical industries. Powerica is the Original Equipment Manufacturer (OEM) in India for Cummins India Limited, the global leaders in the design, manufacture, distribution and servicing of diesel engines.

We engage in manufacturing of diesel generating sets, components and erection, supply-installation-testing & commissioning (SITC), operation maintenance, and other services relating to diesel generating sets. These services are provided for diesel generating sets with capacities from 7.5kVA to 2750kVA prime. In addition, we design and manufacture HHP (750kVA to 2000kVA) sound attenuated containerized DG sets that are portable and simple to install & ready to use (RTU) plug-and-play. We cater to customers from Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu and the union territories of Pondicherry and Andaman and Nicobar Islands. Our diesel generator sets are supplied to almost all market segments including industrial and corporate end-users. We power industries such as automotive, realty, electronics, IT, FMCG, Mining, Agriculture, Oil & Gas, Hospitality, Pharmaceutical, Telecommunication, Data Centers and Textile.

*Powerica's wind power division broadly operates under two verticals:*

Independent Power Producers (IPP): Propelling the sustainable green energy visions of India, Powerica directly invests in wind projects and currently owns 152.75MW of wind farms. Wind Farm Development and Balance of Plant-EPC: This vertical enables Powerica and IPP customers in the market to commission wind power projects through

services provided in-house by us. These entail Wind Research Analysis (WRA), Land and Right of Way (ROW), Power Evacuation, Approvals and Permits, Balance of Plant (BoP) and related integral services.

#### **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. Six Sigma methodologies are being adopted during the past years. The study assists to focus on weak areas and to identify gap and to find procedures to build the pitfall.

#### **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. Six-Sigma came as a remedy that has been widely adopted in recent years in major manufacturing units across the world. It majorly concentrates in reducing errors thereby increasing the quality of outcome. The purpose of the report is to explore the errors that may become a major threat in Powerica Ltd. This report is mainly required to understand the effectiveness of six-sigma being implemented with questionnaire as a primary data collection tool. The major importance of this project is to help the organization to explore new dimensions of Six-Sigma in order to become more competitive in today's global market

#### **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 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 tools and Lean Management are recognized as most popular continuous improvement initiatives and companies are using them widely. The scope of our current study to identify the implementation effectiveness of Six Sigma initiatives start with understanding the current state of the Business processes in organization, integration of various functions and the impact of various process post implementation of six-sigma at Powerica Ltd. This study would address the effectiveness of Six Sigma implementation that are most important within the organization and allow them to achieve the most benefits from this strategy, as well as to identify the gaps and give recommendations for future research. There are also noticeable limitations in the fields of research into areas of Six Sigma which are intended to be addressed from the outcome of the questionnaire response received from the employees of Powerica Ltd in Chennai

## CHAPTER 2

### REVIEW OF LITERATURE

#### 2.1 LITERATURE REVIEW

**1. Stefan Andersson, 2007, Implement Six-sigma in small companies, International Project Management, Chalmers University Of Technology, Sweden**

According to **Stefan Andersson, 2007**, the study has been carried out within the field of Six-sigma. It has been aimed to investigate how a small company could implement the philosophy in own organisation. In order to answer the question what should a small company focus on to implement the Six-sigma concept successfully, an investigation in four middle sizes companies in the south and western parts of Sweden were visited. One interview was carried out with a responsible manager at all the four companies and a questionnaire was handed out to workers, in order to compare the Lean companies with company that not are working with Lean. The aim was to see if there were any large differences between the companies in the way they are working and inform the employees. The four companies were found in different Swedish technical production magazines, they were all middle sizes companies that had been working different long with the principles.

The interview and questionnaire did show that a company should implement Six-sigma if they wanted to accomplish more in the own organization with team work and get more engagement from the employees. They had realized that they could not stay in the traditional Taylorism ways of working when the employees do not need to be involved in the planning and steering of the work. It is important that all coworkers know the vision and goal why a company are implementing Six-sigma. The interview companies did almost follow the same pattern whit the implementation and that this had work quite well. But it is difficult to give any over gripping suggestion in how a company should do, instead be honest about the own organization, understand that no process are fulfill, it could always be better. Do like the company that developed Lean, look at companies that are better yourself, take the best parts of it and develop them into your own organisation. A common mistake is to take on too much, pick a few boulders to work on each year, it took Toyota, the company behind Six-sigma, more than 30 years to develop the system, and they are still improving it.

**2. RasliMuslimen, Sha'riMohdYusof, Ana Sakura ZainalAbidin, 2011, Six-sigma Implementation in Malaysian Automotive Components Manufacturer: a Case Study, Proceedings of the World Congress on Engineering 2011 Vol I WCE 2011, July 6 - 8, 2011, London, U.K.**

**Rasli, Yusof, and Ana (2011)**, in their paper present a case study of Six-sigma implementation in Malaysian automotive components manufacturer. Semi-structured interview and open-ended questionnaire were used to investigate on how to successfully implement Six-sigma in Malaysia manufacturing industry. The interview was conducted at a case study company with two managerial who are familiar with Six-sigma implementation projects. The case study company was selected due to its achievement as a Toyota Production System Model Company awarded by the Malaysia Japan Automotive Industries Cooperation. The finding shows that this case study company used the project approach in their early stage of implementing Six-sigma projects. The project based is a small scale project where the focus of Six-sigma implementation is to solve the problems at a small area. They form a team with five full-time members, determine a model line for Six-sigma implementation project, and then did the continuous improvements effort with focus on reducing the level of inventory. By reducing the level of inventory, this case study company was able to reduce other form of wastes including over production, waiting times, excessive transportation, excessive processing, excessive motion, and defective products. In the project based approach the company, conducted continuous improvement efforts until saturated level of major improvement and achieving a stable condition for the model line. Through their efforts and achievements in implementing Six-sigma, this case study company has become a reference and role model for the other manufacturing companies in Malaysia.

**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. This paper is an attempt to study issues and challenges pertaining to Six-sigma Practices in modern day organizations with special reference to gear industries.

**4. Sharma Neha, MatharouGurpreet Singh, KaurSimran, Gupta Pramod, 2013, Six-sigma Tool and Techniques in Process Industry, International Journal of Scientific Research and Reviews, IJSRR 2013, 2(1), 54-63**

**Sharmaet.al., (2013)** in their paper highlight the lean principles, tools and benefits of lean concepts in industries. Six-sigma is plethora of principles that focus on cost reduction by identifying and eliminating non value added activities. The fiercely globalized and competitive markets of 21st century demand for increasing high variety of products at reducing cost, lesser lead time and perfect quality. This changing scenario calls for a new manufacturing that would enable them to compete in this competitive globalization market. This research addresses the application of Six-sigma concepts to the continuous production/process sector with a focus on the steel industry. The ideas are tested on large manufacturing company.

**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. Wastes are

seven types occurs in industry (TIMWOOD)

- ✓ Transport,
- ✓ Inventory,
- ✓ Motion,
- ✓ Waiting,
- ✓ Over production,
- ✓ Over processing,
- ✓ Defect.

It is eliminating with the help of six-sigma. It is an integrated system that gives production of goods/services with minimum buffering costs. This paper gives the literature survey on various type of industry to apply the Six-sigma, like apply in to automobile industry, and pharmaceutical company, cotton seed oil industry, health care hospital. And also refers other 5 papers gives the information about Six-sigma and discussion. And introducing about lean .what is Six-sigma, why it is needed, and method of Six-sigma that reduces waste. And also to introduces about different lean tools

**6. 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. Respondents have been extracted among bank experts with various backgrounds who experienced both techniques in practice for at least four continues years. Findings depict that customer aspect is the most appropriate aspect for implementing Six Sigma, while Learning; Financial and Internal process aspects are less suitable respectively. It

is fruitful to declare that all BSC aspects are prone to use the advantages of Six Sigma in practice according to respondent's points of view.

**7. Raveen Rathilall and Shalini Singh (2018), A Lean Six Sigma framework to enhance the competitiveness in selected automotive component manufacturing organisations,**

**South African Journal of Economic and Management Sciences, ISSN: (Online) 2222-3436, (Print) 1015-8812**

**Background:** Currently, globalisation, economic uncertainty and fluctuating market demands prompt leaders all over the world to improve their operations and to enhance innovations in processes, products and services in a very reactive manner. Literature shows that the adoption of an integrated Lean Six Sigma tool can assist them to compete with the rest of the world in a manner where productivity, quality and operational costs reduction are crucial for economic success. **Aim:** This article investigates the integration of Lean and Six Sigma tools as a unified approach to continuous improvement and develops a Lean Six Sigma framework for selected automotive component manufacturing organisations in KwaZulu-Natal (KZN), South Africa. **Method:** The quantitative methods of research were adopted. The target population (42) was organisations within the Durban Automotive Cluster of which five were used for the pilot work. An empirical study was conducted using a survey questionnaire in measurable format to gather practical information from the sample organisations on the status of their existing business improvement programmes and quality practices. **Results:** The results of the study demonstrated that the organisations had a very low success rate of Lean and Six Sigma adoption as standalone systems, as they found it difficult to maintain the transition from theory to practice. **Conclusion:** Hence the adoption of an integrated Lean Six Sigma approach was absent and it can be concluded that the proposed Lean Six Sigma framework affords the KZN automotive sector a unique opportunity to integrate and operate with both tools of quality that complement its management style and industry demands.

**8. Kumar, Sanjay, Kumar, Naveen, Luthra, Sunil and Haleem, Abid, “Brief Review of Important Enablers of Lean Six Sigma Implementation,” *Proceedings of International conference on Smart Technologies for Mechanical Engineering*, at Delhi Technological University, New Delhi on October 25-26, 2015, pp. 409-417. ISBN: 978-93-83083-35-0**

Reduction of waste’ has been key theme of ‘lean’ concept implementation in manufacturing, process and up to some extent in service sectors of industries; however, ‘six-sigma’ concept implementation focuses upon ‘quality improvement techniques’ in production and delivery of products/services. ‘Lean six-sigma (LSS)’ concept combines tools and techniques of ‘lean’ and ‘six-sigma’ towards achieving enhanced benefits to gain competitive advantage. Implementation of LSS concept has been emphasized in this paper by addressing identification of appropriate enablers and ranking of these enablers. Literature review and subsequent discussions with experts enabled to: identify; sort and combine; and finalize twelve enablers important to implement ‘lean six-sigma’ concept. Analytical hierarchy process (AHP) has been used to rank identified LSS enablers by utilizing experts’ opinions. ‘Management involvement and funds allocation’ has been rated as top ranked enabler to implement LSS concept. Decision making authorities may be benefitted in dealing with planning and implementation of ‘lean six-sigma’ concept in manufacturing and service sectors

**9. Sukumar. S & Radhika. R (2017), A Study of Implementing Lean Six Sigma in Construction Industry, Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Issue-2, 2017**

In India, the construction industry is one of the largest industries after agriculture industry. It produces a large quantity of waste and consumes more resources, that makes construction a troubling task. The application of a new technology, Lean Six Sigma concept is likely to be effective for improving the efficiency of construction industry. It aims to eliminate all defects and also to minimize the wastage of materials, time and effort in order to generate the maximum possible amount of value. The aim of this study is to evaluate Lean six-sigma is a process improvement method to improve the construction processes by understanding and analyzing the factors affecting the

formation of construction wastes. In this paper, it is tried to improve the whole construction process by using Six Sigma DMAIC methodology. Data are collected from the Respondents and by using SPSS software the collected data are analyzed. The expected results of the study are the reduction of defects and minimization of wastes by the implementation of Lean six

**10. Valles et al. (2007), Implementation of Six Sigma in a Manufacturing Process: A Case Study, International Journal of Industrial Engineering, 16(3), 171-181, 2009.**

This paper presents a Six Sigma project conducted at a semiconductor company dedicated to the manufacture of circuit cartridges for inkjet printers. They are tested electrically in the final stage of the process measuring electrical characteristics to accept or reject them. Electrical failures accounted for about 50% of all defects. Therefore, it is crucial to establish the main problems, causes and actions to reduce the level of defects. With the implementation of Six Sigma, it was possible to determine the key factors, identify the optimum levels or tolerances and improvement opportunities. The major factors that were found through a design of experiments 3 factors and 2 levels were: abrasive pressure (90-95 psi), height of the tool (0.06-0.05) and cycle time (7000-8000 msec.). The improvement was a reduction in the electrical failures of around 50%. The results showed that with proper application of this methodology, and support for the team and staff of the organization, a positive impact on the quality and other features critical to customer satisfaction can be achieved

**11. 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. **Design/methodology/approach** – The literature review on Lean Six Sigma field spans around 17 years that includes peer-reviewed journals from management, business, engineering, healthcare, manufacturing, military among the many disciplines. The study uses a content analysis approach in which several dimensions of the literature were analysed: purpose or focus of study, years of publication, journal name or publications, methodologies, theories used, country of study, industry sub-sectors, active authors in the field, critical success factors, barriers and challenges and the most contribution of Lean Six Sigma papers by universities. **Findings** – Eleven important findings from the analysis were summarized among them; the field of Lean Six Sigma had begun to grow significantly since the new millennium particularly after the 2004-2007 or 2008 period; standalone concepts of Lean and Six Sigma are highly researched compared to the integrated concepts; large proportion of perspective, conceptual and descriptive based studies; lack of empirical validity on the fusion between Lean and Six Sigma; lack of theoretical based studies, etc. **Research limitations/implications** – The study is limited to 102 journals in commonly searched databases in the subject matter which produced 261 journal papers. This study seeks to broaden the summary of studies done under the keyword “Lean Six Sigma”. **Originality/value** – The review analysis uses a content analysis approach in search of valuable gaps in existing research. The study found 261 papers from 102 journals that were published over the past seventeen years (2000-2016). This paper provides scholars, practitioners and managers with insights on the present trends and focus of Lean Six Sigma in addition to what else are lacking in the subject matter, which could pave the way for future research and practical endeavours.

## **12. Kostic-Nikoli. S., Nikolic, I (2013), International Journal of Basic & Applied Sciences IJBAS-IJENS Vol:13 No:06**

It has been widely investigated that the application of operations management techniques is not only based on technical factors, but it is mainly associated with organizational factors such as culture, previous policies and procedures, etc. A very good example of promising operations practices is Lean Six Sigma (L6σ). The main

research question for L6 $\sigma$  is related to its liabilities regarding its implementation and how to do it in food industry. Therefore, this paper aims to explore the impact of the new tool L6s and explain what are the critical factors related to applying L6 $\sigma$ . The context of the analysis is in the general view of food industry. Since it seems that it has been neglected from the literature that mainly focuses is on manufacturing and service sector (telecommunication; healthcare and airline industry). The methodology was based on the structure interviews, of the 16 companies in Europe in food sector. The 16 top- managers will be examined on adequate way. The findings and results will help to give appropriate justifications, such as why food industries must apply L6 $\sigma$ . And also give occasion to compare with the literature review and theory. On the end it will show that there are ten (10) particular factors that influence the implementation of L6 $\sigma$  in food industry.

**13. Okpala Kenneth Enoch (2013), Lean Six Sigma Methodologies and Organizational Profitability: A Review of Manufacturing SMEs in Nigeria, *American Journal of Industrial and Business Management*, 2013, 3, 573-582**

Manufacturing small- and medium-size enterprises (MSMEs) are reluctant to the implementation Lean and Six sigma methodologies (LSS) all the over world. This is traced to the impeding factors which seem stronger than motivating factors coupled with lack of proper documented evidence of LSS's successful implementation in many MSMEs. This paper investigated the influence of LSS on the profitability of MSMEs in Nigeria. The population of the study consists of 450 manufacturing SMEs with 2250 employees. The sample frame is made up of 225 MSMEs with 1026 staff selected at random upon which copies of structured questionnaire were administered. 1002 valid responses received were analyzed. Pearson product moment correction (PPMC) confirmed the formulated propositions with negative association between awareness, achievement CSFs and LSS implementation and the profitability level of MSMEs. The result obtained shows that LSS implementation among MSMEs in Nigeria is almost none existing and has no influence on the profit level. The study recommended that CEOs of MSMEs should undertake training on LSS to enable them to provide a strong leadership and support the initiative, LSS consultants should be engaged to help drive

the quality improvement approach and MSMEs should focus on the impeding factors to reduce the effect on the LSS implementation and achieve continual quality improvement, customers' satisfaction, increase sales volume at a minimized cost to attain targeted market share and profit level.

