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Six Sigma Perceptions for Capacity Waste Management in Indian Manufacturing Sector

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Abstract: **Six Sigma has been considered as a commanding best in class strategy that employs a well planned continuous improvement methodology to reduce variability of process and force out waste from the business processes using successful application of statistical tools and techniques. Although there is a broader acceptance of Six Sigma in business today, there appears to be practically no in depth case study on different aspects of Six Sigma like how the Six Sigma strategy has been used, how Six Sigma techniques have been executed and how the benefits have been produced. This paper presents a study illustrating the effective use of Six Sigma to reduce capacity waste. It also shows how various techniques and methods within the Six Sigma methodology have been employed to achieve considerable benefits.**

Keywords: **Capacity, Capacity Waste, Six Sigma, DMAIC methodology**

1. INTRODUCTION

Capacity is the actual or potential ability to perform; capacity of a facility is its limiting capability to produce an output over a period of time [1]. Capacity is subjected to seriousness of use of the facilities[2] and it is possible to enhance capacity by working for more days or additional hours. Provisionally capacity can be improved to meet additional demand by these methods. Imagine a transformation process having many sub-processes, each of them inter- linked. Here the capacity limit is determined by the capacity of that sub process which produces the smallest amount. The concept of capacity is thus connected with the weakest link in the series. This means that still when capacity is completely utilized in terms of the description of capacity, there may be particular processes that might remain underutilized. In many cases, processes are partially manual and partially mechanical. Expertise in many cases is undividable. Capacity has something to do with making in-house or buying or subcontracting from external source. We can buy specific parts or even the entire production from elsewhere, when we do not have in-house capacity[3]. At the time of setting up the plant, total ideal capacity of production is called installed capacity. When production is judged in a period of time, the maximum rate is recognized by trial and it is called the rated capacity. Various names and adjectives are associated in the midst of capacity. Installed capacity is firmed on the basis of capacity as indicated by suppliers of plant and machinery in their technical citations. We also come across terms like practical capacity, expected capacity, normal capacity and ideal capacity. Capacity utilization is a concept which refers to the extent to which an enterprise or a nation actually uses its installed productive capacity[4]. Thus, it refers to the relationship between actual output that 'is' produced with the installed equipment and the potential output which 'could' be produced with it, if capacity was fully used. Proper capacity utilization helps in achieving the ultimate objective of the industries to earn more profit and customer satisfaction and also helps in growing the economy of country[5]. Various researchers have used several techniques of operation research and mathematical modelling to reduce capacity waste levels but their application has a limited use [6]. In this context Six Sigma is a highly efficient strategy that focuses on developing and delivering good operational performance in a consistent way. It is a management strategy that utilizes simple statistical tools to achieve profitability and improvement in process and quality.

2. SIX SIGMA AND ITS EVOLUTION

Six-Sigma has been used all over the world and many companies testify to its pivotal role in their success [7]. Its

application focuses resources on reducing variation in all systems, including manufacturing systems, administrative systems etc. The unmistakable measure on the improvement work is referred to as Six Sigma. Well-known examples of Six-Sigma industries include Motorola, General Electric, Honeywell, Polaroid, Sony, America Express, Ford, Honda and Solectron [8]. From 1987 to 1997 Motorola achieved a fivefold growth in sales, with profits climbing nearly 20% per year, cumulative saving at 14 billion US dollars and stock price gains compounded to an annual rate of 21.3%. Motorola was also cited as the first winner of America's Malcolm Baldrige national quality award in 1988 [9].Six-Sigma is a tool of great value in achieving operational superiority. Operational superiority is needed for the overall attainment of business excellence; a notion that also requires customer correlated and financial performance superiority [10]. Six-Sigma explicitly links the tactical activities with planned ones. Thus, an properly configured and organized Six-Sigma program may be highly consistent with international quality awards, such as Australian Quality Award, America's Malcolm baldrige national quality award (MNBQA), Canada' Excellence Award and the European Quality Award [11].

In the case of MBNQA, the reward winning firms reported a 44% higher stock-price return, 48% higher growth in operating income and a 37% higher growth in sales than the control group of firms [12]. Organizations are using various criteria to help them during implementation efforts to evaluate themselves against criteria to determine how well their improvement efforts are rolling. Sets of standards being used by companies include Deming prize classes, Crosby's fourteen points, Juran's ten points and the MBNQA criteria [13]. Six Sigma is a company-wide systematic approach to achieve continuous process improvement. As a philosophy also, Six Sigma means producing only 3.4 defects out of every million opportunities for a business process[14].Table 1 shows the sigma level and respective defects per million opportunities (DPMO) . There has been a significant increase and development of Six Sigma technology and methodology in organizations [15]. Especially in the last decade, as a change and improvement strategy, Six Sigma has received considerable attention in global companies to generate maximum business benefit and competitive advantage [16].

