Standards and Quality Practices in Production, Construction, Maintenance and Services

Comprehensive Theory *with* Practice Questions

As per new syllabus of ESE 2017
ESE-2017 : Preliminary Examination
Paper-I : General Studies and Engineering Aptitude

Standards and Quality Practices in Production, Construction, Maintenance and Services
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Preface

The compilation of this book *Standards and Quality Practices in Production, Construction, Maintenance and Services* was motivated by the desire to provide a concise book which can benefit students to understand the concepts of its topics.

This textbook provides all the requirements of the students, i.e. comprehensive coverage of theory, fundamental concepts and objective type questions articulated in a lucid language. The concise presentation will help the readers grasp the theory of this subject with clarity and apply them with ease to solve objective questions quickly. This book not only covers the syllabus of ESE but also addresses the need of many other competitive examinations. Topics like ‘Quality, Quality Control Tools, Sampling, Total Quality Management, Six Sigma, ISO Standards, Inventory Control, Quality in Construction and Services, Maintenance and Non-Destructive Examination’ are given full emphasis, keeping in mind of our research on their importance in competitive examinations.

We have put in our sincere efforts to present detailed theory and MCQs without compromising the accuracy of answers. For the interest of the readers, some notes, do you know and interesting facts are given in the comprehensive manner. At the end of each chapter, Objectives Brain Teasers are given with their keys, that will allow the readers to evaluate their understanding of the topics and sharper their question solving skills.

Our team has made their best efforts to remove all possible errors of any kind. Nonetheless, we would highly appreciate and acknowledge if you find and share with us any printing and conceptual errors.

It is impossible to thank all the individuals who helped us, but we would like to sincerely thank all the authors, editors and reviewers for putting in their efforts to publish this book.

With Best Wishes

B. Singh
CMD, MADE EASY
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5.1 HISTORICAL VIEW

- The term “Six Sigma” was coined by Bill Smith (Father of Six Sigma), an engineer with Motorola.
- Late 1970s - Motorola started experimenting with problem solving through statistical analysis.
- In 1987 - Motorola officially launched its Six Sigma programme, and due to the use of Six Sigma, Motorola is known worldwide as a quality leader and a profit leader. The secret of their success became public knowledge after Motorola won the Malcolm Baldrige National Quality Award in 1988.
- In 1991-Motorola certified its first “black belt” experts, which indicates the beginning of formalization of the accredited training of six sigma methods.
- In 1995-Six sigma become well known after Mr. Jack Welch made it a central focus of his business strategy at General Electric (An American multinational conglomerate corporation incorporated in New York) today it is used in different sectors of Industry.

What is Sigma?

- The term “sigma” is used to designate the distribution or spread about the mean (average) of any process or procedure. For a process, the sigma capability (z-value) is a metric that indicates how well that process is performing. The higher the sigma, capability will be better. Sigma capability measures the capability of the process to produce defect-free outputs.

What is Six Sigma?

- Six Sigma has been around for more than 20 years and heavily influenced by TQM (total quality management) and Zero Defect principles. In its methodology, it asserts that in order to achieve high quality manufacturing and business processes, continued efforts must be made to reduce variations.
- The idea behind Six Sigma is that if you can measure how many “defects” you have in a process, you can systematically figure out how to eliminate them and get as close to “zero defects” as possible. It starts with the application of statistical methods for translating information from customers into specifications for products or service being developed or produced.
- It is a highly disciplined process that enables organizations to deliver nearly perfect products and services. Six Sigma is a methodology that provides businesses with the tools to improve the capability of their business processes. This increase in performance and decrease in process variation leads to defect reduction and vast improvement in profits, employee morale and quality of product.

<table>
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<th>Do You Know?</th>
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<tr>
<td><strong>Why do we call Six Sigma as Six Sigma and not Four or Five Sigma or Eight Alpha?</strong></td>
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<tr>
<td>Sigma is a statistical term that measures process deviation from process mean or target. Mean is also referred as average in common language. The figure of six was arrived statistically by looking at the current average maturity of most business enterprises.</td>
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- It is a rigorous and a systematic methodology that utilizes information (management by facts) and statistical analysis to measure and improve a company's operational performance, practices and
systems by identifying and preventing ‘defects’ in manufacturing and service-related processes in order to anticipate and exceed expectations of all stakeholders to accomplish effectiveness.

**Note:** *Six Sigma is not a standard or certification or another metric like percentage. Rather! It is a Quality Philosophy and the way of improving performance by knowing where you are and where you could be.*

### 5.1.1 Benefits of Six Sigma

- Six Sigma emerged as a natural evolution in business to increase profit by eliminating defects (A defect is any incident or event which fails to meet the customers expectations). By aiming processes at Six Sigma, there would not be more than 3.4 defects per one million opportunities. Then processes can be evaluated to reach a target level with upper and lower limits. In order to reach these limits, the process variation will have to be reduced. Then as a result of which the curve will become more peaked.