**14. 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. To understand insight in how organizations translate CSFs into practice and cope with impeding factors, additional in-depth qualitative information was gathered from secondary source. The study outlines the issues that were fundamental to their successes in implementing the concept as a strategy. A research methodology comprises of literature review, observation of companies' practices and personal interviews have been employed to reach to the conclusion.

**15. Mohit Taneja, Arpan Manchanda (2013), Six Sigma an Approach to Improve Productivity in Manufacturing Industry International Journal of Engineering Trends and Technology (IJETT) – Volume 5 Number 6- Nov 2013**

Simulation of business and manufacturing processes has been helping companies improve their operations for several decades. During that time, business improvement programs have appeared disappeared, grown and evolved. Six-Sigma introduced another way of thinking about process improvement by focusing primarily on the financial impact and how defect reduction, customer satisfaction and improved processes all contribute. Only recently has Six Sigma broadly accepted the benefits and approach of simulation to streamline projects, improve results and in still a deeper understanding and appreciation of “the process.” This paper begins with an overview of Six Sigma, followed by a description of the benefits of iGrafx Process for Six Sigma to a Six Sigma Black Belt and ends with an example of the benefits received by an

organization through the use of simulation.

**16. K. Prabu et al.(2013), Six Sigma implementation through DMAIC: a case Study, Int. J. Process Management and Benchmarking, Vol. 3, No. 3, 2013**

This paper reports a research in which the impact of implementing define, measure, analyse, improve and control (DMAIC) phases of Six Sigma concept was examined in the production of submersible pumps. During this examination, the problem of overcoming ovality in a component called stage casing was examined through the application of DMAIC phases of Six Sigma. Conduct of design of experiment formed a core activity of this examination. At the end of conducting this examination, two solutions for overcoming ovality were evolved. One of those two solutions was implemented practically. The calculations carried out during this examination revealed that, on the implementation of these solutions, the Sigma level quality is prone to increase from 3.90 to 3.97. This increase in Sigma level indicates that, the implementation of DMAIC would aid small and medium size pumps manufacturing companies to improve their operations so as to perform at Six Sigma level quality.

**17. Kifayah Amar and Douglas Davis (2008), A Review of Six Sigma Implementation Frameworks and Related Literature, Proceedings of the International Multi Conference of Engineers and Computer Scientists 2008 Vol II IMECS 2008, 19-21 March, 2008, Hong Kong** This paper presents a review of Six Sigma focusing on implementation frameworks/models in the literature. The work is a part of a research project aimed at developing a Lean Six Sigma implementation framework for Indonesian SMEs. Most implementation frameworks examined used the concept of critical success factors in their development. In this paper, the authors examine four implementation frameworks found in the literature from two perspectives. Firstly, from a critical success factor perspective and secondly from the perspective of Rogers' diffusion of innovations theory. None of the frameworks examined comprehensively address issues suggested by Rogers' diffusion of innovations theory. The most robust framework appears to be the one developed by Burton and Sams. Our research suggests a customized implementation framework needs to be designed for

Indonesian SMEs based on Rogers' diffusion of innovations approach, but also drawing from literature on critical success factors.

**18. M. F. Elbermawy et. al., (2014) Implementation of Lean six sigma For Improving Supply Chain processes in a Pharmaceutical Industry, International Journal of Scientific & Engineering Research, Volume 5, Issue 8, August-2014, ISSN 2229-5518**

Lean and Six Sigma are recent developments in continuous improvement methodology that have been popularized by several high-profile companies. The success and complementary nature of these methodologies has led to their combination into a single methodology, commonly called Lean Six Sigma or Lean Sigma. Although there is considerable literature available and many consultants involved with Lean Six Sigma, very little published research addresses the practical experiences of companies that have implemented Lean Six Sigma. The research questions for this research are what extent applying the lean six sigma concept in supply chain process will improve the physical and information flow of the raw materials and finished goods. And what extent improving of the supply chain process by applying the lean six sigma concept will affect Delivery and speed, Quality, Flexibility, and Cost.

**19. Virender Narula, Sandeep Grover (2015), Six Sigma: Literature Review and Implications for Future Research, International Journal of Industrial Engineering & Production Research, January 2015, Volume 26, Number 1pp. 13-26**

There has been considerable number of papers published related to Six Sigma applications in manufacturing and service organizations. However, very few studies are done on reviewing the literature of Six Sigma in all the areas including manufacturing, construction, education, financial service, BPOs and healthcare etc. Considering the contribution of Six Sigma in recent time, a more comprehensive review is presented in this paper. The authors have reviewed Six Sigma literatures in the way that would help research academicians and practitioners to take a closer look at the growth, development, and applications of this technique. The authors have reviewed various journal papers and suggested different schemes of classification. In addition, certain gap areas are identified that would help researchers in further research. The paper has

been categorized in four sections. Section one & two present introduction to Six Sigma and preamble to literature review respectively. Section three presents classification of Six Sigma papers based on research methodology & research contents. Section four presents key findings, conclusion and areas for future research.

**20. Aminudin Omar & Zainol Mustafa (2014), IMPLEMENTATION OF SIX SIGMA IN SERVICE INDUSTRY, Journal of Quality Measurement and Analysis, JQMA 10(2) 2014, 77-86**

As providing high quality services becomes the major focus in many service organisations, a better understanding of the unique characteristics of services offered will be of advantage. This in turn will help assist in identification of areas to improve by implementation of quality program initiatives such as Six Sigma in such organisation. Many service processes are not visible, intangible, and even immeasurable. As such, they are not amendable to improvement using a Six Sigma approach. This thinking has turned out to be rather presumptuous at least for the health care, banking, and call centre services which have successfully implemented Six Sigma in their daily operations. Other services such as education and hospitality are also beginning to apply Six Sigma quality initiatives. This paper provides summary of limitations and suggestions for implementation of Six Sigma in the service industries

**21. Md. Enamul Kabir, S. M. Mahbubul Islam Boby, Mostafa Lutfi, Productivity Improvement by using Six-Sigma, 2013, International Journal of Engineering and Technology Volume 3 No. 12, December, 2013**

Globalization, advanced technology, and increased sophisticated customer demands change the way of conducting business. Old business models no longer work in new economy. Defects rate of product plays an important role for the improvement of yield and financial conditions of any company. The objectives of this paper are to study and evaluate processes of the case organization, to find out current sigma level and finally to improve existing sigma level through productivity improvement. According to the objectives, current sigma level has been calculated and given suggestions for improvement. This has been done by using six-sigma DMAIC cycle. Especially in

improve phase of DMAIC cycle, different improvement tools are used like 5s, supermarket and line balancing etc. By using these it has been possible to improve productivity by reducing defect rate. This research work has been carried out in a fan manufacturing company to show how to improve its productivity and quality by using Six-sigma. This paper related to work is not only applied to fan manufacturing company but also in any other types of organizations. By implementing Six-sigma a perfect synchronization among cost, quality, production time and control time will be observed

**22. Mohammad Mahmoudi Meymand, 2Iman Hakimi, Khalil Safari and Mohammad Naji(2014), A Survey on the Impact of Six Sigma Approach on Competitiveness, International Journal of Current Life Sciences - Vol.4, Issue, 9, pp. 6528-6532, September, 2014**

In today's competitive world, tiniest mistakes of organizations lead to their elimination form the competition. Therefore, organizations should seek a way in order to gain customers' satisfaction and competitive advantage. Six-Sigma is one of the newest quality control tools for gaining customer's satisfaction. It has been used by various organizations and had desirable results. We studied the impact of implementing Six Sigma approach on the competitiveness of companies located in Sirjan special economic zone. In the extant paper, questionnaire was used for gathering data and multiple regressions were used for analyzing the data. The obtained results indicate that some of the executive principles of Six Sigma including project implementations and the methods used for seeking the results, investment on the fundamental sources, analyzing data using the available data, considering the short-term and long-term goals, project's accordance with the company's business strategy, system's accordance with knowledge management and using Six Sigma tool have a significant impact on competitiveness.

**23. James E. Brady and Theodore T. Allen (2006), Six Sigma Literature: A Review and Agenda for Future Research, Quality and Reliability Engineering International; 22:335–367**

Like quality management in general, Six Sigma has penetrated into most sectors of

today's business world. Although Six Sigma originated in industry, it has inspired a considerable amount of academic literature. This paper reviews this literature describing the trends, sources, and findings. The paper also seeks to synthesize the literature, with an emphasis on establishing its relationship to quality management theory and topics for future research. In doing so, there is an attempt to answer the following fundamental questions. (i) What is Six Sigma? (ii) What are its impacts on operational performance? (iii) What roles can academics usefully play in relation to Six Sigma?

**24. Ayon Chakrabarty, Kay Chuan Tan (2014), A Survey on Six Sigma Implementation in Singapore Service Industries, Conference Paper · January 2008**

The concept of Six Sigma was initiated in 1980s by Motorola. Since then it has been implemented in several manufacturing and service organizations. Manufacturing organizations have registered success in terms of substantial bottom line results. In case of services, health care and finance were major beneficiaries till now. The application of Six Sigma is gradually picking up on other types of services like call centers, utilities and public services etc. This paper provides empirical evidence on Six Sigma implementation in service industries in Singapore. A questionnaire survey is done involving 250 service organizations. The main findings are the following. Top management commitment and cultural change emerged as the most important success factors confirming almost similar findings from literatures. Whereas attaching the Six Sigma success to financial benefits is the least important of success factors according to the respondents. Companywide commitment and customer focus are followed by organizational readiness, education and training etc to complete the list of success factors. In case of critical to quality characteristics, time (service time, waiting time and cycle time) emerged as the most important followed by response time to customer complaints. The use of tools and techniques represent similarities across services in their usage at different stages of DMAIC (Define, Measure, Analyze, Improve and Control) methodology. Efficient service and customer satisfaction emerged as most important key performance indicators followed by reduced cost and reduced variation.

Surprisingly financial benefit is less preferred as performance indicator as observed from the responses. The major reasons for not applying Six Sigma which emerged from this survey of service organizations are difficulty in collecting data, difficulty in identifying process parameters and time consuming. Some service organizations also felt that Six Sigma is not relevant to their organization. These reasons will probably help in understanding the still limited application of Six Sigma in services. Finally, the survey also shows that there are certain organizations which are planning to implement Six Sigma in near future. Overall, the results help in understanding the status of Six Sigma in service organizations in Singapore.

**25. P. Nonthaleerak and L.C. Hendry (2006), Six Sigma: literature review and key future research Areas, Int. J. Six Sigma and Competitive Advantage, Vol. 2, No. 2, 2006**

It is a timely point to extensively review the literature on Six Sigma given the recent increased research interest. This paper reviews more than 200 Six Sigma papers, classifying them according to their research content and the research methodology employed. A comprehensive list of future research areas is given. Key examples are further development of a scientific foundation for the methodology; integrating Six Sigma with other methodologies such as adding Lean Tools; considering implementation issues in areas other than North America and Europe and furthering the debate on how to adapt the approach for use in a service context.

## CHAPTER 3

### 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. The key objective of any research is to obtain accurate, relevant and timely information. The research problem having been formulated in clear in terms, the research will be required to prepare a research design i.e. research design i.e. researcher will have to state the conceptual structure with which research would be conducted. This study is descriptive in nature.

#### 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. When there are very large populations, it is often difficult or impossible to identify every member of the population, so the pool of available subjects becomes biased.

#### 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. A questionnaire is designed to measure the process improvement done using six sigma methodologies in various departments of Powerica Ltd and collected information. The research instrument for this study is questionnaire. Questionnaire is a set of questions prepared in order to collect the

required information.

#### Structure of Questionnaire

= Basic Introduction

= Personal Details

= Likert Scaling Questions

Strongly Agree, Agree, Neutral, Disagree and strongly Disagree

Highly Satisfied, Satisfied, Neutral, Dissatisfied, Highly Dissatisfied

= Suggestion Question

### 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<sub>0</sub>** = 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.

Null Hypothesis:  $H_0$  = There is no statistically significant relationship between gender of the respondents and their opinion on improved flexibility as a benefit of implementing Six-Sigma

Alternate Hypothesis:  $H_1$  = There is a statistically significant relationship between gender of the respondents and their opinion on improved flexibility as a benefit of implementing Six-Sigma study

Null Hypothesis:  $H_0$  = 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:  $H_1$  = 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

Null Hypothesis:  $H_0$  = There is no statistically significant relationship between educational qualification of the respondents and their opinion on a fully integrated management philosophy as a reason for implementing six-sigma

Alternate Hypothesis:  $H_1$  = There is a statistically significant relationship between educational qualification of the respondents and their opinion on a fully integrated management philosophy as a reason for implementing six-sigma

$H_0$  (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

$H_1$  (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.

## CHAPTER 4

### DATA ANALYSIS AND INTERPRETATION

#### 4.1 PERCENTAGE ANALYSIS

TABLE 4.1.1: 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> |

Source of data: Primary data

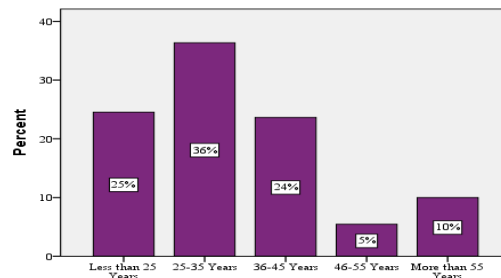


CHART 4.1.1: AGE OF THE RESPONDENTS

#### INTERPRETATION

The above table 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 10% respondents are more than 55 years old

#### INFERENCE

Majority (36%) of the respondents are in the age category of 25-35

TABLE 4.1.2: GENDER OF THE RESPONDENTS

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

Source of data: Primary data

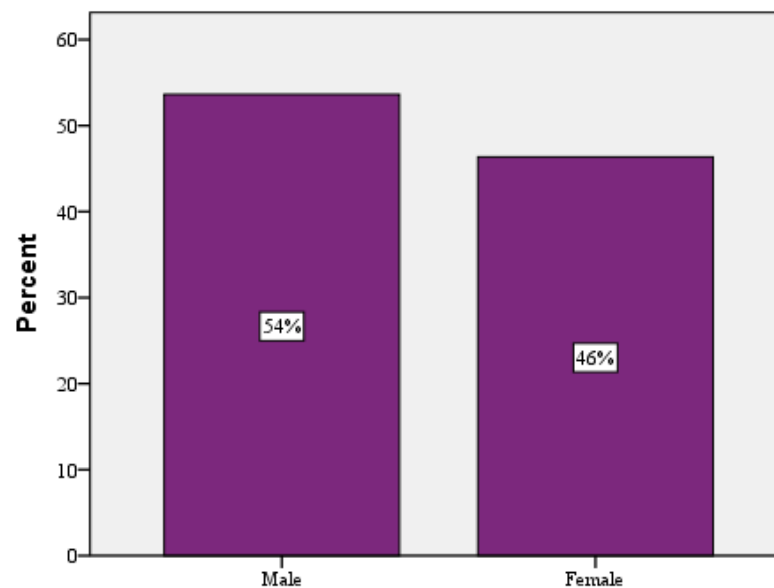


CHART 4.1.2: GENDER OF THE RESPONDENTS

#### INTERPRETATION

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

#### INFERENCE

Majority (54%) of the respondents are male

TABLE 4.1.3: QUALIFICATION OF THE RESPONDENTS

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

Source of data: Primary data

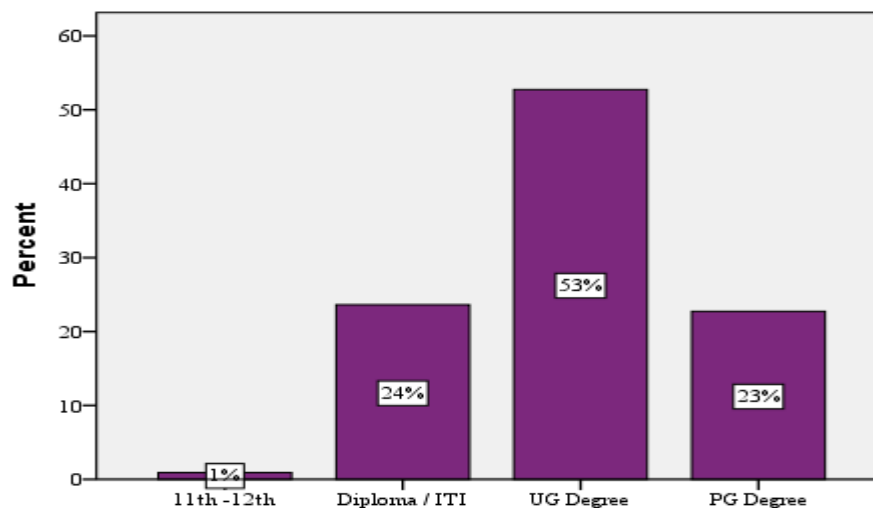


Chart 4.1.3: QUALIFICATION OF THE RESPONDENTS

#### 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

#### INFERENCE

Majority (53%) of the respondents are studied Under Graduated

TABLE 4.1.4: DESIGNATION OF THE RESPONDENTS

| Options        | No.of Respondents | Percentage  |
|----------------|-------------------|-------------|
| Top management | 5                 | 5%          |
| Manager        | 6                 | 5%          |
| Officer        | 28                | 25%         |
| Supervisor     | 24                | 22%         |
| General Staff  | 47                | 43%         |
| <b>Total</b>   | <b>110</b>        | <b>100%</b> |

