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The Master Book for

Lean Six Sigma Green Belt Certification

Nilakantasrinivasan J

Part I, II & III

CSSGB

Comprehensive Study Guide for Certification Exams & Job Interviews

Canopus Business Management Group

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Foreword

Are you looking for a compendium of references on Lean Six Sigma that is a comprehensive guide with answers for the questions that arise – this book is for you. *The Master Book for Lean Six Sigma Green Belt Certification* is a good companion to help assimilate your learning. Structured in a simple Question and Answer format, it is easy on the reader in getting answers from a practical stand point, for day to day application of concepts, certification or preparing for job interviews.

Lean Six Sigma Certification boosts career progression, from my own personal experience. However, preparation for Certification can be quiet daunting. While too many aids are available, this book covers all the topics of ASQ and IASSC Green Belt Body of Knowledge. As a certified in Lean Six Sigma Green Belt holder – you are expected to know the concepts and also be able to answer in job interviews. This Q&A format, with relevant examples and infographics, comes handy in preparing for such job interviews.

I have known Neil both professionally as well as on a personal front for more than fifteen years. He has contributed significantly to the process management community through various training programs that lead to certification, custom projects or advisory initiatives. I am sure you will enjoy referring to this book in your Lean Six Sigma journey.

Hussain Thameezdeen
Head of Operations
Qatar First Bank

Purpose of the Book

In my experience of coaching over 3000 candidates for Lean Six Sigma Certifications and having interviewed over 300 candidates for Lean Six Sigma roles, one thing I can say with conviction is that ***Six Sigma is overwhelming and a difficult subject when it comes to answers questions in exams or in interviews.*** While many practitioners understand the concepts of Lean Six Sigma, they fail to give 'right' answers in these instances. They fail to create the right impression in the interview. Instead, they leave an impression of mere familiarity, which doesn't make the cut either in Interviews or Exams.

Why this book?

While preparing for CSSGB exams of ASQ & IASSC, a learner like you encounters a lot of doubt. If you have to clear exams, you should have crystal clear understanding of all the concepts and you should know to paraphrase it in the right way. Whether you are taking objective or subjective type exams, these are critical aspects.

- As a result, this book is structured in the form of Q & A.
- All necessary concepts are explained with examples across industries. In interviews, interviewers test application knowledge; I have seen candidates drawing a blank when you ask them for an example.
- It is comprehensive and covers all the necessary topics that a CSSGB needs to know. It is drawn based on universal curriculum that maps to both ASQ & IASSC Body of Knowledge.

How to use this book?

- While preparing for CSSGB exams, reading the book sequentially will help
- Before an interview, you can brush up the topics of your choice

Structure of this Book?

As this is an in-depth study material, it is voluminous. Thus, the content is split into 3 parts. While Part 1 covers, Six Sigma Overview & Define Phase, Part 2 covers Measure, Part 3 Analyze, Improve & Control phases.

Further reading?

If you wish to learn about various application aspects, tips and practical nitty-gritties, you will find out online learning courses invaluable.

For more details visit: www.SixSigmaCertificationCourse.com or www.Collaborat.com

All the best!

Nilakantasrinivasan (Neil)

Contents

Part One
Six Sigma Overview & Define Phase

1 Fundamentals of Six Sigma

Understanding Six Sigma

The Six Sigma is an approach to business process improvement and performance management which encompasses a statistical and method-driven process. In order to effectively deploy the process in your organization, it is necessary to identify the basic elements that drive the Six Sigma methodology. Knowledge of the Six Sigma fundamentals is the first step toward a successful Six Sigma implementation. Before applying any business strategy in an organization, you must identify the goals and benefits of the strategy. You must also recognize the need for such a business strategy in the organization.

What is the definition of Six Sigma?

Six Sigma is a process improvement approach that strives to enhance the quality and efficiency of process outputs by eliminating the causes of defects and variation in a process. Sigma (σ) is a Greek letter that represents standard deviation and is used by statisticians to measure process variation.

Six Sigma is a customer-focused approach that aims at achieving increased bottom line profitability. Its goal is for a near perfection or zero defects. The driving forces behind Six Sigma are the complete grasp of customer requirements, data-driven decision-making, and statistical analysis that promotes the improvement of business processes in an organization.

