

A Review: Implementation of Six Sigma in Manufacturing Industries

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Abstract— Looking at the current era of globalization, Competitiveness between the organizations to be better in all aspect we all know. The development and implementation of six sigma in various industries to make customers satisfaction without compromising with organization profitability. Six sigma is proven, it is most beneficial methodology of process improvement from its evolution. The objective of this review paper is to examine the methodology as well as factors which are affecting implementation of six sigma .This paper also integrates the observations and different manufacturing sector where six sigma is needed having brief literature review of research paper about the six sigma implementation.. This paper will help the organization which are looking to implement six sigma, Students which are interested in knowing six sigma and various researchers for their further research.

Keywords-Six Sigma, Reviews, Tools&Technique, DMAIC, CSFs, DFSS, Defination.

I. INTRODUCTION

The importance of quality in an industries as we all know to sustain in the environment of such competitiveness gaining importance in the field of operation research. Organization making continuous improvement in Quality and their service. They have to fulfill the customer's satisfaction without compromising with business profitability. That means they have to deliver excellent quality and services on other sides they have to keep cost at minimum level. To achieve this ,Organization are adopting numerous methodologies like six sigma, TQM, lean manufacturing or theory of constraints.(Thomas et al.,2016;Gijo et al.,2014;Lee chang,2012).

According to survey report presented by Dyn Corp that six sigma is the most effective quality improvement technique (Dusharme., 2012). If six sigma is such efficient methodology then to implement it in organization can meet not only customers satisfaction but also at minimum cost.

Six sigma is introduced in 1986 by bill smith it was presented in front of the world by chairman of Motorola Robert Galvin. Mathematically the word, "Six Sigma" represents Six Standard Deviations from arithmetic mean. As a Methodology it presents a 'Systematic and

organized approach. (Harry and Schroeder.,2000; Henderson and Evans.,2000).

In methodology practice the term six sigma level, means 3.4 defects per million opportunities (DPMO) or success rate of 99.999660 percentages.

The following table shows the relation between six sigma level and DPMO level

Sigma Level	Percentage output	Defect per million opportunities (DPMO)
1 σ	30.23	697700
2 σ	69.13	308700
3 σ	93.32	66810
4 σ	99.3790	6210
5 σ	99.976700	233
6 σ	99.9996600	3.4

Table 1 : - Variations between sigma level & DPMO

At present Motorola, Ford, TATA, Bank of America, Infosys, WIPRO, Amazon, Dell, 3M, Inventec ,Cooper

Tire & Rubber Company, Mumbai's dabbavala etc. successfully implementing six sigma in their organization (Source- Wikipedia)

A. Numerous Definition Of six Sigma

There are numerous definition of six sigma presented by various researchers across the years and from these definitions concept of six sigma can be understood .

Hammer (2002); Stated the definition of six sigma as a "project based methodology to solve specific problems recognized by an organization".

According to Antony and Banuelous (2002) Six sigma can be defined as "Six sigma is a business approach and an efficient methodology ,by which Organization leads to progression in profitability in terms of product/service quality ,customer satisfaction and productivity".

Byrne(2003); He defined that "An extremely robust and stastically passionate approach to quality process inhancement that requires both technical knowledge to implement and also strong organizational resolution to launch and sustain in environment of an organization"

Wang (2009); "six sigma is an approach that improves quality by analyzing data with Statistics"

However ,Schroeder et al (2008) , this researchers has a opinion that many of definition proposed in literature are very general and does not provide any sufficient information and its meaning of implementation and he defined "Six Sigma as an organized ,parallel-meso structure to reduce the variations in organizational process by implementing specialist , a relevant method performing metrices with aim of achieving organizational goal".

It is impossible to develop a fixed definition of six sigma because of changes in need of organization as period changes.

Antony and Coronado (2002); they defined as a "Six sigma is an approach to drive variability from process using influential statistical tools and techniques"

These are some of the definition of six sigma purposed by researchers which are helps us to understand our review on implementation of six sigma in manufacturing industries.