Source of data: Primary data

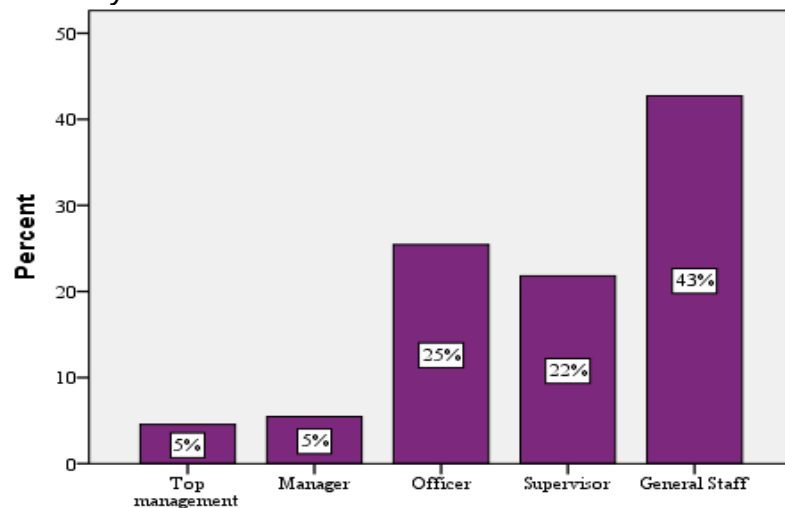


CHART 4.1.4: DESIGNATION OF THE RESPONDENTS

#### 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

#### INFERENCE

Majority (43%) of the respondents are belong to General Staff

TABLE 4.1.5: 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                | 25%         |
| 10-15 Lakh        | 7                 | 6%          |
| More than 15 Lakh | 4                 | 4%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data

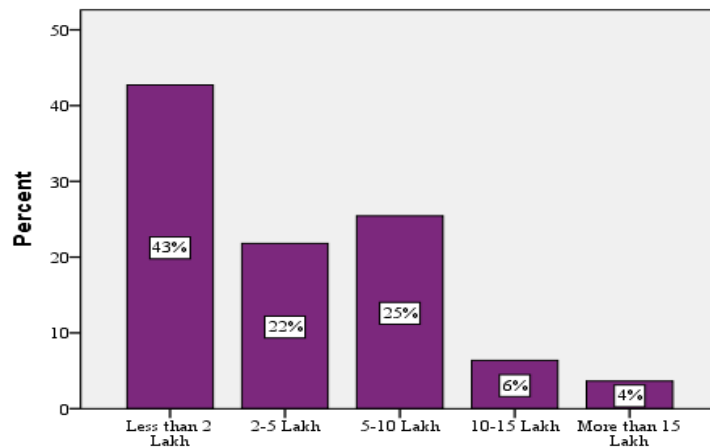


CHART 4.1.5: ANNUAL INCOME OF THE RESPONDENTS

#### INTERPRETATION

43% of the respondents are earning less than 2 Lakh per annum, 22% of them earn 2-5 lakh, 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

#### INFERENCE

Majority (43%) of the respondents are Less than two Lakhs

TABLE 4.1.6: EXPERIENCE OF THE RESPONDENTS

| Options            | No.of Respondents | Percentage  |
|--------------------|-------------------|-------------|
| 0 – 5 Years        | 27                | 25%         |
| 5 – 10 Years       | 40                | 36%         |
| 10 – 15 Years      | 25                | 23%         |
| 15 – 20 Years      | 7                 | 6%          |
| 20 Years and Above | 11                | 10%         |
| <b>Total</b>       | <b>110</b>        | <b>100%</b> |

Source of data: Primary data

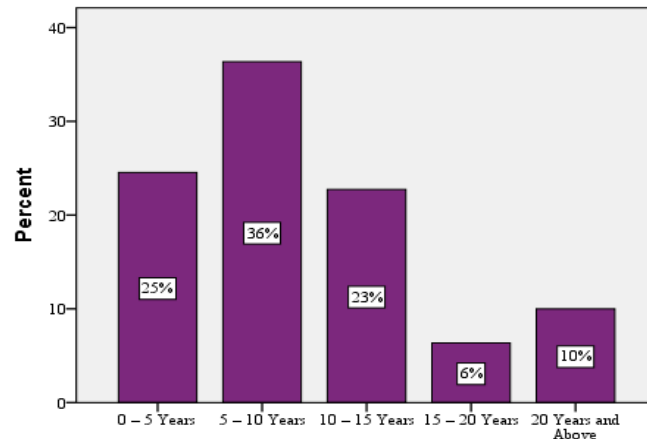


CHART 4.1.6: EXPERIENCE OF THE RESPONDENTS

#### INTERPRETATION

25% of the respondents are having less than less than 5 years of experience, 36% of them have 5-10 years of experience, 23% respondents have 10-15 years of work experience, 6% respondents have 15-20 years of experience and rest 10% of them have more than 20 years of work experience

#### INFERENCE

Majority (36%) of the respondents have 5-10 years of experience

TABLE 4.1.7: DEPARTMENT ADOPTING SIX-SIGMA MORE EFFICIENTLY

| Options                           | No.of Respondents | Percentage  |
|-----------------------------------|-------------------|-------------|
| Production Department             | 83                | 76%         |
| HR Department                     | 4                 | 4%          |
| Finance Department                | 6                 | 5%          |
| Purchase Department               | 6                 | 5%          |
| Sales and Marketing Department    | 4                 | 4%          |
| Operations and service department | 7                 | 6%          |
| <b>Total</b>                      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data

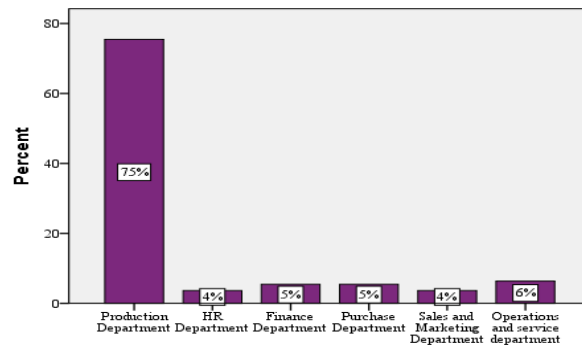


CHART 4.1.7: DEPARTMENT ADOPTING SIX-SIGMA MORE EFFICIENTLY

#### INTERPRETATION

75% of the respondents said that the production department is adopting six-sigma efficiently, 4% of the respondents said HR department is following efficiently, 5% said finance department, 5% said it is the purchase department adopting efficiently, 4% said sales and marketing department and rest 6% of them said operations and service department

#### INFERENCE

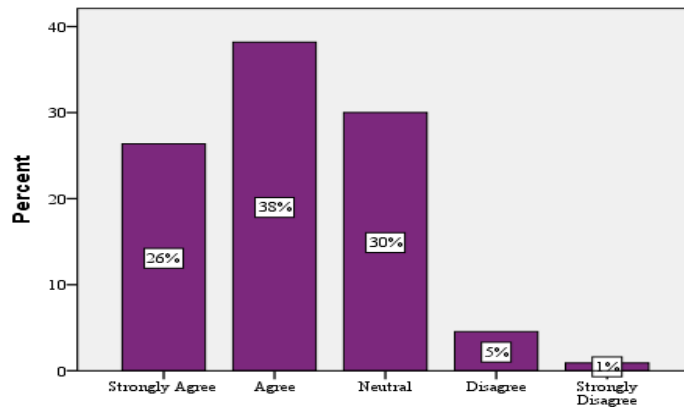
Majority (75%) of the respondents said that the production department is adopting six-sigma efficiently

### Reasons for using Six-Sigma in the production department

**TABLE 4.1.8: MAINTAIN COMPETITIVE ADVANTAGE IN PRICE AND SERVICE**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 29                | 26%         |
| Agree             | 42                | 38%         |
| Neutral           | 33                | 30%         |
| Disagree          | 5                 | 5%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.8: MAINTAIN COMPETITIVE ADVANTAGE IN PRICE AND SERVICE**

#### INTERPRETATION

26% of the respondents strongly agree that to maintain competitive advantage in price and service they use six-sigma, 38% of them agree with this, 30% respondents neither agree nor disagree, 5% of them disagree and rest 1% of them strongly disagree with this

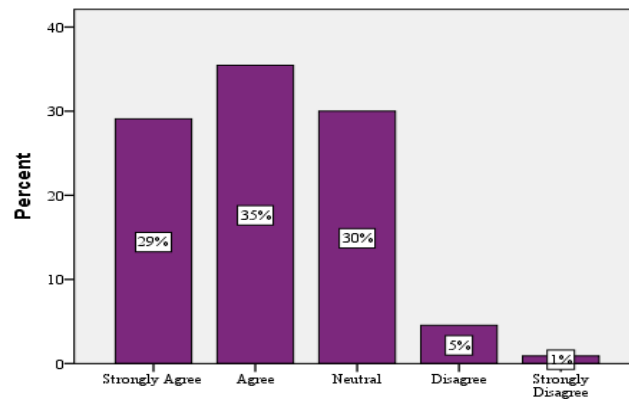
#### INFERENCE

Majority (38%) of the respondents are said Agree

**TABLE 4.1.9: PRESSURE TO IMPROVE PROFIT**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 32                | 29%         |
| Agree             | 39                | 35%         |
| Neutral           | 33                | 30%         |
| Disagree          | 5                 | 5%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.9: PRESSURE TO IMPROVE PROFIT**

#### INTERPRETATION

29% of the respondents strongly agree that six-sigma is used as the customers demanding shorter order cycle times, 35% of them agree with this, 30% respondents neither agree nor disagree, 5% of them disagree and rest 1% of them strongly disagree with this

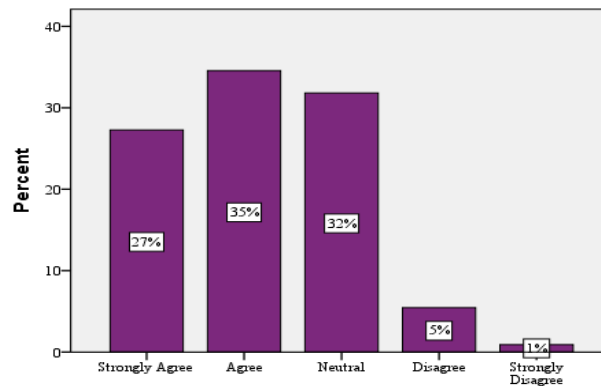
#### INFERENCE

Majority (35%) of the respondents are said Agree

**TABLE 4.1.10: CUSTOMERS DEMANDING SHORTER ORDER CYCLE TIMES**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 30                | 27%         |
| Agree             | 38                | 35%         |
| Neutral           | 35                | 32%         |
| Disagree          | 6                 | 5%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.10: CUSTOMERS DEMANDING SHORTER ORDER CYCLE TIMES**

#### INTERPRETATION

27% of the respondents strongly agree that six-sigma is used as the customers demanding reduced prices, 35% of them agree with this, 32% respondents neither agree nor disagree, and 5% of them disagree and rest 1% of them strongly disagree with this

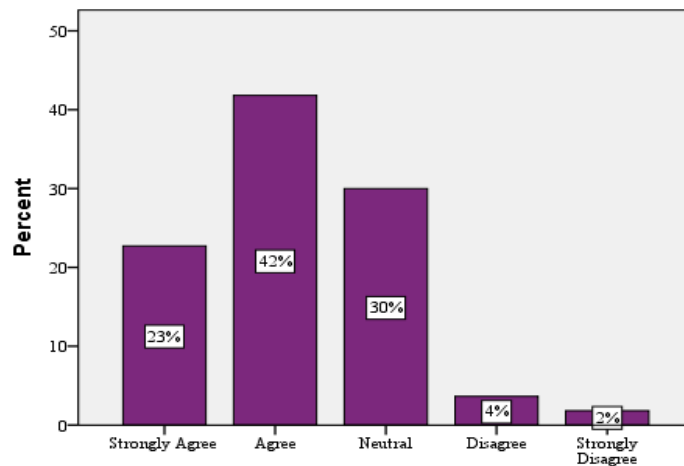
#### INFERENCE

Majority (35%) of the respondents are said Agree

**TABLE 4.1.11: CUSTOMERS DEMANDING REDUCED PRICES**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 25                | 23%         |
| Agree             | 46                | 42%         |
| Neutral           | 33                | 30%         |
| Disagree          | 4                 | 3%          |
| Strongly Disagree | 2                 | 2%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.11: CUSTOMERS DEMANDING REDUCED PRICES**

#### INTERPRETATION

23% of the respondents strongly agree that six-sigma is used as the customers demanding reduced prices, 42% of them agree with this, 30% respondents neither agree nor disagree, 4% of them disagree and rest 2% of them strongly disagree with this

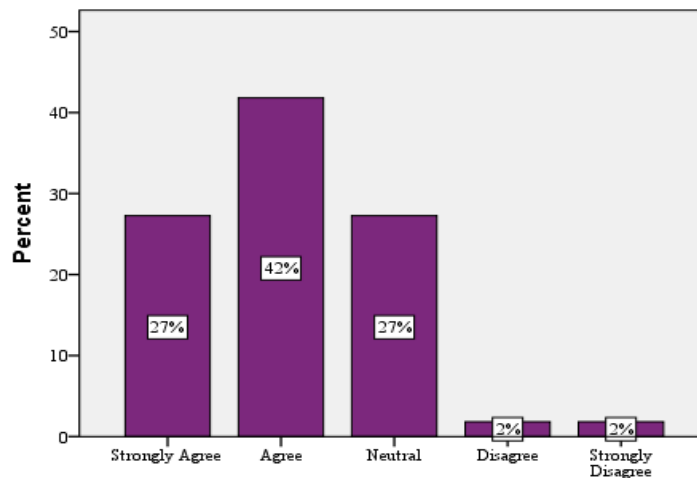
#### INFERENCE

Majority (42%) of the respondents are said Agree

**TABLE 4.1.12: USE OF TEAM WORK AND CONTINUOUS IMPROVEMENT**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 30                | 27%         |
| Agree             | 46                | 42%         |
| Neutral           | 30                | 27%         |
| Disagree          | 2                 | 2%          |
| Strongly Disagree | 2                 | 2%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.12: USE OF TEAM WORK AND CONTINUOUS IMPROVEMENT**

#### INTERPRETATION

27% of the respondents strongly agree that the use of team work and continuous improvement is the reason for using six-sigma, 42% of them agree with this, 27% respondents neither agree nor disagree, 2% of them disagree and rest 2% of them strongly disagree with this