Let's understand this with an example. Assume, John Smith, a manager at Janrex Inc., realizes that there has been a substantial increase in customer complaints about the products developed by his company. He calls for further investigation, which reveals loopholes in the overall product development process, leading to inconsistencies in the final product. The product development process needs to be addressed using an appropriate improvement approach. For this purpose, John chooses the Six Sigma approach, which focuses on improving the process by reducing defects in the product.

What are the important terms associated with Six Sigma?

Here are some of the common terms used in Six Sigma:

- **Standard Deviation -** *Standard deviation* is a statistical measure of variation from the mean in a distribution or set of data.
- **DPMO -** Defects Per Million Opportunities (DPMO) is the average number of defects across a million opportunities.
- **Defects -** Any product, service, or parameter that fails to meet customer requirements is considered a defect. Therefore, defects are undesirable and efforts should be made to reduce them and improve customer satisfaction. In fact, a Six Sigma quality performance indicates less than 3.4 defects per million opportunities.
- **Process Variation -** If a process or a set of processes delivers variable outputs, then the variation is called process variation. For example, a manufacturer will source raw materials from various suppliers. However, in instances, where different suppliers supply the same raw material, the quality may vary from one supplier to another. This

variation in quality of the input may cause variation in output quality. This variation is called process variation.

- **Process Sigma Level -** Before improving a process, it is necessary to understand the Sigma level of the process you are trying to improve. The Sigma level will give a short-term internal estimate that will predict the long-term Sigma level for the process and provide an estimate of the effort needed to achieve the Six Sigma level. Additionally, Sigma levels—such as Sigma 1, Sigma 2, Sigma 3, Sigma 4, Sigma 5, and Sigma 6—will provide a consistent method of comparing different processes and critical activities. They provide a measure to see how well or how poorly a process performs.

What is the need for Six Sigma?

Surviving in a business world that is full of competition is crucial to any organization. Six Sigma provides the means to handle declining product prices in the market, which helps any organization compete with the best companies in business. It targets zero defects by setting a common performance goal for the entire organization. Six Sigma helps an organization achieve increased profitability and quality improvement rates, ahead of any of its competitors. Reduced scrap-related costs, rework, improved yield, and increased customer satisfaction are identified in companies striving to achieve Six Sigma.

A Six Sigma initiative differs from other quality improvement methodologies because it ensures that the costs involved in implementation are offset by the gains received from improvements.

What do we mean by Six Sigma Philosophy?

The Six Sigma philosophy considers any “work” as a process that requires inputs to produce outputs and asserts that variations in the quality of the output (Y) can be reduced by controlling the inputs (X). It looks at a process as one that can be defined, measured, analysed, improved, and then controlled and is expressed as $Y = f(X)$.

What are the Goals of Six Sigma?

The primary goal of Six Sigma is to implement a measurement-based strategy in an organization that concentrates on process improvement and reducing variation. In addition to this, the other important goals of Six Sigma include:

- Reducing the number of defects, leading to the improved quality of a product or service.
- Achieving customer satisfaction by ensuring that customer expectations are met.
- Reducing cycle time, which enables the faster delivery of products.
- And, higher profitability by improving efficiency and effectiveness of the organization.

Explain about the evolution of Six Sigma?

Six Sigma is a combination of the best elements of various quality improvement methodologies and a rigorous statistic-driven approach to performance improvement. The term “Six Sigma” was coined by Bill Smith, an engineer at Motorola. Six Sigma, in the present form, originated in the early 1980s at Motorola as a tool for reducing product-failure

levels by 10 times in five years. General Electric (GE) implemented Six Sigma in 1995 after Motorola, and Allied Signal followed the Six Sigma trail after GE.
Six Sigma methodology evolved by combining the best elements of earlier quality improvement innovations.