From all definitions that are proposed we can conclude that six sigma is a combination of so many aspects which are shown by following flowchart (Riddhish Thakore; 2014)

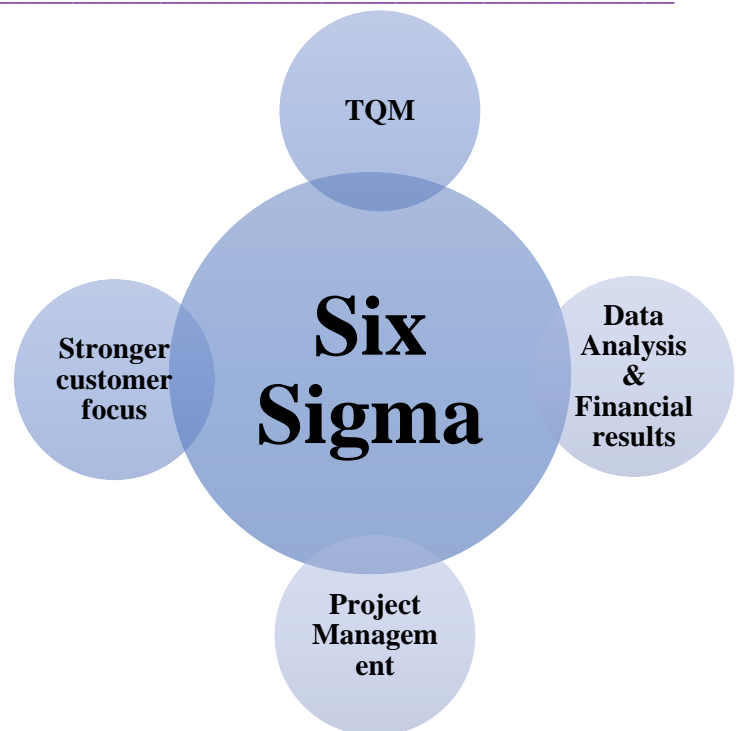


Figure 1:- factors involve in six Sigma

II. IMPORTANCE OF SIX SIGMA

To sustain in this increased competition among organization creates an environment there is no chance of mistakes. Organization have to be perfect in everything whether it is Product , service or Quality. For which the ,The main purpose of six sigma methodology is the customer satisfaction and improve profitability of an organization.

According to carraher and shields (2009) ; it shows that data that means Organization productivity is improved by 35% after arrival of six sigma in quality management programme.

Authors	year	Key observations
Anderson et al.	2006	<ul style="list-style-type: none"> • Reduction in work-in-progress & Cycle time • Increased in Capacity, inventory turns • Improvement Customer satisfaction, operations ,Strategy and administrations
Antony and Desai	2009	<ul style="list-style-type: none"> • Reduction is Scrap rate, cycle time , customer complaints • Improvement in Reputation, employee morale &attitude of employee &top management toward Problem solving • Increase in productivity & Profitability
Kumar et al	2005	<ul style="list-style-type: none"> • Increase in profitability and productivity • Reduction in process variability, operational costs,COPQ, Cycle time & customer complaints • Improved in sales
Antony and Banuelas	2002	<ul style="list-style-type: none"> • Improvement in cash management • Reduction in Process defects, manufacturing costs, new product introduction time, manufacturing costs • Increased in savings and customer loyalty &satisfaction
Zhang et al.	2012	<ul style="list-style-type: none"> • Increased in Efficiency • Cost reduction • Waste elimination • Reduction in variation
Mohamed	2010	<ul style="list-style-type: none"> • Improvement in sales , accuracy of resource allocation, accuracy of reporting ,customer satisfaction, cross functional teamwork. • Increased in market share, employee morale, profitability and productivity • Reduction in process variability ,cycle-time, operational cost, COPQ , documentary defects, service preparation times • Leading to great job satisfaction
Dr. P. Ramasubramanian	2012	<ul style="list-style-type: none"> • Improvement in mentality of employees by giving them promotions and belts of understanding the six sigma process • Increased in sales and cross functional teamwork • Reduction in process time and process defects
Byrne	2003	<ul style="list-style-type: none"> • Positive attitude towards demand variation • Reduction in the quality variation,product change over time • Robust & Reliable design • Stability in process

Table2)Observations from various research paper about importance/benefits of six sigma

The above table shows the Key observations/benefits observed from the various research papers(R patil et al) These are the some main benefits of six sigma which are help to satisfy customer satisfaction and profitability of organization presented by various researchers through their paper

III. FACTORS AFFECTING SIX SIGMA IMPLEMENTATION

As we understand the importance and versatility of six sigma in above points so to implement it on an organization is all they want but practically this is not the case some of the factors which are affecting the implementation of six sigma in manufacturing industries . Without considering this affecting factors while implementing six sigma organization rather face Sevier Loss because Six sigma is bit costlier to implement and time taking.