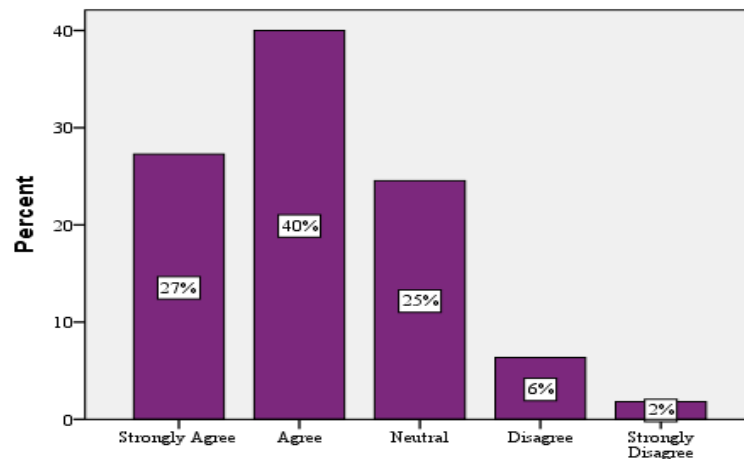
#### INFERENCE

Majority (42%) of the respondents are said Agree

**TABLE 4.1.13: ELIMINATION OF NON-VALUE ADDING TASKS**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 30                | 27%         |
| Agree             | 44                | 40%         |
| Neutral           | 27                | 25%         |
| Disagree          | 7                 | 6%          |
| Strongly Disagree | 2                 | 2%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.13: ELIMINATION OF NON-VALUE ADDING TASKS**

#### INTERPRETATION

27% of the respondents strongly agree that the elimination of non-value adding tasks is the reason for using six-sigma, 40% of them agree with this, 25% respondents neither agree nor disagree, and 6% of them disagree and rest 2% of them strongly disagree

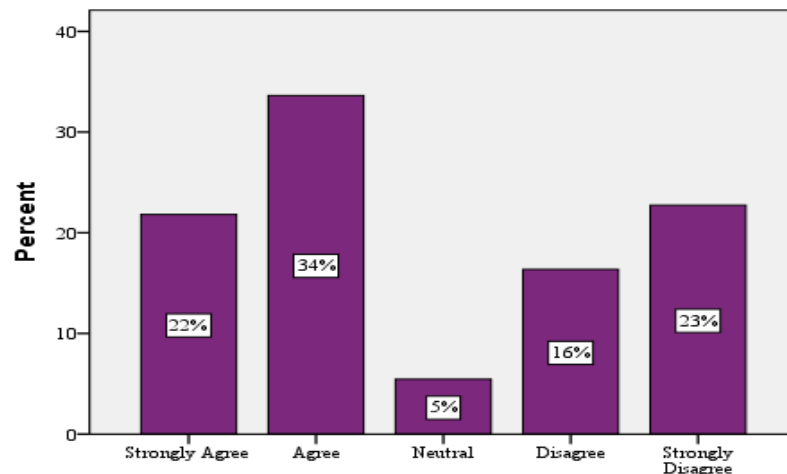
#### INFERENCE

Majority (40%) of the respondents are said Agree

**TABLE 4.1.14: A FULLY INTEGRATED MANAGEMENT PHILOSOPHY**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 24                | 22%         |
| Agree             | 37                | 34%         |
| Neutral           | 6                 | 5%          |
| Disagree          | 18                | 16%         |
| Strongly Disagree | 25                | 23%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.14: A FULLY INTEGRATED MANAGEMENT PHILOSOPHY**

#### INTERPRETATION

22% of the respondents strongly agree that a fully integrated management philosophy is the reason for adopting six-sigma, 34% of them agree with this, 5% of them strongly disagree, 16% of them disagree and rest 23% of them neither agree nor disagree with this

#### INFERENCE

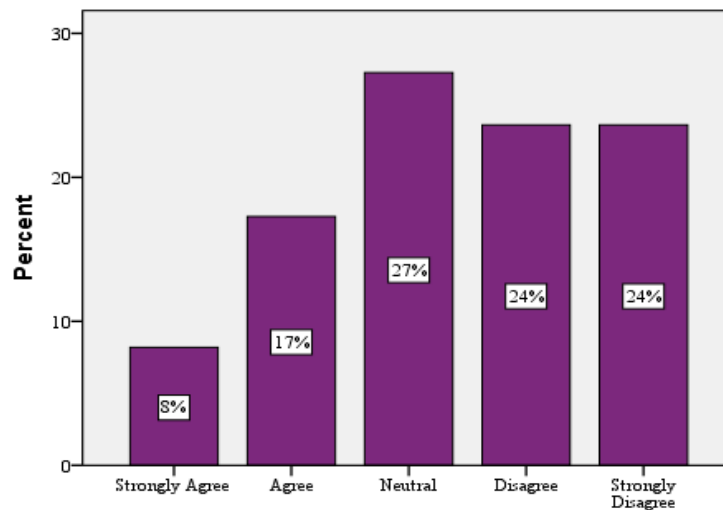
Majority (34%) of the respondents are said Agree

### Benefits of Implementation in the production department

**TABLE 4.1.15: SIX-SIGMA IMPLEMENTATION BRINGS IMPROVED FLEXIBILITY**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 9                 | 8%          |
| Agree             | 19                | 17%         |
| Neutral           | 30                | 27%         |
| Disagree          | 26                | 24%         |
| Strongly Disagree | 26                | 24%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.15: SIX-SIGMA IMPLEMENTATION BRINGS IMPROVED FLEXIBILITY**

#### INTERPRETATION

8% of the respondents strongly agree that improved flexibility is the benefit of implementing six-sigma, 17% of them agree with this, 27% of them neither agree nor disagree with this, 24% of them disagree and rest 24% of them strongly disagree

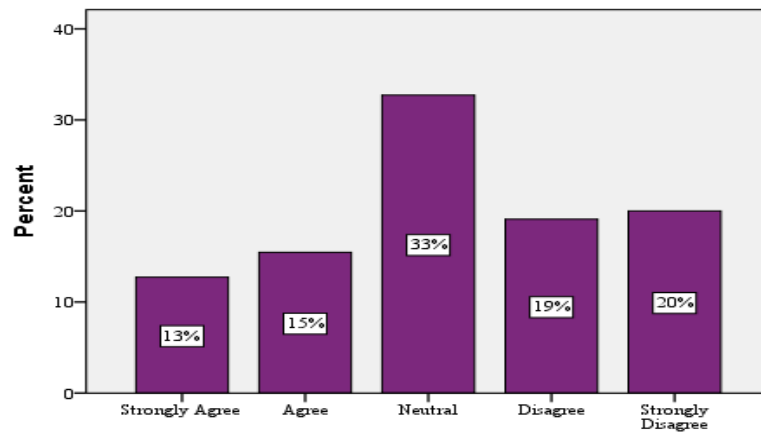
#### INFERENCE

Majority (27%) of the respondents are said neither agree nor disagree

**TABLE 4.1.16: SIX-SIGMA IMPLEMENTATION BRINGS IMPROVED RESPONSE TIME**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 14                | 13%         |
| Agree             | 17                | 15%         |
| Neutral           | 36                | 33%         |
| Disagree          | 21                | 19%         |
| Strongly Disagree | 22                | 20%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.16: SIX-SIGMA IMPLEMENTATION BRINGS IMPROVED RESPONSE TIME**

#### INTERPRETATION

13% of the respondents strongly agree that improved response time is the benefit of implementing six-sigma, 15% of them agree with this, 33% of them neither agree nor disagree with this, 19% of them disagree and rest 20% of them strongly disagree

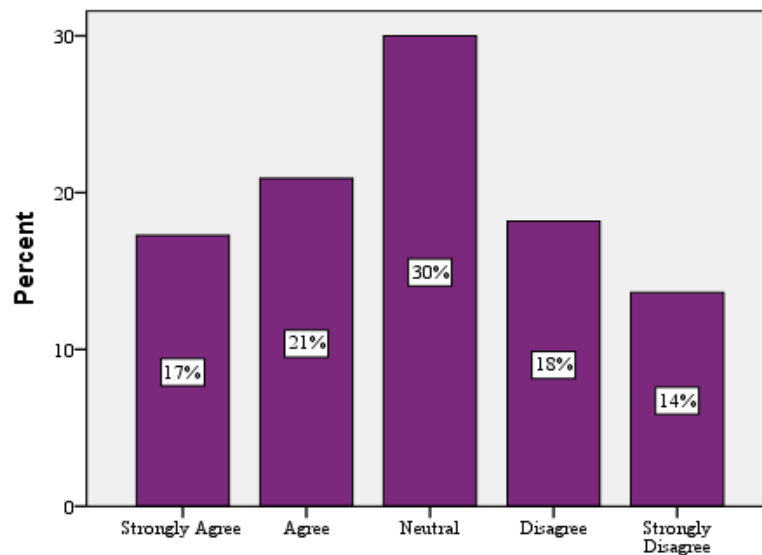
#### INFERENCE

Majority (33%) of the respondents are said neither agree nor disagree

**TABLE 4.1.17: SIX-SIGMA IMPLEMENTATION BRINGS IMPROVED QUALITY**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 19                | 17%         |
| Agree             | 23                | 21%         |
| Neutral           | 33                | 30%         |
| Disagree          | 20                | 18%         |
| Strongly Disagree | 15                | 14%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.17: SIX-SIGMA IMPLEMENTATION BRINGS IMPROVED QUALITY**

#### INTERPRETATION

17% of the respondents strongly agree that improved quality is the benefit of implementing six-sigma, 21% of them agree with this, 30% of them neither agree nor disagree with this, 18% of them disagree and rest 14% of them strongly disagree

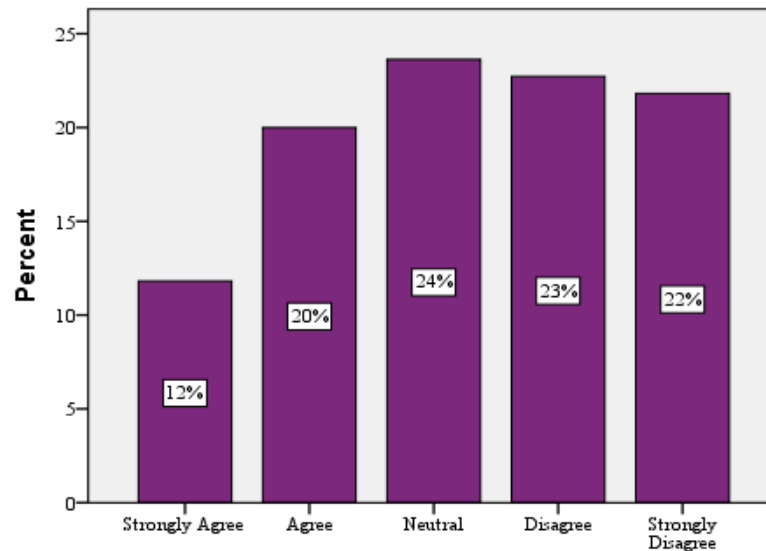
#### INFERENCE

Majority (30%) of the respondents are said neither agree nor disagree

**TABLE 4.1.18: SIX-SIGMA IMPLEMENTATION BRINGS INCREASED PROFIT**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 13                | 12%         |
| Agree             | 22                | 20%         |
| Neutral           | 26                | 24%         |
| Disagree          | 25                | 23%         |
| Strongly Disagree | 24                | 21%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.18: SIX-SIGMA IMPLEMENTATION BRINGS INCREASED PROFIT**

#### INTERPRETATION

12% of the respondents strongly agree that increased profit is the benefit of implementing six-sigma, 20% of them agree with this, 24% of them neither agree nor disagree with this, 23% of them disagree and rest 21% of them strongly disagree

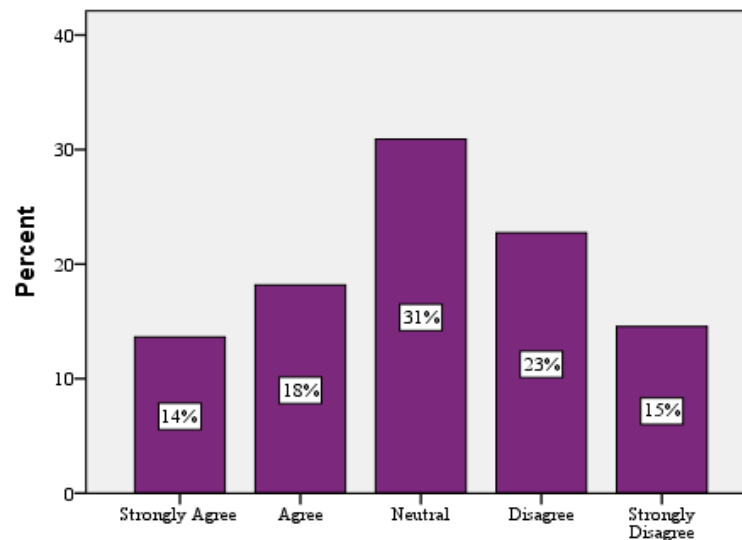
#### INFERENCE

Majority (24%) of the respondents are said neither agree nor disagree

**TABLE 4.1.19: SIX-SIGMA IMPLEMENTATION REDUCE WASTE**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 15                | 14%         |
| Agree             | 20                | 18%         |
| Neutral           | 34                | 31%         |
| Disagree          | 25                | 23%         |
| Strongly Disagree | 16                | 14%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.19: SIX-SIGMA IMPLEMENTATION REDUCE WASTE**

#### INTERPRETATION

14% of the respondents strongly agree that reduced waste is the benefit of implementing six-sigma, 18% of them agree with this, 31% of them neither agree nor disagree with this, 23% of them disagree and rest 15% of them strongly disagree

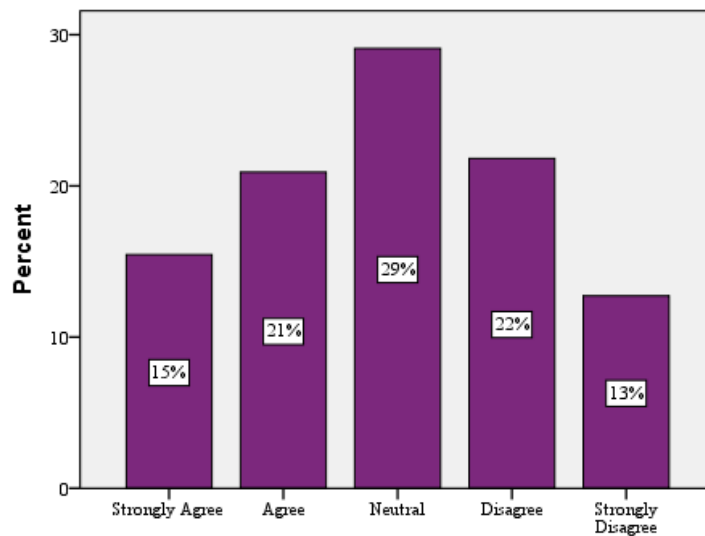
#### INFERENCE

Majority (31%) of the respondents are said neither agree nor disagree

**TABLE 4.1.20: SIX-SIGMA IMPLEMENTATION IMPROVES PRODUCTIVITY**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 17                | 15%         |
| Agree             | 23                | 21%         |
| Neutral           | 32                | 29%         |
| Disagree          | 24                | 22%         |
| Strongly Disagree | 14                | 13%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.20: SIX-SIGMA IMPLEMENTATION IMPROVES PRODUCTIVITY**

#### INTERPRETATION

15% of the respondents strongly agree that improved productivity is the benefit of implementing six-sigma, 21% of them agree with this, 29% of them neither agree nor disagree with this, 22% of them disagree and rest 13% of them strongly disagree