Innovation	Description
Uniformity system	• Introduced by Eli Whitney in 1798 • Created a necessity for measuring dimensions • Evolved into specifications
Moving assembly line	• Introduced by Henry Ford in 1913 • Highlighted the importance of part consistency • Led to the sampling method, replacing 100% inspection
Control charts	• Introduced by Walter Shewhart in 1924 • Signaled the age of statistical quality control
Quality movement	• Introduced by the Japanese in 1945 • Pioneered the usage of data to quantify variation • Ensures integration of quality across all levels of an organization
Customer Centric Products	• Japanese focused on eliminating defects and reducing cycle time • Resulted in production of high-quality, efficient, and customer-centric products
.Zero defects	• Was introduced by Philip Crosby in 1980 • Led to perfection in a product, process, or service is attainable.
Quality standards	• Introduced by the International Organization for Standardization (ISO) in 1987 • Led to uniformity in quality practices across countries
Six Sigma	• Motorola wins the first Malcolm Baldrige National Quality Award in 1987 • Led to the present Six Sigma methodology

What is the definition of Process?

A *process* is a set of structured activities or tasks that produce a specific output or a product that meets customer requirements or specifications. The customer is the beneficiary of a process, and therefore, it is a sequence of activities that convert one or more inputs into a specific output that is of value to the customer. A process may lead to a sequence of interrelated processes where the culmination of one process is the start of another.

What are Process Inputs?

Process inputs can be data, services, or material that a process converts into outputs. The recipient of a process input is the process itself. Generally, a process can have several inputs, and if you consider an organization as a single process, then the components, dimensions, and process settings can be considered process inputs.
If the process is developed according to the goals of Six Sigma, process inputs, referred to by the term “X,” are the focus of attention because they are vital for the output to meet customer specifications.

Process inputs are also referred to as Key Performance Input Variables (KPIVs), or the independent variables, causes, problems, or metrics, which can be controlled.

What are Process Outputs?

A *process output* is the material, service, or data that results from the operation of a process. The recipient of a process is normally the customer or the client. In some processes, outputs are used as inputs for the next stage of the process or for a different process. Generally, a process can result in more than one output, and if an organization is considered a single process, then the final product is their primary output. If the process is developed as per the goals of Six Sigma, then the process output, referred to by the term "Y," is a good measure of customer requirements. If the process consistently delivers on the output metric, then customer requirements are met.

Process outputs are also referred to as Key Performance Output Variables (KPOV), or the dependent variables, effects, symptoms, or metrics, which will be monitored.

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Identify Organizational Drivers and Metrics

To identify the right process for your performance improvement efforts, it is important to identify the key business drivers and performance metrics of your organization.

In this topic, you will identify the key business drivers and metrics that impact an organization. Key drivers and metrics are the basis by which organizations evolve their business and performance goals. Identifying them will enable you to focus your performance improvement efforts on business processes that will have maximum impact.

What are Organizational Processes?

Organizational processes are a set of core processes that make an organization effective, efficient, and adaptable. These core processes are focused on delivering the right quality of products or services to customers, per their requirements. Core processes may differ from one organization to another and are dependent on the organizational structure.

Example: A manufacture of semiconductor devices.

A manufacturer of semiconductor devices, such as transducers and load cells, sources raw materials from their vendors. The material and resource requirement planning include inward and outward logistics. Inward logistics include in-warding material in stores, moving from supply to the production line in a timely manner, and storing raw materials. Outward logistics include dispatching finished goods and forming a part of an organizational process called supply chain management. This process cuts across different departments, geographies, and products that the organization manufactures.

What are Sub-Processes?

Core processes are supported by sub-processes, which enable them to achieve higher customer satisfaction, better product quality, and increased delivery and time to market

speed. In a manufacturing environment, these sub-processes are performed in a sequence that enables effective and efficient completion of a manufacturing process.

What are some examples of Sub-Process?

- **Purchase -** To increase profitability of a business by procuring high-quality raw materials at the most cost-effective price and by optimizing the inventory cost of raw materials.
- **Production -** To process raw materials efficiently and produce high yields by reducing defects and rework. Attention is paid to training and reducing machine downtime through suitable maintenance programs for the production machinery.
- **Sales and marketing :** Innovative strategies are employed as part of public relations. Advertising and sales campaigns are used to increase the willingness of a customer to buy manufactured products.
- **Delivery** - Care is taken to process the order quickly, freeze the scheduled time of delivery, and ensure that the delivery schedule is met in the most cost-effective manner. Obtaining customer feedback is a key element in this sub-process.

What are Organizational Drivers?