In this Review paper we collected some of the main factors affecting six sigma implantation in manufacturing industries

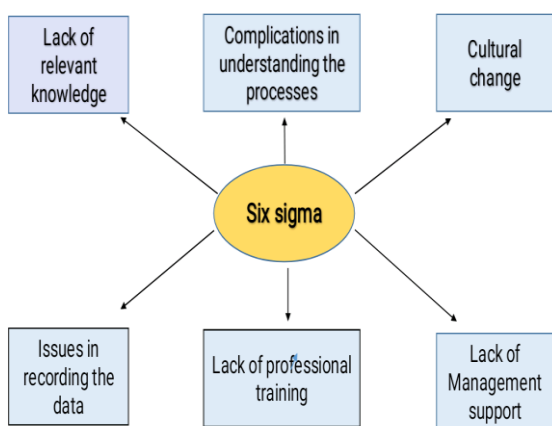


Figure 2:- Factors Affecting Six sigma Implementation

A. Lack Of Management Support

Those who have implemented & practiced six sigma agree that the most important factor is continued top management support and enthusiasm (Henderson& Evans ; 2000)

B. Lack of Relevant Knowledge

In today's era, the organization wants skilled employers but they don't get the skilled employers, so to

implement any new organization lots of knowledge required, Due to lack of relevant knowledge about the methodology's of six sigma its been proving difficult while implementing six sigma

C. Complications in understanding the process

To understand any process knowledge is required otherwise poor execution happens & process improvement are not aligned with the organization goals.

D. Cultural Change

Six sigma involves substantial change in the Organization structure & infrastructure .usually when change occurs the employee in organization are afraid of unknown & they do not understood the need for change(Antony,J. & Cornado ; 2002). To select appropriate process with respect to culture and requirement can play a vital role in implementing six sigma

E. Issues in Recording the Data

Six sigma is a process of continuous improvement in an organization with respect to time and quality level. To perform an continues improvement it required past data for analyzing and improving in the current processes while implementing six sigma.

F. Lack Of Infrastructure

The sector which are Economical consist of five sector, namely ELECTRCITY, BANKING, TRANSPORT, IRRIGATION, & COMMUNICATION therefore if this section and facilities are not performing well as per requirement then problem will occur.

IV. METHODOLOGY

Implementing six sigma in manufacturing sector required to go through DMAIC (Define Measure Analyze improve Control) ,DFSS Process (Design for six sigma) and Critical Success factor (CSFs) from various literatures and researchers we came to know some basic fundamentals of these approaches which can be crucial while implementing.

A. DMAIC Process

DMAIC is, the data driven six sigma methodology for improving existing process. The DMAIC should be used when an existing process can be improved to meet or exceed customer requirements & expectations.(Ravindra karwande, IEJ 2016)

Table 3: Description and Tools & Techniques Of DMAIC Approach

Initials	process	Description	Tools & Techniques
D	Define	Find the requirement & expectation of the customer, identify, classify it & translate the requirements to critical qualities.	<ul style="list-style-type: none"> • Market survey • Requirement gathering. • Customers requirement. • Focus on groups. • Contextual enquiry. • Reactive logging indicator. • Observe the requirements & collect the datas.
M	Measure	For any improvement, measurement is necessary, which is use to plan to collect data & ensure that measurement uncertainty is known and suitable.	<ul style="list-style-type: none"> • Quality control support system. • Unit of measure. • Upper specification limit. • Target. • Defect definition. • Measurement support system. • Accuracy. • Linearity. • Attributes.
A	Analyze	Identify all possible causes and confirm real or high risk causes & confirm real cause with estimate confidence. Compare with different techniques .	<ul style="list-style-type: none"> • Test the hypothesis. • Sample t test. • Sample sign test.E • Nature of relationship. • Strength of the relationship. • Precision of relationship • Purity of relationship.
I	Improve	Act on real high risk causes also act on the analyzed problems. If Analyzing the process if any change is needed then we have to improve on it	<ul style="list-style-type: none"> • Projects. • Management plan. • Prioritization. • Implement new processes
C	Control	Sustain the improved status.	<ul style="list-style-type: none"> • Collect data after improvement and test for significance. • Ensure control online with improved status. • Estimate benefit. • Cost benefit estimation. • Control plan. • Project document template. • Through various charts and tables

B. DFSS Process

DFSS (Design For Six Sigma) is nothing but design for six sigma methodology used to develop a process or product which does not exist in company. DFSS process is also known as DMADV (Design Measure Analyze Design Verify). DFSS consist of five phases or four phases.