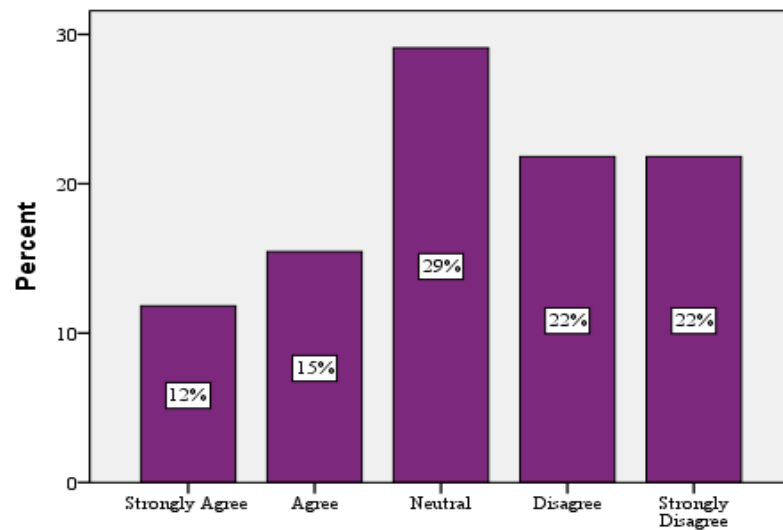
#### INFERENCE

Majority (29%) of the respondents are said neither agree nor disagree

**TABLE 4.1.21: SIX-SIGMA IMPLEMENTATION REDUCED COST**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 13                | 12%         |
| Agree             | 17                | 15%         |
| Neutral           | 32                | 29%         |
| Disagree          | 24                | 22%         |
| Strongly Disagree | 24                | 22%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.21: SIX-SIGMA IMPLEMENTATION REDUCED COST**

#### INTERPRETATION

12% of the respondents strongly agree that reduced cost is the benefit of implementing six-sigma, 15% of them agree with this, 29% of them neither agree nor disagree with this, 22% of them disagree and rest 22% of them strongly disagree

#### INFERENCE

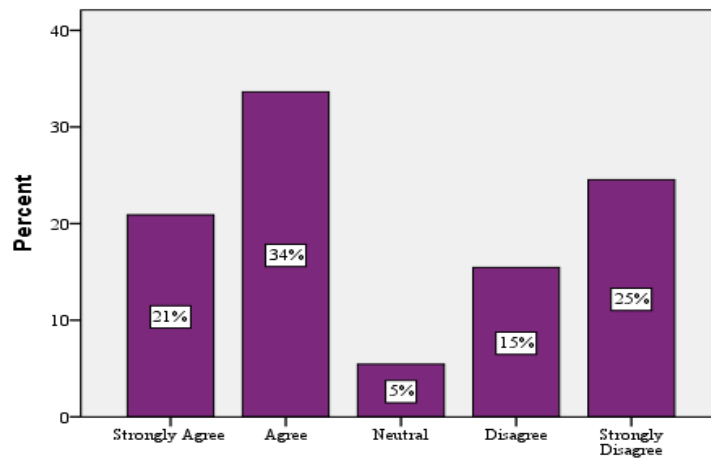
Majority (29%) of the respondents are said neither agree nor disagree

### Obstacles in implementation of Six-Sigma in the production department

**TABLE 4.1.22: LACK OF TOP MANAGEMENT SUPPORT**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 23                | 21%         |
| Agree             | 37                | 34%         |
| Neutral           | 6                 | 5%          |
| Disagree          | 17                | 15%         |
| Strongly Disagree | 27                | 25%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.22: LACK OF TOP MANAGEMENT SUPPORT**

#### INTERPRETATION

21% of the respondents strongly agree that lack of top management support is the obstacle in implementing six-sigma, 34% of them agree with this, 5% of them strongly disagree, 15% of them disagree and rest 25% of them neither agree nor disagree with this

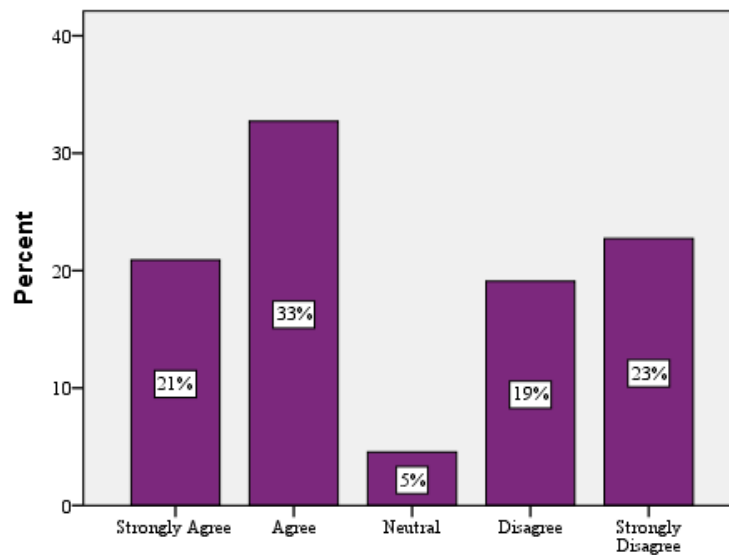
#### INFERENCE

Majority (34%) of the respondents are said Agree

**TABLE 4.1.23: FAILURE OF PAST LEAN PROJECTS**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 23                | 21%         |
| Agree             | 36                | 33%         |
| Neutral           | 5                 | 4%          |
| Disagree          | 21                | 19%         |
| Strongly Disagree | 25                | 23%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.23: FAILURE OF PAST LEAN PROJECTS**

#### INTERPRETATION

21% of the respondents strongly agree that failure of past lean project is the obstacle in implementing six-sigma, 33% of them agree with this, 5% of them neither agree nor disagree with this, 19% of them disagree and rest 23% of them strongly disagree

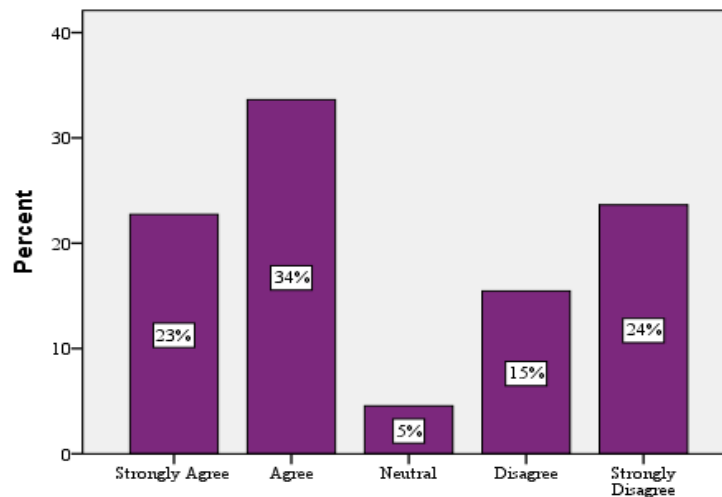
#### INFERENCE

Majority (33%) of the respondents are said Agree

**TABLE 4.1.24: FINANCIAL BENEFITS NOT RECOGNIZED**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 25                | 23%         |
| Agree             | 37                | 34%         |
| Neutral           | 5                 | 4%          |
| Disagree          | 17                | 15%         |
| Strongly Disagree | 26                | 24%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.24: FINANCIAL BENEFITS NOT RECOGNIZED**

#### INTERPRETATION

23% of the respondents strongly agree that financial benefits not recognized is the obstacle in implementing six-sigma, 34% of them agree with this, 5% of them neither agree nor disagree with this, 15% of them disagree and rest 24% of them strongly disagree

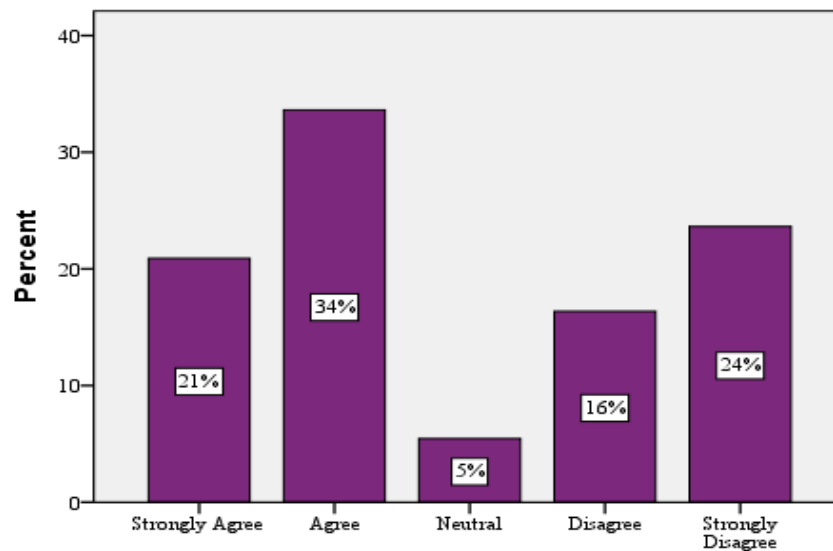
#### INFERENCE

Majority (34%) of the respondents are said Agree

**TABLE 4.1.25: LACK OF TIME TO IMPLEMENT**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 23                | 21%         |
| Agree             | 37                | 34%         |
| Neutral           | 6                 | 5%          |
| Disagree          | 18                | 16%         |
| Strongly Disagree | 26                | 24%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.25: LACK OF TIME TO IMPLEMENT**

#### INTERPRETATION

21% of the respondents strongly agree that lack of time to implement is the obstacle in implementing six-sigma, 34% of them agree with this, 5% of them neither agree nor disagree with this, 16% of them disagree and rest 24% of them strongly disagree

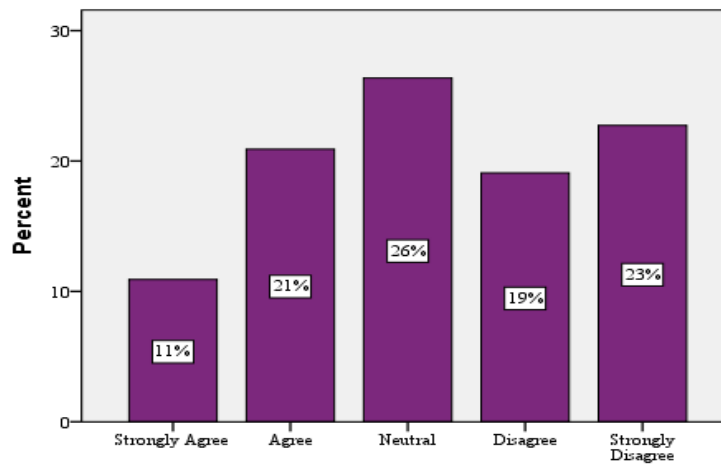
#### INFERENCE

Majority (34%) of the respondents are said Agree

**TABLE 4.1.26: EMPLOYEE RESISTANCE AS AN OBSTACLE IN IMPLEMENTATION OF SIX-SIGMA**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 12                | 11%         |
| Agree             | 23                | 21%         |
| Neutral           | 29                | 26%         |
| Disagree          | 21                | 19%         |
| Strongly Disagree | 25                | 23%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.26: EMPLOYEE RESISTANCE AS AN OBSTACLE IN IMPLEMENTATION OF SIX-SIGMA**

#### INTERPRETATION

11% of the respondents strongly agree that employee resistance is the obstacle in implementing six-sigma, 21% of them agree with this, 26% of them neither agree nor disagree with this, 19% of them disagree and rest 23% of them strongly disagree

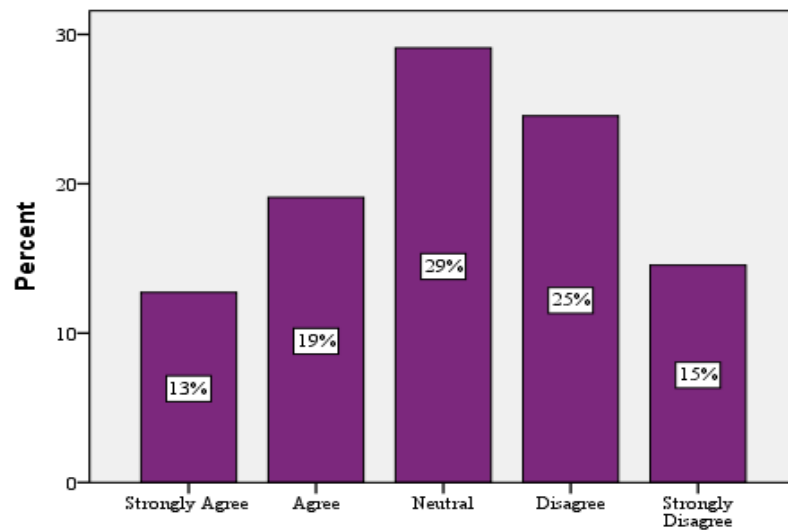
#### INFERENCE

Majority (26%) of the respondents are said neither agree nor disagree

**TABLE 4.1.27: BUDGET CONSTRAINTS IN IMPLEMENTATION OF SIX-SIGMA**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 14                | 13%         |
| Agree             | 21                | 19%         |
| Neutral           | 32                | 29%         |
| Disagree          | 27                | 25%         |
| Strongly Disagree | 16                | 15%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.27: BUDGET CONSTRAINTS IN IMPLEMENTATION OF SIX-SIGMA**

#### INTERPRETATION

13% of the respondents strongly agree that budget constraint is the obstacle in implementing six-sigma, 19% of them agree with this, 29% of them neither agree nor disagree with this, 25% of them disagree and rest 15% of them strongly disagree

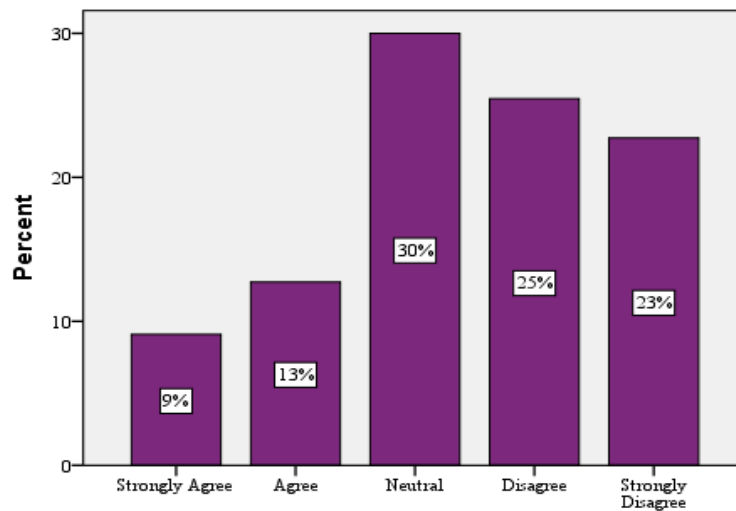
#### INFERENCE

Majority (29%) of the respondents are said neither agree nor disagree

**TABLE 4.1.28: LACK OF KNOW-HOW TO IMPLEMENT**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 10                | 9%          |
| Agree             | 14                | 13%         |
| Neutral           | 33                | 30%         |
| Disagree          | 28                | 25%         |
| Strongly Disagree | 25                | 23%         |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.28: LACK OF KNOW-HOW TO IMPLEMENT**

#### INTERPRETATION

9% of the respondents strongly agree that lack of know-how to implement is the obstacle in implementing six-sigma, 13% of them agree with this, 30% of them neither agree nor disagree with this, 25% of them disagree and rest 23% of them strongly disagree

#### INFERENCE

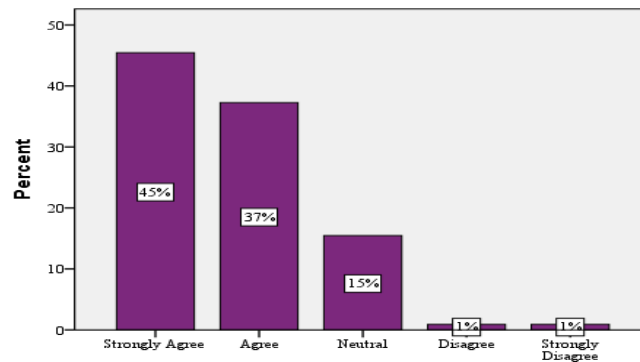
Majority (30%) of the respondents are said neither agree nor disagree

**Issues and common industrial challenges or problems after implementing Six-Sigma in the production department**

**TABLE 4.1.29: CONTINUED PRESSURES TO IMPROVE OPERATIONAL PERFORMANCE**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 50                | 45%         |
| Agree             | 41                | 37%         |
| Neutral           | 17                | 15%         |
| Disagree          | 1                 | 1%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.29: CONTINUED PRESSURES TO IMPROVE OPERATIONAL PERFORMANCE**