![Diagram of Six Sigma Process](image)

**Fig. 5.1**

**Remember:** *The goal of Six Sigma is to increase profits by eliminating variability, defects and waste that undermine customer loyalty.*

**Use of Six Sigma:**

- Its usage depends on the type of business. In general, “If there are processes that generate a lot of negative customer feedback, whether that customer is internal or external, the components of Six Sigma should be considered as a means to study and rectify the problem.”

- With in any organization, Six Sigma:
  - Generates sustained success
  - Sets performance goal for everyone
  - Enhances value for customers
  - Accelerates rate of improvement
  - Promotes learning across boundaries
  - Executes strategic change
Key Success Factors for Six Sigma:
- Committed leadership from top management
- Integration with existing initiatives, business strategy, and performance measurement
- Process thinking
- Disciplined customer and market intelligence gathering
- A bottom-line orientation and continuous reinforcement and rewards
- Training

5.1.2 Six Sigma Management
- When practiced as a management system, Six Sigma is a high performance system for executing business strategy.
- Six Sigma is a top down solution to help organizations:
  - Align their business strategy to critical improvement efforts
  - Mobilize teams to attack high impact projects
  - Accelerate improved business results
  - Govern efforts to ensure improvements are sustained

Six Sigma Roles and Responsibilities:
1. Top management must champion the process of improvement
2. Corporation-wide training in Six Sigma concepts and tools
3. Setting stretch objectives for improvement
4. Quantitating incentives for improvement
5. Continuous reinforcement and rewards

5.1.3 Defects Per Million Opportunities (DPMO)
- To maintain Six Sigma quality, a process must not produce more than 3.4 defects per million opportunities. Opportunities can be defined as the total number of chances per unit to exhibit a defect. Each opportunities must be independent of other opportunities and must be measurable and observable.
- The DPMO can also be thought of as the capability of the process. The more capable the process the less the DPMO. Finally, this can be converted into a Sigma or standard deviation. The higher the standard deviation the lower the DPMO, which indicates a more capable process.
- Defects Per Million Opportunities (DPMO) can be defined as

\[
DPMO = \frac{\text{Number of Defects}}{\text{Number of opportunities for error per unit}} \times \frac{1,000,000}{\text{No. of units}}
\]

5.2 SIX SIGMA METHODOLOGY
The Six Sigma methodology is widely used in many top corporations in the United States and around the world. It is normally defined as a set of practices that improve efficiency and eliminate defects.

Six Sigma project follow two project methodologies:
1. DMAIC
2. DMADV
1. **DMAIC**

DMAIC is a basic component of the Six Sigma methodology - a way to improve work processes by eliminating defects.

- **Define:** Define is the first step in the process. In this step, it is important to define specific goals in achieving outcomes that are consistent with both your customer’s demands and your own business’s strategy. In essence, you are laying down a road map for accomplishment.

- **Measure:** In order to determine whether or not defects have been reduced, you need a base measurement. In this step, accurate measurements must be made and relevant data must be collected so that future comparisons can be measured to determine whether or not defects have been reduced.

- **Analyze:** Analysis is extremely important to determine relationships and the factors of causality. If you are trying to understand how to fix a problem, cause and effect is extremely necessary and must be considered.

- **Improve:** Making improvements or optimizing your processes based on measurements and analysis can ensure that defects are lowered and processes are streamlined.

- **Control:** This is the last step in the DMAIC methodology. Control ensures that any variances stand out and are corrected before they can influence a process negatively causing defects. Controls can be in the form of pilot runs to determine if the processes are capable and then once data is collected, a process can transition into standard production. However, continued measurement and analysis must ensure to keep processes on track and free of defects below the Six Sigma limit.

2. **DMADV**

There are certain situations where the management team members may feel that a process needs to be replaced by a new process rather than simplyfying and improving the existing process. The demands of the customers with respect to quality cannot be satisfied by the existing process. At times, an organization must decide to launch a new product or service to grab a new business opportunity offered by the environment. In all such situations, the last two steps used in the DMAIC, namely, “improve” and “control” can be replaced by “design” and “verify” so that it becoms DMADV.

- **Define:** It refers to define the design goals that are consistent with customer demand and business strategy.
• **Measure**: It refers to identify and indentify characteristics that are critical to quality, product capabilities, production process capabilities, and risks.

• **Analyze**: It refers to develop and design alternatives.

• **Design**: It refers to design an improved alternative that is best suited as design perspective.

• **Verify**: It refers to verify the design, set up pilot runs, implement the production process and it over to the process owner.

5.3 **DIFFERENT LEVELS IN SIX SIGMA**

• The Six Sigma Belts (Green, Black, and Master Black) denote the different levels an individual can achieve in Six Sigma. It has its basis on attentive and meticulous planning and constant determined application that can be made exclusive in dealing with issues that concern a business so as to improve on the marketability of their products and services.

![Diagram of Six Sigma Belts](image_url)

- **The Executive Leader** must be committed to this program and provide the leadership both to promote team work and collaboration among all the players in the program. In order to do this, they must be knowledgeable in the Six Sigma process and assign valued, committed individuals into the Champion/Sponsor positions.