TABLE 1: Sigma Table

Sigma level	DPMO	% Yield
1	691462	31%
2	308538	69%
3	66807	93.3%
4	6210	99.38%
5	233	99.977%
6	3.4	99.99966%

In essence, Six Sigma is an extension of other quality initiatives such as Deming's statistical quality control and total quality management (TQM). Six sigma, as with most of the management strategies on quality initiatives is focused around meeting the customer requirements as its main objective[17]. Six Sigma can be defined as a strategy that comprises TQM, burly customer focus, supplementary data examination tools, monetary results and assignment management [18]. Although it originated in the manufacturing industry to reduce the wastes due to wrong processes, it is now being used by almost all service industries[19]. Although some authors imply that Motorola first embarked on its Six Sigma quality initiative in the mid-1960s[20], the concept of implementing Six Sigma processes was pioneered at Motorola in the 1980s. Their approach was based on rigorous Japanese theories of TQM for use in the manufacturing process, where defects are relatively easy to spot and count and thus well suited to the high-volume, high precision electronics industry that has highly complex processes [21]. Motorola's definite attachment with Six Sigma began in 1982, when it implemented a quality-improvement program focused on manufacturing. Motorola's CEO asked his corporate managers to cut quality costs in half that year. He repeated the charge in 1983. By 1984, the cost reduction efforts were beginning to point to the need for improved analytical methods and product design for continued process improvement. The company's emphasis focused on design quality and a number of advanced quality tools were employed [22]. The first proponents of Six Sigma after Motorola were Allied Signal Texas Instruments, Eastman Kodak, GenCorp, Navistar International [18].

3. IMPLEMENTING SIX SIGMA

Today, nearly all companies are facing the harsh realities of a competitive environment. Some of the key reasons to adopt Six Sigma are:

1. To improve product and service performance:

- The aim of Six Sigma is to get better product and service performance by reducing defects inherent in the processes and materials used to produce them.
- Company managements say that they wish for zero defects from their plants.

2. To improve financial performance and profitability of business:

- Most manufacturers in the USA operate at on three sigma, agitate out 66, 000 defective parts for every million produced. These companies lose up to 25 percent of their total revenue due to defects [23].
- Over the past 15 years, GE has pursued business-performance improvement and corporate profitability using a wide range of programs. Corporate profitability must be the driver of such an effort.

3. To be responsive to and focused on the customer base:

- We realized early on that just as our customers were instituting changes, we also needed to change some of our processes so that we could be more responsive. Customers now needed solutions faster and were asking us to be faster.

4. We need to do what the customer wants before they want it. We needed to look at the future and match customer needs with our core competencies. We need to operate in dynamic systems and change direction fast in response to the environment.

5. Quantify its quality programs:

- The Six Sigma process strives to eliminate those defects by forcing a company to enumerate its quality. A record is established to gather information about every process inside a resource. Improvement can then be placed on a truthful basis. Implementation of Six Sigma within a business's processes eliminates I think and I feel from conversations about plant operations[24].

The concept of Six Sigma deals with measuring and improving how close the company comes in delivering on what it planned to do. Six Sigma provides a way for improving processes so that the company can more efficiently and predictably produce world class products and services. There is a five-phased methodology applied by a Six Sigma team to tackle specific problems to reach Six Sigma levels.

4. FIVE PHASE (DMAIC) METHODOLOGY:

The mainly used Six Sigma approach for process and quality improvement is the DMAIC (Define, Measure, Analyze, Improve and Control) methodology, which utilizes and many statistical tools to solve the problems like, control charts, design of experiments, process capability analysis pareto principle and many moreFig.1 shows the process of DMAIC methodology. Major points under different phases are:

Fig. 1. DMAIC Cycle

a) Define:

- It is the first step of the process where it is decided on the project. The objectives, scope, goals and the team members are also finalized during this phase. In this phase, project charter, SIPOC and CTQ Tree are important tools.
- Who are the patrons and what are their main concerns?
- As part of this phase, the team recognizes those attributes, called CTQs (critical to quality characteristics), that the customer considers having the most impact on quality.

b) Measure:

- To determine number of defects and also to measure their reduction. Accuracy of measurements is very important for success of Six Sigma project.
- How is the process measured and how is it going on?
- The team recognizes the key internal process that influences CTQs and measures the defects,

c) Analyze:

- In this step all measurements will be analyzed, By understanding them one can get to the basic problem easier. The idea is to search for the factors that have the biggest impacts on process performance and determine the roots causes.
- What are the important reasons for defects?
- The team finds out why faults are generated by identifying the key variables that are most likely to create process variation.

d) Improve:

- Improving or optimizing processes is done in this step. After all data has been analyzed, problems can be attacked more efficiently. DOE is a powerful tool that can be used in this phase besides lean tools like poke yoke, 5 S's etc.
- How do we tackle the reasons of the defects?
- The team verifies the key factors and quantifies their effects on the CTQs.

e) Control:

- This is the last step of the DMAIC methodology. Control ensures that processes are being taken care of and that any variance is corrected before it influences the process results.
- How can we maintain the improvements?