**INTERPRETATION**

45% of the respondents strongly agree that continued pressures to improve operational performance is the issue and common industrial challenge or problem after implementing Six-Sigma, 37% of them agree with this, 15% respondents neither agree nor disagree, 1% of them disagree and rest 1% of them strongly disagree with this

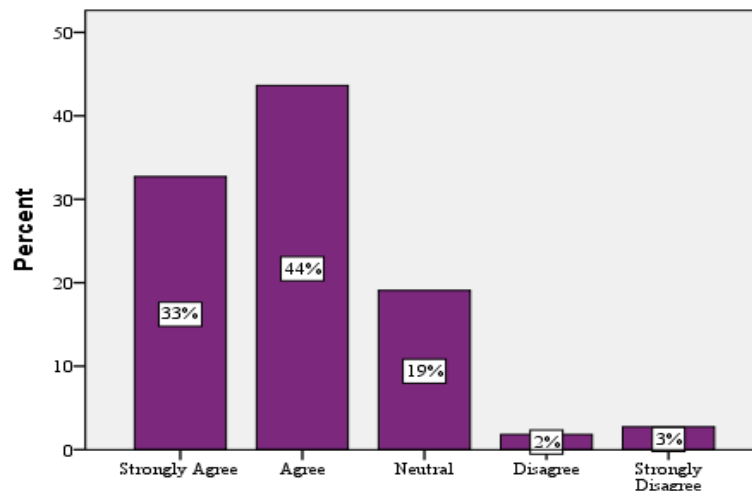
**INFERENCE**

Majority (45%) of the respondents are said Strongly Agree

**TABLE 4.1.30: ACHIEVEMENT OF ZERO WASTE**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 36                | 33%         |
| Agree             | 48                | 44%         |
| Neutral           | 21                | 19%         |
| Disagree          | 2                 | 2%          |
| Strongly Disagree | 3                 | 3%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.30: ACHIEVEMENT OF ZERO WASTE**

#### INTERPRETATION

33% of the respondents strongly agree that achievement of zero waste is the issue and common industrial challenge or problem after implementing Six-Sigma, 44% of them agree with this, 19% respondents neither agree nor disagree, 2% of them disagree and rest 3% of them strongly disagree with this

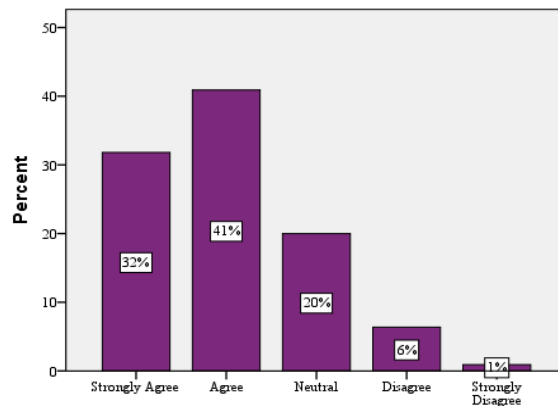
#### INFERENCE

Majority (44%) of the respondents are said Agree

**TABLE 4.1.31: ORGANIZATIONAL CULTURE AS AN ISSUE AFTER IMPLEMENTING SIX-SIGMA**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 35                | 32%         |
| Agree             | 45                | 41%         |
| Neutral           | 22                | 20%         |
| Disagree          | 7                 | 6%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.31: ORGANIZATIONAL CULTURE AS AN ISSUE AFTER IMPLEMENTING SIX-SIGMA**

#### INTERPRETATION

32% of the respondents strongly agree that organizational culture is the issue and common industrial challenge or problem after implementing Six-Sigma, 41% of them agree with this, 20% respondents neither agree nor disagree, 6% of them disagree and rest 1% of them strongly disagree with this

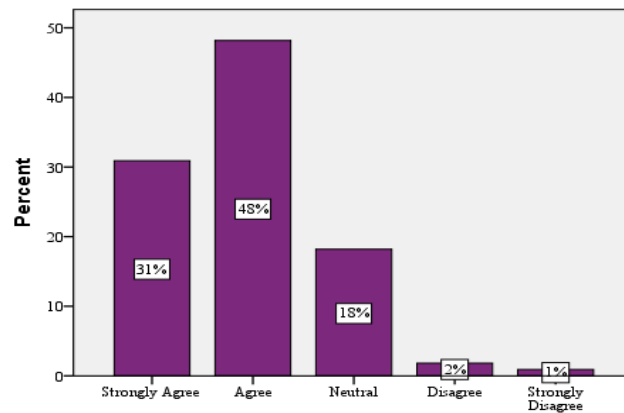
#### INFERENCE

Majority (41%) of the respondents are said Agree

**TABLE 4.1.32: UNUSED PEOPLE SKILL AS AN ISSUE AFTER IMPLEMENTING SIX-SIGMA**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 34                | 31%         |
| Agree             | 53                | 48%         |
| Neutral           | 20                | 18%         |
| Disagree          | 2                 | 2%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 32: UNUSED PEOPLE SKILL AS AN ISSUE AFTER IMPLEMENTING SIX-SIGMA**

#### INTERPRETATION

31% of the respondents strongly agree that unused people skill is the issue and common industrial challenge or problem after implementing Six-Sigma, 48% of them agree with this, 18% respondents neither agree nor disagree, 2% of them disagree and rest 1% of them strongly disagree with this

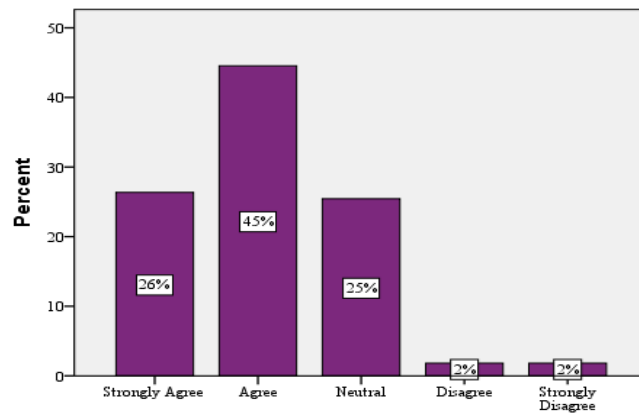
#### INFERENCE

Majority (48%) of the respondents are said Agree

**TABLE 4.1.33: APPLICATION CONSTRAINT DUE TO LARGER SCALE OF OPERATIONS**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 29                | 26%         |
| Agree             | 49                | 45%         |
| Neutral           | 28                | 25%         |
| Disagree          | 2                 | 2%          |
| Strongly Disagree | 2                 | 2%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 33: APPLICATION CONSTRAINT DUE TO LARGER SCALE OF OPERATIONS**

#### INTERPRETATION

26% of the respondents strongly agree that they application constraint due to larger scale of operations is the issue and common industrial challenge or problem after implementing Six-Sigma, 45% of them agree with this, 25% respondents neither agree nor disagree, 2% of them disagree and rest 2% of them strongly disagree with this

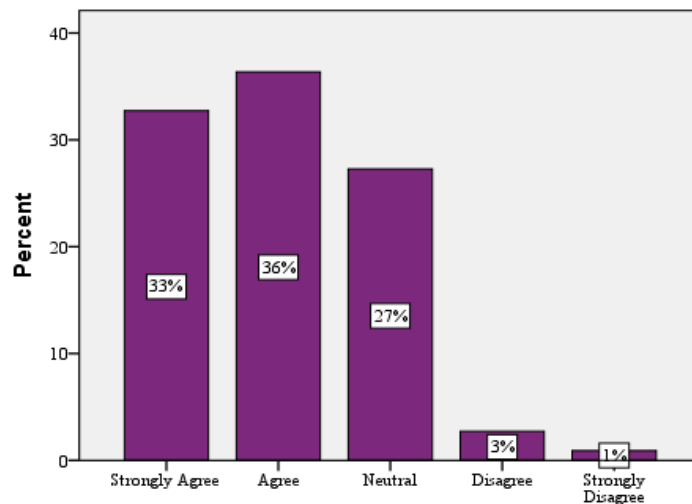
#### INFERENCE

Majority (45%) of the respondents are said Agree

**TABLE 4.1.34: DEFECTS IDENTIFICATION AFTER IMPLEMENTING SIX-SIGMA**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 36                | 33%         |
| Agree             | 40                | 36%         |
| Neutral           | 30                | 27%         |
| Disagree          | 3                 | 3%          |
| Strongly Disagree | 1                 | 1%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 34: DEFECTS IDENTIFICATION AFTER IMPLEMENTING SIX-SIGMA**

#### INTERPRETATION

33% of the respondents strongly agree that defects identification is the issue and common industrial challenge or problem after implementing Six-Sigma, 36% of them agree with this, 27% respondents neither agree nor disagree, 3% of them disagree and rest 1% of them strongly disagree with this

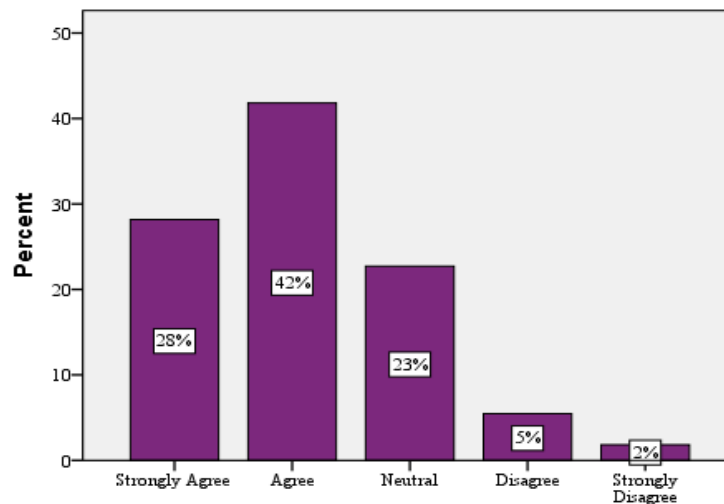
#### INFERENCE

Majority (36%) of the respondents are said Agree

**TABLE 4.1.35: FLEXIBILITY OF EMPLOYEES IMPLEMENTING SIX-SIGMA**

| Options           | No.of Respondents | Percentage  |
|-------------------|-------------------|-------------|
| Strongly Agree    | 31                | 28%         |
| Agree             | 46                | 42%         |
| Neutral           | 25                | 23%         |
| Disagree          | 6                 | 5%          |
| Strongly Disagree | 2                 | 2%          |
| <b>Total</b>      | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.35: FLEXIBILITY OF EMPLOYEES IMPLEMENTING SIX-SIGMA**

#### INTERPRETATION

28% of the respondents strongly agree that flexibility of employees is the issue and common industrial challenge or problem after implementing Six-Sigma, 42% of them agree with this, 23% respondents neither agree nor disagree, 5% of them disagree and rest 2% of them strongly disagree with this

#### INFERENCE

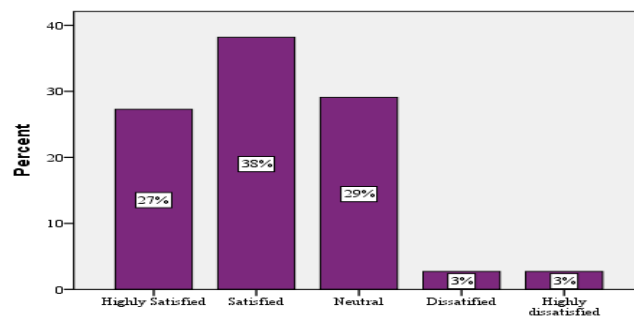
Majority (42%) of the respondents are said Agree

**Satisfaction on enhanced production process after six-sigma implementation in the production department**

**TABLE 4.1.36: DETECTING THE ROOT CAUSE AND GIVING A REMEDIAL MEASURE TO TAKE CORRECTIVE ACTION**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 30                | 27%         |
| Satisfied           | 42                | 38%         |
| Neutral             | 32                | 29%         |
| Dissatisfied        | 3                 | 3%          |
| Highly dissatisfied | 3                 | 3%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.36: DETECTING THE ROOT CAUSE AND GIVING A REMEDIAL MEASURE TO TAKE CORRECTIVE ACTION**

**INTERPRETATION**

29% of the respondents are highly satisfied with the detecting the root cause and giving a remedial measure to take corrective action, 38% of them are satisfied, 29% respondents are neither satisfied nor dissatisfied, 3% of them are dissatisfied and rest 3% of them are highly dissatisfied

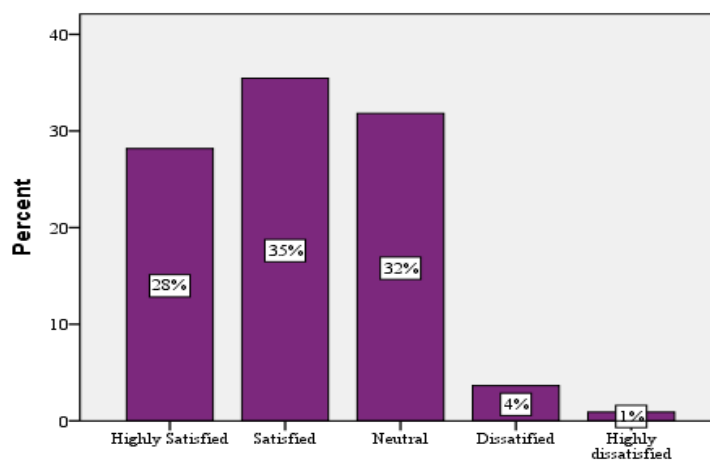
**INFERENCE**

Majority (38%) of the respondents are said Satisfied

**TABLE 4.1.37: TRAINING ARRANGED ON THE FREQUENT DEFECTIVE PROCESSES**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 31                | 28%         |
| Satisfied           | 39                | 35%         |
| Neutral             | 35                | 32%         |
| Dissatisfied        | 4                 | 4%          |
| Highly dissatisfied | 1                 | 1%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.37: TRAINING ARRANGED ON THE FREQUENT DEFECTIVE PROCESSES**

#### INTERPRETATION

28% of the respondents are highly satisfied with the training arranged on the frequent defective processes, 35% of them are satisfied, 32% respondents are neither satisfied nor dissatisfied, 4% of them are dissatisfied and rest 1% of them are highly dissatisfied

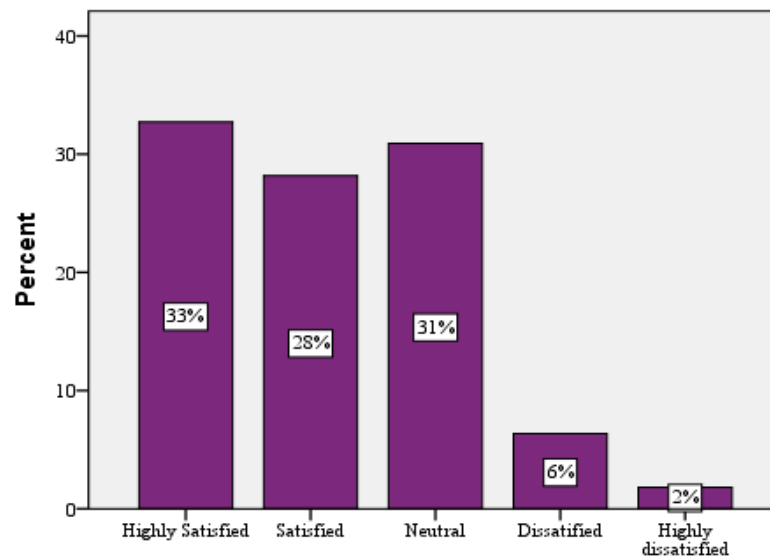
#### INFERENCE

Majority (35%) of the respondents are said Satisfied

**TABLE 4.1.38: VALUE STREAMED THE PRODUCTION PROCESS**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 36                | 33%         |
| Satisfied           | 31                | 28%         |
| Neutral             | 34                | 31%         |
| Dissatisfied        | 7                 | 6%          |
| Highly dissatisfied | 2                 | 2%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.38: VALUE STREAMED THE PRODUCTION PROCESS**

#### INTERPRETATION

33% of the respondents are highly satisfied with the value stream of the production process, 28% of them are satisfied with this, 31% respondents neither satisfied nor dissatisfied, 6% of them are dissatisfied and rest 2% of them are highly dissatisfied