- **The Champion/Sponsor** decides what needs to be done and provides the assistance to the Black Belts both with monetary resources as well as dedicated staff. In addition, this position benchmarks with other organizations in order to gain key information in processes they may need to improve.

- **The master, or master black belt** is a person who is at the highest level of expertise on the subject. They are fully devoted to the process and have no other job responsibilities outside the methodology. They are involved in every aspect of training and mentoring of all of the lower belt ranks. Example - instructors, coaches, technical leaders

- **A certified Black Belt** exhibits team leadership, understands team dynamics, and assigns their team members with roles and responsibilities. They have a complete understanding of the DMAIC model in accordance with the Six Sigma principles, have a basic knowledge of lean enterprise concepts, and
they can quickly identify “non-value-added” activities. Black Belts primarily focus on project execution, whereas Champions and Master Black Belts focus on identifying projects and functions for Six Sigma. Example - project team leaders and team members.

- **Green Belt** has emphasis on the DMAIC (Define, Measure, Analyze, Improve and Control) model. Six Sigma Green Belt certification helps the employee serve as a trained team member within his or her function-specific area of the organization. This focus allows the Green Belt to work on small, carefully defined Six Sigma projects, requiring less than a Black Belt’s full-time commitment to Six Sigma throughout the organization. Example – project team members, temporary team members.

**Implementation of Six Sigma:**
The main aim of Six Sigma is to achieve less than 3.4 defects per million opportunities by training internal leaders to apply established techniques. The following is a step-by-step approach for implementing Six Sigma.

- **Step - 1**: Every Successful performance improvement must begin with senior leadership. make sure all top-level management is on board and that financial and managerial resources are available. Training needs are rigorously assessed and training programmes are conductor for employees. Commitment is made to the project.

- **Step - 2**: Define the project scope and aim based on customer feedback and needs. Inspiration for Six Sigma projects can come from surveys, studies or existing projects. Always set goals for the whole organization or for a specific level of the organization that needs improvement.

- **Step - 3**: Analyse the system to identify defects. Measure the defects in the current system and performance. Identify the possible causes of problems. Explore possible solutions of the problems and assess their possible effect on the organization.

- **Step - 4**: Improve the system by finding different ways to do things faster, cheaper or better. Use management and planning tools to put improvement projects into place.

- **Step - 5**: Control the new process by modifying systems and measuring processes to continue and get good results. Use customer feedback to recognize and solve future problems.

**Six Sigma Improvement Model:**

- Suppose a company existing business is not working properly. Then by applying Six Sigma strategy, it can be improved, which we can see in the figure shown below:

![Diagram of DMAIC process](image-url)
What is DOE?

- Design of Experiments (DOE) is a statistical test to determine cause-and-effect relationships between process variables and output.
- By the use of DOE, it is easy to detect quality such as:
  - Material problem are corrected with suppliers.
  - Equipment faults are put right by improved maintenance programs or replacement.
  - People are trained
  - Partnership are built
  - Continuous improvement is observable
  - Business grows

Objective Brain Teasers

Q.1 Which of the following is the key objective of a six sigma project?
(a) Developing detailed control charts for critical processes
(b) Developing a matrix to understand how’s and what’s of a problem process
(c) Reducing variation in critical processes
(d) Reducing investment costs while improving output quality

Q.2 For a normal distribution, two standard deviations on each side of the mean would include what percentage of the total population?
(a) 95%  (b) 68%  (c) 47%  (d) 34%

Q.3 Six Sigma is a business-driven, multi-dimensional structured approach to:
(a) Reducing process variability
(b) Increasing customer satisfaction
(c) Lowering Defects
(d) All of the above

Q.4 One of the key roles of a Champion (Sponsor) is
(a) Hire team of Master Black Belt, Black Belts, among others
(b) Develop process maps
(c) Perform Statistical Analysis
(d) Play a pivotal role in that they own the processes of the business and, therefore, must ensure process improvements are captured and sustained

Q.5 They set very clear scope for all Six Sigma projects. They are responsible for approving any changes to the scope of the project.
(a) Six Sigma Deployment Leader
(b) Champion (Sponsor)
(c) Master Black Belt
(d) Black Belt

Q.6 They are expert statisticians and help the Black Belts in case of issues.
(a) Six Sigma Deployment Leader
(b) Champion (Sponsor)
(c) Master Black Belt
(d) Black Belt

Q.7 He drives more than one process improvement projects within the functional area and achieves the savings and quality goals.
(a) Six Sigma Deployment Leader
(b) Champion (Sponsor)
(c) Master Black Belt
(d) Black Belt

Q.8 These are the project-specific, full-or part-time resources that provide process and cross-functional knowledge, as well as help to sustain the gains.
(a) Yellow Belt
(b) Champion (Sponsor)
(c) Master Black Belt
(d) Black Belt
Q.9 Analyse phase - includes
   (a) Identify Vital Project X’s and statistically validate them
   (b) Communicate & sign off to close Project
   (c) Generate Potential Solutions & Assess Failure Mode
   (d) all of the above

Q.10 Six-sigma gives a precision of:
   (a) 95.45%     (b) 99.73%
   (c) 99.99%     (d) 68.27%

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