This process is used when the existing product or process of organization does not meet the level of customers specification . Practically DFSS is more efficient than the DMAIC approach as its implementation is in early stage of new product or process development (Riddhish Thakore ;2014)

DFSS process is itself is abroad perspective every work should by given to its respective member of organization this is stated and systematically presented by this following figure (Riddhish Thakore ; 2014) describing the systematic working of an Design for six sigma process

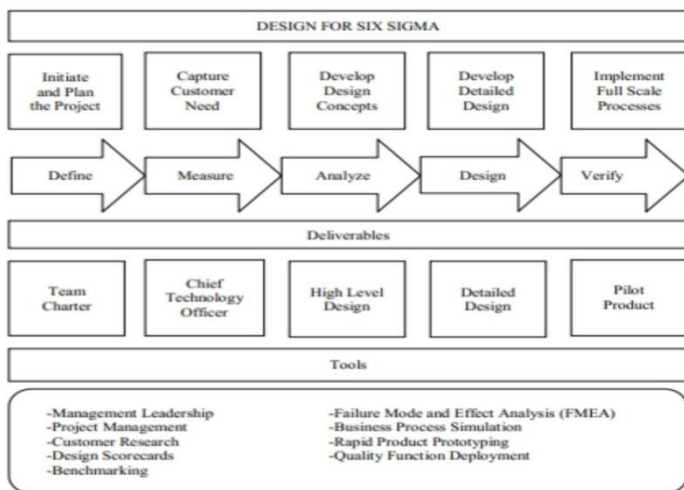


Figure 4:- DFSS process

C. CSFs Approach

Critical Success Factors (CSFs) are those critical factors which are success of any organization after implementing six sigma. that means if the objective associated with factor are not achieved ,the organization will fail in implementing six sigma.(Rockart; 1979)

The main CSFs from the various research papers and literature reviews are collected with their code (code is given by us for understanding purpose) are tabulated below (R. Patil ;2017) (Antony,J. and Cornado; 2002).

Code	Critical Success factor
1	Management commitment involvement and enthusiasm
2	Cultural change
3	Communication
4	Organization Infrastructure

5	Understanding tools and techniques
6	Concept of master belt and black belt
7	Linking six sigma to business strategies
8	Training
9	Linking Six sigma to customer
10	Linking six sigma to human source
11	Linking six sigma to Suppliers
12	Project management skills
13	Project Priority & selection
14	Reward and recognition System

Table 4– Critical Success Factors with their Codes

The following table shows the listed critical success factors which are included by various researchers in their paper as stated below

Authors	(years)	CSFs Codes
Desai et al.	2012	1, 2, 5, 6, 7, 8, 9, 13
Ricardo Banuelo et al.	2005	1, 4, 8, 7, 8, 9, 10
Antony ,J. and Cornado;	2002	1,2, 3, 4, 5, 7, ,8 ,9, 10, 11
Byrne;	2003	1, 6, 8, 9,
Kwak and Ambari;	2004	1, 2, 6, 8, 12,
Kumar et al;	2005	2, 4, 7, 11, 13
AntonyDesai;	2009	1,2,5,9.11,12, 13,
Zu et al ;	2005	8, 14
A Thomas et al	2008	6, 8
M. Shanmugaraj et al.	2012	1, 2, 3, 4, 5, 6, 12

Table 5: - Authors included CSFs in their research paper

V. CONCLUSION

This study is done by keeping in my mind of manufacturing industries in 21st century. We conclude that six sigma can play a vital role in improvement of organization to sustain in this competitive era. But while implementing six sigma Organization have to take care of factors which are affecting six sigma implementation (which are stated in our review paper)and look up to the implementation of Methodology that leads to the success of six sigma.

While analyzing various research papers I in our study the Management commitment & involvement is the most crucial factor in success along with training, Project selection, Linking six sigma to various department. And last but not the least Understanding Methodology (i.e. DMAIC, DFSS or CFSs) are also equally important.

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