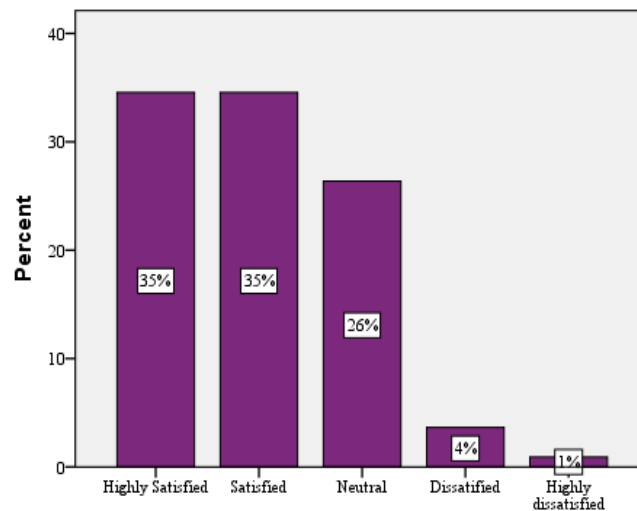
#### INFERENCE

Majority (33%) of the respondents are said Highly Satisfied

**TABLE 4.1.39: ANALYSIS TO CARRY OUT FOR NON-VALUE ADDED HOURS**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 38                | 35%         |
| Satisfied           | 38                | 35%         |
| Neutral             | 29                | 26%         |
| Dissatisfied        | 4                 | 4%          |
| Highly dissatisfied | 1                 | 1%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.39: ANALYSIS TO CARRY OUT FOR NON-VALUE ADDED HOURS**

#### INTERPRETATION

35% of the respondents are highly satisfied with the analysis to carry out the reasons for non-value added hours, 35% of them are satisfied with this and 26% respondents neither satisfied nor dissatisfied, 4% of them are dissatisfied and rest 1% of them are highly dissatisfied

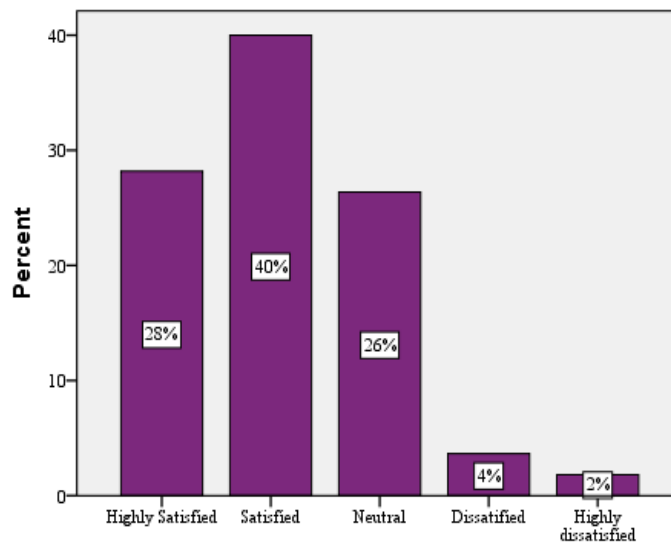
#### INFERENCE

Majority (35%) of the respondents are said both Highly Satisfied and Satisfied

**TABLE 4.1.40: PARETO ANALYSIS TO DEPICT THE DEFECT PERCENTAGE**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 31                | 28%         |
| Satisfied           | 44                | 40%         |
| Neutral             | 29                | 26%         |
| Dissatisfied        | 4                 | 4%          |
| Highly dissatisfied | 2                 | 2%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.40: PARETO ANALYSIS TO DEPICT THE DEFECT PERCENTAGE**

#### INTERPRETATION

28% of the respondents are highly satisfied with the Pareto Analysis to depict the defect Percentage, 40% of them are satisfied with this and 26% respondents neither satisfied nor dissatisfied, 4% of them are dissatisfied and rest 2% of them are highly dissatisfied

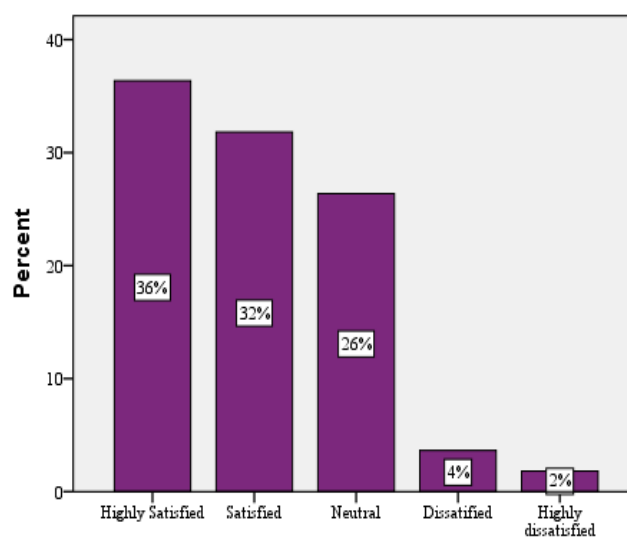
#### INFERENCE

Majority (40%) of the respondents are said Satisfied

**TABLE 4.1.41: REDUCTION IN REJECTION RATE**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 40                | 36%         |
| Satisfied           | 35                | 32%         |
| Neutral             | 29                | 26%         |
| Dissatisfied        | 4                 | 4%          |
| Highly dissatisfied | 2                 | 2%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.41: REDUCTION IN REJECTION RATE**

#### INTERPRETATION

36% of the respondents are highly satisfied with the reduction in rejection rate, 32% of them are satisfied with this and 26% respondents neither satisfied nor dissatisfied, 4% of them are dissatisfied and rest 2% of them are highly dissatisfied

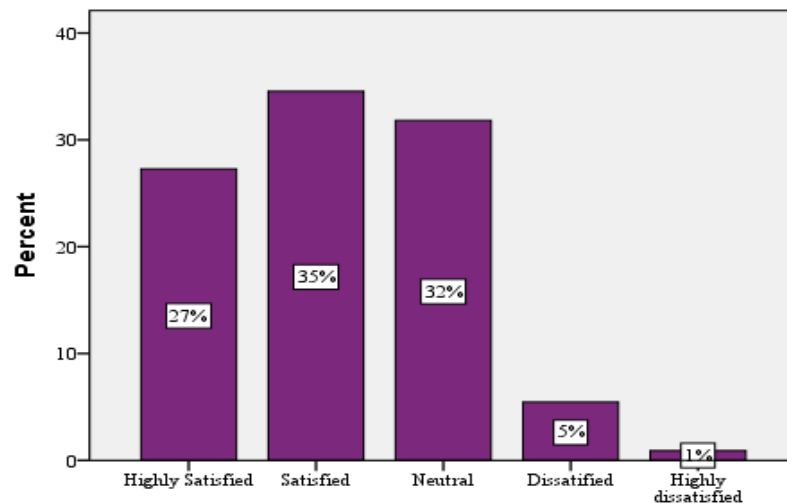
#### INFERENCE

Majority (36%) of the respondents are said Highly Satisfied

**TABLE 4.1.42: FUNCTIONS OF OPERATIONS**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 30                | 27%         |
| Satisfied           | 38                | 35%         |
| Neutral             | 35                | 32%         |
| Dissatisfied        | 6                 | 5%          |
| Highly dissatisfied | 1                 | 1%          |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.42: FUNCTIONS OF OPERATIONS**

#### INTERPRETATION

27% of the respondents are highly satisfied with the functions of operations, 35% of them are satisfied with this and 32% respondents neither satisfied nor dissatisfied, 5% of them are dissatisfied and rest 1% of them are highly dissatisfied

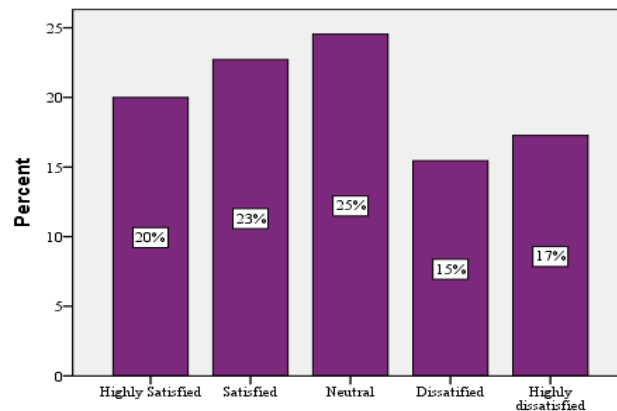
#### INFERENCE

Majority (35%) of the respondents are said Satisfied

**TABLE 4.1.43: OVERALL SATISFACTION LEVEL ON THE IMPLEMENTATION OF SIX-SIGMA IN THE PRODUCTION DEPARTMENT**

| Options             | No.of Respondents | Percentage  |
|---------------------|-------------------|-------------|
| Highly Satisfied    | 22                | 20%         |
| Satisfied           | 25                | 23%         |
| Neutral             | 27                | 25%         |
| Dissatisfied        | 17                | 15%         |
| Highly dissatisfied | 19                | 17%         |
| <b>Total</b>        | <b>110</b>        | <b>100%</b> |

Source of data: Primary data



**CHART 4.1.43: OVERALL SATISFACTION LEVEL ON THE IMPLEMENTATION OF SIX-SIGMA IN THE PRODUCTION DEPARTMENT**

#### INTERPRETATION

20% of the respondents are highly satisfied with the overall implementation of six-sigma in the production department of the company, 23% of them are satisfied, 25% of them are neither satisfied nor dissatisfied, 15% of them are dissatisfied and rest 17% of them are highly dissatisfied with the implementation

#### INFERENCE

Majority (25%) of the respondents are said neither agree nor disagree

## 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 |                          |                   |                       |           |             |              |                              |           |
|--------------------------------------|--------------------------|-------------------|-----------------------|-----------|-------------|--------------|------------------------------|-----------|
|                                      |                          |                   | Organizational        |           |             |              |                              | Total     |
|                                      |                          |                   | Stron<br>gly<br>Agree | Agre<br>e | Neutr<br>al | Disagr<br>ee | Strongl<br>y<br>Disagre<br>e |           |
| Age                                  | 21-25<br>Years           | Count             | 6                     | 16        | 12          | 4            | 0                            | 38        |
|                                      |                          | Expected<br>Count | 12.1                  | 15.5      | 7.6         | 2.4          | .3                           | 38.0      |
|                                      | 26-30<br>Years           | Count             | 10                    | 19        | 8           | 3            | 0                            | 40        |
|                                      |                          | Expected<br>Count | 12.7                  | 16.4      | 8.0         | 2.5          | .4                           | 40.0      |
|                                      | 31-35<br>Years           | Count             | 14                    | 9         | 2           | 0            | 1                            | 26        |
|                                      |                          | Expected<br>Count | 8.3                   | 10.6      | 5.2         | 1.7          | .2                           | 26.0      |
|                                      | More<br>than 35<br>Years | Count             | 5                     | 1         | 0           | 0            | 0                            | 6         |
|                                      |                          | Expected<br>Count | 1.9                   | 2.5       | 1.2         | .4           | .1                           | 6.0       |
| Total                                |                          | Count             | 35                    | 45        | 22          | 7            | 1                            | 110       |
|                                      |                          | Expected<br>Count | 35.0                  | 45.0      | 22.0        | 7.0          | 1.0                          | 110.<br>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

$$\begin{aligned}\text{Degree of freedom} &= (R-1) (C-1) \\ &= (4-1) (5-1) \\ &= 12\end{aligned}$$

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

**At 5% level of significance and df (12) the table value is 26.273**

**Calculated value = 0.010**

**Table value > calculated value**

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

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

### 4.3 ONE WAY ANOVA TEST

Hypothesis set between educational qualification of the respondents and their opinion on a fully integrated management philosophy as a reason for implementing six-sigma.

Null Hypothesis:

Ho = There is no statistically significant relationship between educational qualification of the respondents and their opinion on a fully integrated management philosophy as a reason for implementing six-sigma

Alternate Hypothesis:

H<sub>1</sub> = There is a statistically significant relationship between educational qualification of the respondents and their opinion on a fully integrated management philosophy as a reason for implementing six-sigma

| Descriptives  |     |      |                |            |                                  |             |         |         |
|---------------|-----|------|----------------|------------|----------------------------------|-------------|---------|---------|
| Fully         |     |      |                |            |                                  |             |         |         |
|               | N   | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean |             | Minimum | Maximum |
|               |     |      |                |            | Lower Bound                      | Upper Bound |         |         |
| 11th -12th    | 2   | 4.50 | .707           | .500       | -1.85                            | 10.85       | 4       | 5       |
| Diploma / ITI | 13  | 2.92 | 1.382          | .383       | 2.09                             | 3.76        | 1       | 5       |
| UG Degree     | 63  | 2.75 | 1.481          | .187       | 2.37                             | 3.12        | 1       | 5       |
| PG Degree     | 32  | 2.91 | 1.634          | .289       | 2.32                             | 3.50        | 1       | 5       |
| Total         | 110 | 2.85 | 1.510          | .144       | 2.56                             | 3.13        | 1       | 5       |

| ANOVA          |                |     |             |      |      |
|----------------|----------------|-----|-------------|------|------|
| Fully          |                |     |             |      |      |
|                | Sum of Squares | df  | Mean Square | F    | Sig. |
| Between Groups | 6.294          | 3   | 2.098       | .919 | .435 |
| Within Groups  | 242.078        | 106 | 2.284       |      |      |
| Total          | 248.373        | 109 |             |      |      |

#### INTERPRETATION

This is the table that shows the output of the ANOVA analysis and we have no statistically significant difference between our group means. We can see that the significance level is 0.435 ( $p = .435$ ), which is more than 0.05, therefore, there is no statistically significant relationship between educational qualification of the respondents and their opinion on a fully integrated management philosophy as a reason for 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:  $H_0$  = 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:  $H_1$  = 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 |                     |            |         |
|--------------|---------------------|------------|---------|
|              |                     | Experience | Knowhow |
| Experience   | 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

#### 4.5: LINEAR REGRESSION ANALYSIS

Null Hypothesis:  $H_0$  = There is no statistically significant relationship between gender of the respondents and their opinion on improved flexibility as a benefit of implementing Six-Sigma

Alternate Hypothesis:  $H_1$  = There is a statistically significant relationship between gender of the respondents and their opinion on improved flexibility as a benefit of implementing Six-Sigma study

| Variables Entered/Removed <sup>a</sup> |                     |                   |        |
|----------------------------------------|---------------------|-------------------|--------|
| Model                                  | Variables Entered   | Variables Removed | Method |
| 1                                      | Gender <sup>b</sup> | .                 | Enter  |
| a. Dependent Variable: Flexibility     |                     |                   |        |
| b. All requested variables entered.    |                     |                   |        |

| Model Summary                     |                   |          |                   |                            |
|-----------------------------------|-------------------|----------|-------------------|----------------------------|
| Model                             | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1                                 | .044 <sup>a</sup> | .002     | -.007             | 1.252                      |
| a. Predictors: (Constant), Gender |                   |          |                   |                            |

| ANOVA <sup>a</sup>                |            |                |     |             |      |                   |
|-----------------------------------|------------|----------------|-----|-------------|------|-------------------|
| Model                             |            | Sum of Squares | df  | Mean Square | F    | Sig.              |
| 1                                 | Regression | .327           | 1   | .327        | .209 | .649 <sup>b</sup> |
|                                   | Residual   | 169.391        | 108 | 1.568       |      |                   |
|                                   | Total      | 169.718        | 109 |             |      |                   |
| a. Dependent Variable: Flexibil   |            |                |     |             |      |                   |
| b. Predictors: (Constant), Gender |            |                |     |             |      |                   |

| Coefficients <sup>a</sup>       |            |                             |            |                           |       |       |
|---------------------------------|------------|-----------------------------|------------|---------------------------|-------|-------|
| Model                           |            | Unstandardized Coefficients |            | Standardized Coefficients | T     | Sig.  |
|                                 |            | B                           | Std. Error | Beta                      |       |       |
| 1                               | (Constant) | 3.213                       | .370       |                           | 8.677 | .0005 |
|                                 | Gender     | .109                        | .239       | .044                      | .457  | .649  |
| a. Dependent Variable: Flexibil |            |                             |            |                           |       |       |

#### INTERPRETATION

The results of linear regression analysis show the significance value of 0.0005 which is less than 0.005. To present the regression equation as:

Gender of the respondents and their opinion on improved flexibility as a benefit of implementing Six-Sigma =  $3.213 \pm 0.109$

#### 4.6 INDEPENDENT T TEST

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.

| Group Statistics |        |    |      |                |                 |
|------------------|--------|----|------|----------------|-----------------|
|                  | Gender | N  | Mean | Std. Deviation | Std. Error Mean |
| Operations       | Male   | 59 | 2.17 | .834           | .109            |
|                  | Female | 51 | 2.20 | 1.040          | .146            |

In the Group Statistics box, the mean for condition 1 (Female) is 3.26. The mean for condition 2 (Male) is 2.93. The standard deviation for condition 1 is 0.817 and for condition 2, 0.961. The number of participants in each condition (N) is 5.

| Independent Samples Test |                             |                                         |      |                              |        |                 |                 |                       |                                           |       |
|--------------------------|-----------------------------|-----------------------------------------|------|------------------------------|--------|-----------------|-----------------|-----------------------|-------------------------------------------|-------|
|                          |                             | Levene's Test for Equality of Variances |      | t-test for Equality of Means |        |                 |                 |                       |                                           |       |
|                          |                             | F                                       | Sig. | T                            | Df     | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |       |
|                          |                             |                                         |      |                              |        |                 |                 |                       | Lower                                     | Upper |
| Operations               | Equal variances assumed     | 3.338                                   | .070 | -.149                        | 108    | .882            | -.027           | .179                  | -.381                                     | .328  |
|                          | Equal variances not assumed |                                         |      | -.146                        | 95.573 | .884            | -.027           | .182                  | -.387                                     | .334  |

INTERPRETATION: From the above table it is clear that the significance (0.070) is greater than 0.05. A value greater than .05 means that the variability in the two conditions is about the same. That the scores in one condition do not vary too much more than the scores in the second condition. Put scientifically, it means that the variability in the two conditions is not significantly different. This is a good thing.