- Tools are placed to make sure that in the modified process the key variables remain within the maximum acceptable ranges over time.
- As both philosophy and measurement, Six Sigma focuses on gaining full-process understanding, including thorough analysis of how the key process inputs affect the process output. Data about output alone is not the defining parameter, but rather that information is analyzed together with the input data to confirm the root cause. Once the key inputs are identified, assuring sustainability of any process, improvement is simplified by linking the control plan to controlling the input rather than controlling the output [25].

5. COMPONENTS OF SUCCESSFUL SIX SIGMA IMPLEMENTATIONS

There are several key elements that are necessary for successfully implementing Six Sigma approach. Some of these elements are:

1. Top management involvement
2. Training
3. Organizational infrastructure
4. Tools
5. Six Sigma home page

In Six Sigma, many people have to be directly involved, and many support systems have to be in place to make it all work smoothly. Attaining Six Sigma quality levels requires total commitment from every department and active participation of every member of the company team. Employees with specific roles and responsibilities are important in deploying Six Sigma. The employees in an organization practicing Six Sigma are highly trained, have undergone rigorous statistical training, and lead teams in identifying and executing Six Sigma projects. They can be divided into various levels of expertise: green belt, black belt, master black belt, and champions. Together they have helped generate hundreds of projects, ranging across every function of the company[26]. The black belt/green belt growth today includes a diverse population of technical and non-technical people, managers, and people from key business areas:

- Six Sigma experts are fully skilled business organizers who promote and lead the deployment of Six Sigma in a significant area of the business.
- Back belts are fully-trained Six Sigma experts who lead advances teams, who work across the industry and mentor green belts.
- Green belts are full time teachers with quantitative skills as well as teaching and leadership ability. They are fully trained quality leaders responsible for Six Sigma strategy, training, advice ring, arrangement, and outcomes.
- Team elements are entities that support definite projects in their area.

Employees should be armed with the proper tools to successfully approach and complete Six Sigma projects. A healthy portion of Six Sigma training involves introduction to, theory behind, typical use of, and practical experimentation with three groups of tool used: process tools, team tools, and statistical tools.

- Team tools and process tools are those used to prepare the Six Sigma project leader with the team and leadership and skills required through the run of the project. These tools also help the project leader create a shared need for the project as well as establish an extended project team.
- Statistical tools and a well-organized methodology used by specially trained individuals can improve processes by helping identify potential causes for variation and then reducing variation and defects.

In addition to these components of Six Sigma success, early communication to employees, measurement systems, and an information technology infrastructure are also important.

The individual fear of the Six Sigma tools themselves became increasingly apparent as the mandate to train all exempt employees went into effect. As larger numbers of nonmanufacturing functions were enrolled in the training, some people were literally terrified of the thought of learning statistics and using a computer for more than just e-mail. Pre-training stress levels were unnecessarily high for many of the participants [27].

A communication plan addressing the importance of Six Sigma quality and how the method works is thought to be critical in driving out two basic fears at individual levels that come with the true cultural revolution that Six Sigma brings: fear of change and fear of not measuring up to the new standards. GE Appliances noted that it became abundantly clear that there were more required elements to infrastructure than human resources. ``In many cases, the measurement systems needed to be developed or were not repeatable or reproducible enough to be used. Not having adequate gauges or control systems in our systems in [their] factories represented a major roadblock to implementation of early projects [28].

6. CONCLUSIONS

Having explored the perception, definitions, approaches and successful elements of Six Sigma for capacity waste management it is concluded that; some processes may perform at Six Sigma levels, at this time no company has actually achieved Six Sigma performance levels. However, the rewards of striving for Six Sigma levels appear to be significantly beneficial and exhibit enough potential results for those

industries that have invested the time and money to grasp the initiative to continue improvements and reduce wastage. The success of this Six Sigma study can be attributed to the following key factors:

- Six Sigma strategy is an effective problem solving methodology.
- Training and teamwork.
- Improved performance/financials.
- Improved customer satisfaction.
- Improved product development.
- The quality profession and finally.
- Better capacity waste management.

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