## **CHAPTER 5**

### **FINDINGS, SUGGESTIONS AND CONCLUSION**

#### **5.1 FINDINGS OF THE STUDY**

- ✓ Majority (36%) of the respondents are in the age category of 25-35
- ✓ Majority (54%) of the respondents are male
- ✓ Majority (53%) of the respondents are studied Under Graduated
- ✓ Majority (43%) of the respondents are belong to General Staff
- ✓ Majority (43%) of the respondents are Less than two Lakhs
- ✓ Majority (36%) of the respondents have 5-10 years of experience
- ✓ Majority (75%) of the respondents said that the production department is adopting six-sigma efficiently

#### **Reasons for using Six-Sigma in the production department**

- ✓ Majority (38%) of the respondents are said Agree
- ✓ Majority (35%) of the respondents are said Agree
- ✓ Majority (35%) of the respondents are said Agree
- ✓ Majority (42%) of the respondents are said Agree
- ✓ Majority (42%) of the respondents are said Agree
- ✓ Majority (40%) of the respondents are said Agree
- ✓ Majority (34%) of the respondents are said Agree

#### **Benefits of Implementation in the production department**

- ✓ Majority (27%) of the respondents are said neither agree nor disagree
- ✓ Majority (33%) of the respondents are said neither agree nor disagree
- ✓ Majority (30%) of the respondents are said neither agree nor disagree
- ✓ Majority (30%) of the respondents are said neither agree nor disagree
- ✓ Majority (31%) of the respondents are said neither agree nor disagree
- ✓ Majority (29%) of the respondents are said neither agree nor disagree
- ✓ Majority (29%) of the respondents are said neither agree nor disagree

### **Obstacles in implementation of Six-Sigma in the production department**

- ✓ Majority (34%) of the respondents are said Agree
- ✓ Majority (33%) of the respondents are said Agree
- ✓ Majority (34%) of the respondents are said Agree
- ✓ Majority (34%) of the respondents are said Agree
- ✓ Majority (26%) of the respondents are said neither agree nor disagree
- ✓ Majority (29%) of the respondents are said neither agree nor disagree
- ✓ Majority (30%) of the respondents are said neither agree nor disagree

### **Issues and common industrial challenges or problems after implementing Six-Sigma in the production department**

- ✓ Majority (45%) of the respondents are said Strongly Agree
- ✓ Majority (44%) of the respondents are said Agree
- ✓ Majority (41%) of the respondents are said Agree
- ✓ Majority (48%) of the respondents are said Agree
- ✓ Majority (45%) of the respondents are said Agree
- ✓ Majority (36%) of the respondents are said Agree
- ✓ Majority (42%) of the respondents are said Agree

### **Satisfaction on enhanced production process after six-sigma implementation in the production department**

- ✓ Majority (38%) of the respondents are said Satisfied
- ✓ Majority (35%) of the respondents are said Satisfied
- ✓ Majority (33%) of the respondents are said Highly Satisfied
- ✓ Majority (35%) of the respondents are said both Highly Satisfied and Satisfied
- ✓ Majority (40%) of the respondents are said Satisfied
- ✓ Majority (36%) of the respondents are said Highly Satisfied
- ✓ Majority (35%) of the respondents are said Satisfied
- ✓ Majority (25%) of the respondents are said neither agree nor disagree

## 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
- ✓ Finally provide assurance that the proper improvement has been made post implementing six sigma at the company
- ✓ The Sigma level achieved after implementation of DMAIC Six Sigma methodology can be further improved & new performance standards can be realized.
- ✓ Six Sigma methodologies expect that the new learning will be validated & evaluated with practice.
- ✓ It can be integrated effectively in the community of company employees for maintaining & further improving the improved performances.
- ✓ Six Sigma shifts the paradigm quality as the cause of good business performance and not the effect.
- ✓ Six Sigma propagates that all-round quality performance is bound to result in the attainment of the desired business excellence in terms of reduction in cost of production, maximization of productivity, customers' (external as well as internal) satisfaction, profitability and ROI by achieving reduction in cost of production and processing by continuous process improvement, reduction and elimination of wastages, rework and excess consumption of resources.

### **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. Based on the taxonomy developed, industries such as steel, pharmaceutical, and textile will be a good fit to adapt six sigma tools that were developed for the industry. For other manufacturing industries there are six sigma tools which could easily be applied to the manufacturing setting, e.g., setup reduction, TPM, 5S, and VS are applicable in any manufacturing industry that wants to become lean. Finally, one of the contributions of this work is the reduction of non-value adding hours and efficiency in production, (which is major concerns in any industry) which was accomplished when implementing six-sigma.

This project shows that the performance of the company is increased to a better level as regards to: enhancement in customers' (both internal and external) satisfaction, adherence of delivery schedules, development of specific methods to redesign and reorganize a process with a view to reduce or eliminate errors, defects; development of more efficient, capable, reliable and consistent manufacturing process and more better overall process performance, creation of continuous improvement and "do it right the first time" mindset. Six-Sigma provides business leaders and executives with the strategy, methods, tools and techniques to change their organizations. Six Sigma as a powerful business strategy has been well recognized as an imperative for achieving and The Sigma level achieved after implementation of Six Sigma methodology can be further improved & new performance standards can be realized. Six Sigma methodologies expect that the new learning will be validated & evaluated with practice. It can be integrated effectively in the community of company employees for maintaining & further improving the improved performances.

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

## **QUESTIONNAIRE**

Hi. This is Ashok from Sathyabama University. Kindly fill in the following questionnaire to fulfill the research project titled: A STUDY ON THE EFFECTIVENESS OF SIX SIGMA IMPLEMENTATION IN POWERICA LTD IN CHENNAI. The feedback recorded in this survey is completely confidential and is not used for any other than the academic purposes

Thanking You

### **PERSONAL FACTOR**

**1. Name:** \_\_\_\_\_

**2. Age (in Years):**

- ☐ Less than 25 Years
- ☐ 25 – 35 Years
- ☐ 36 – 45 Years
- ☐ 46 – 55 Years
- ☐ More than 55 Years

**3. Gender:**

- ☐ Male
- ☐ Female

**4. Qualification:**

- ☐ 11th -12th
- ☐ Diploma / ITI
- ☐ UG Degree
- ☐ PG Degree

**5. Designation:** \_\_\_\_\_

- ☐ Top management
- ☐ Manager
- ☐ Officer
- ☐ Supervisor
- ☐ General Staff

**6. Annual Income**

- ☐ Less than 2 Lakh
- ☐ 2-5 Lakh
- ☐ 5-10 Lakh
- ☐ 10-15 Lakh
- ☐ More than 15 Lakh

**7. Experience:**

- ☐ 0 – 5 Years
- ☐ 5 – 10 Years
- ☐ 10 – 15 Years
- ☐ 15 – 20 Years
- ☐ 20 Years and Above

**8. Which department of the organization adopts six-sigma more efficiently?**

- ☐ Production Department
- ☐ HR Department
- ☐ Finance Department
- ☐ Purchase Department
- ☐ Sales and Marketing Department
- ☐ Operations and service department

**STUDY FACTOR**

| Q.No | Reasons for using Six-Sigma in the production department | SA | A | N | DA | SDA |
|------|----------------------------------------------------------|----|---|---|----|-----|
| 15   | Maintain competitive advantage in price and service      |    |   |   |    |     |
| 16   | Pressure to improve profit                               |    |   |   |    |     |
| 17   | Customers demanding shorter order cycle times            |    |   |   |    |     |
| 18   | Customers demanding reduced prices                       |    |   |   |    |     |
| 19   | The use of team work and continuous improvement          |    |   |   |    |     |
| 20   | Elimination of non-value adding tasks                    |    |   |   |    |     |
| 21   | A fully integrated management philosophy                 |    |   |   |    |     |

| Q.No | Benefits of Implementation in the production department | SA | A | N | DA | SDA |
|------|---------------------------------------------------------|----|---|---|----|-----|
| 29   | Improved flexibility                                    |    |   |   |    |     |
| 30   | Improved response time                                  |    |   |   |    |     |
| 31   | Improved quality                                        |    |   |   |    |     |
| 32   | Increased profit                                        |    |   |   |    |     |
| 33   | Reduced waste                                           |    |   |   |    |     |
| 34   | Improved productivity                                   |    |   |   |    |     |
| 35   | Reduced cost                                            |    |   |   |    |     |

| <b>Q.No</b> | <b>Obstacles in implementation of Six-Sigma in the production department</b> | <b>SA</b> | <b>A</b> | <b>N</b> | <b>DA</b> | <b>SDA</b> |
|-------------|------------------------------------------------------------------------------|-----------|----------|----------|-----------|------------|
| <b>22</b>   | Lack of top management support                                               |           |          |          |           |            |
| <b>23</b>   | Failure of past lean projects                                                |           |          |          |           |            |
| <b>24</b>   | Financial benefits not recognized                                            |           |          |          |           |            |
| <b>25</b>   | Lack of time to implement                                                    |           |          |          |           |            |
| <b>26</b>   | Employee resistance                                                          |           |          |          |           |            |
| <b>27</b>   | Budget constraints                                                           |           |          |          |           |            |
| <b>28</b>   | Lack of know-how to implement                                                |           |          |          |           |            |

| <b>Q.No</b> | <b>Issues and common industrial challenges or problems after implementing Six-Sigma in the production department</b> | <b>SA</b> | <b>A</b> | <b>N</b> | <b>DA</b> | <b>SDA</b> |
|-------------|----------------------------------------------------------------------------------------------------------------------|-----------|----------|----------|-----------|------------|
| <b>1</b>    | Continued pressures to improve operational performance                                                               |           |          |          |           |            |
| <b>2</b>    | Achievement of Zero Waste                                                                                            |           |          |          |           |            |
| <b>3</b>    | Organizational Culture                                                                                               |           |          |          |           |            |
| <b>4</b>    | Unused people skill                                                                                                  |           |          |          |           |            |
| <b>5</b>    | Application constraint due to larger scale of operations                                                             |           |          |          |           |            |
| <b>6</b>    | Defects Identification                                                                                               |           |          |          |           |            |
| <b>7</b>    | Flexibility of employees                                                                                             |           |          |          |           |            |

| <b>Q.No</b> | <b>Satisfaction on enhanced production process after six-sigma implementation in the production department</b> | <b>HS</b> | <b>S</b> | <b>N</b> | <b>DS</b> | <b>HDS</b> |
|-------------|----------------------------------------------------------------------------------------------------------------|-----------|----------|----------|-----------|------------|
| <b>8</b>    | Detecting the root cause and giving a remedial measure to take corrective action                               |           |          |          |           |            |
| <b>9</b>    | Training arranged on the frequent defective processes                                                          |           |          |          |           |            |
| <b>10</b>   | Value Streamed the production process                                                                          |           |          |          |           |            |
| <b>11</b>   | Analysis to carry out the reasons for non-value added hours                                                    |           |          |          |           |            |
| <b>12</b>   | Pareto Analysis to depict the Defect Percentage                                                                |           |          |          |           |            |
| <b>13</b>   | Reduction in rejection rate                                                                                    |           |          |          |           |            |
| <b>14</b>   | Functions of Operations                                                                                        |           |          |          |           |            |

**36. What is your overall satisfaction level on the implementation of Six-Sigma in the production department?**

- ☐ Highly satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Dissatisfied
- ☐ Highly dissatisfied

**37. Your Overall suggestions** \_\_\_\_\_

**ANNEXURE 2 ARTICLE**  
**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



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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 power applications.

### 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.

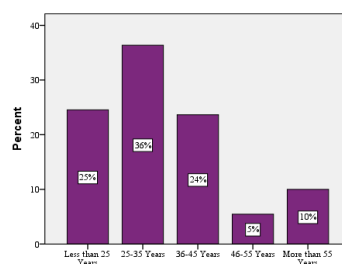
## DATA ANALYSIS AND INTERPRETATION

### 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



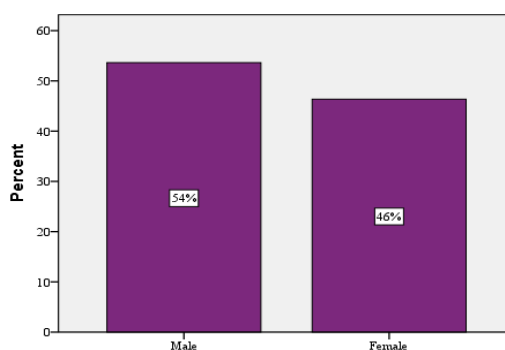
## INTERPRETATION

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



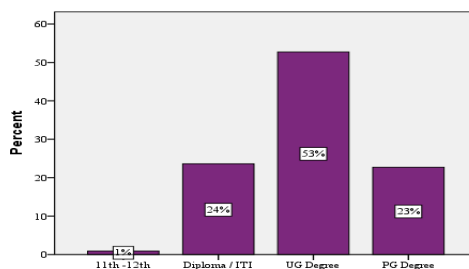
## INTERPRETATION

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



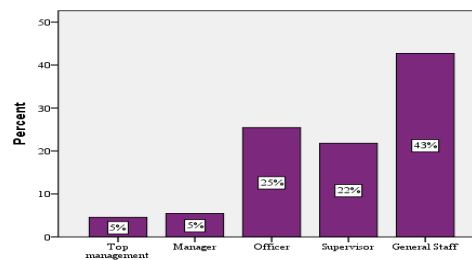
#### INTERPRETATION

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



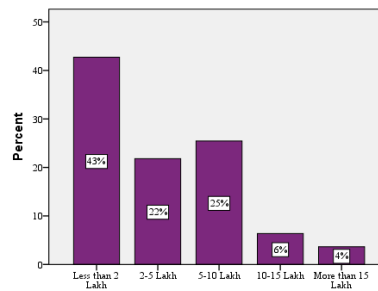
#### INTERPRETATION

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, 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.

#### 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 |                |                |       |         |          |                   |       |
|--------------------------------------|----------------|----------------|-------|---------|----------|-------------------|-------|
|                                      |                | Organizational |       |         |          |                   | 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:** H<sub>0</sub> = 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 |                     |            |         |
|--------------|---------------------|------------|---------|
|              |                     | Experience | Knowhow |
| Experience   | 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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