Organizational drivers are the highest level of measure in a business process. They are strongly linked to the strategic goals of an organization. Organizations depend heavily on them for measuring performance. If the key drivers of an organization are achieved, then the organization can be considered to have achieved its overall goal set for that period. Usually, organizational goals are defined for a three-to five-year time frame.

Organizational drivers are usually business-level metrics, such as financial and performance measures. Other organizational drivers are customer, market, product, and supplier related. They form the backbone of any business effort to improve customer, operational, and financial performance. Some organizations go with just one strategic goal. Others have more but limit the number of goals to five at the maximum. Because a measurement system is established to measure the progress of the strategic goals, these strategic goals are referred to as the Big Y and are considered outputs in operational processes. These organizational drivers are in turn linked to the downstream key metrics of processes.

What are Metrics?

Metrics are process-level and operational-level measures of efficiency and effectiveness of processes. Only efficient processes can help an organization meet the three- to five-year strategic goal. Gauging the organization and its processes is dependent on the selection and use of these metrics. These operational and process-level metrics are considered the Xs and inputs for the organizational drivers, which are regarded as the Big Y.

Compared to organizational drivers, metrics are more tactical in nature, are measured more often, and can be easily impacted. Because X is considered the input for achieving the Big Y, an organization will achieve the Big Y by monitoring and controlling X.

Operational-level metrics are measures that relate to the efficiency or effectiveness of cost, performance, time, and much more. They provide inputs to constantly gauge the effectiveness and efficiency of process improvement efforts.

What is Balanced Scorecard?

A *Balanced Scorecard (BSC)* is a strategic performance management framework for measuring the impact of strategic decisions across all organizational drivers of an organization. A BSC provides a wider perspective on strategic decisions made by an organization by measuring the impact on key business drivers such as finance, customer requirements, internal processes, innovation, and growth perspectives.

The BSC was conceived with the intent to overcome the limitations of traditional performance measurement tools. At the basic level, managers utilize it to track the activities of their direct reports and monitor the impact of their actions. At the decision-making level, a BSC is used both as a tool that facilitates strategic decision-making and as one that provides an insight into future performances.

Share an example of Balanced Scorecard?

An automobile manufacturer embraced BSC as a way to remain competitive in a rapidly evolving sector. The ensuing benchmarks show how BSC permeated into each department to coordinate the delivery of quality products and the ability to offer diverse models.

Financial Perspective – How does the organization look to resource providers? • Profitability – percent excess revenue and percent of net revenue • Efficiency – efficient processing of raw materials • Leverage- total debt to total assets	**Customer Perspective** – How do customers view the organization? • Understand needs • Ease of ordering • Variety/availability • Professional • Courteous
Internal Process Perspective – is the organization productive and effective? • Operation and maintenance perspective • Suitability of equipment and procedures to achieve defined targets and objectives • Appropriateness of the training given to key personal	**Innovation and Learning Perspective** – How do employees view the organization? • Influence in the community • Know how to use tools • Manage workload • Advancement opportunities • Valuable training

What are the different Six Sigma Improvement Methodologies?

There are two basic Six Sigma models: DMAIC (Define, Measure, Analyze, Improve, and Control) and DFSS (Design for Six Sigma), also known as DMADV (Define, Measure, Analyze, Design, and Verify). These methodologies use a measurement-based strategy to achieve the Six Sigma objectives of process improvement and variation reduction.

- **DMAIC** is used to add incremental improvements to an existing process.
- **DFSS** is used to develop new processes, services, or products when existing process require more than just incremental improvements.

- **JDI** is another method for problem solving. In a continuous improvement process where rigorous methodologies, such as DMAIC, are not required, **JDI** (Just Do It) method of problem solving is deployed. Though JDI is considered a shortcut approach to process improvement, it is used in instances where management believes it has sufficient information to bypass or shorten the Measure or Analyze phase. JDI is also deployed in instances when the process improvement team wants to demonstrate immediate results. It is used to reduce data collection and analysis effort and move on to the execution stage; thus, saving time and effort.

How can your organization benefit by implementing Six Sigma?

Answers will vary, but may include increased profit margins by reducing costs and growing revenue, improved business performance due to the reduction of variations and defects, reduced delivery time due to reduced manufacturing lead time, enhanced customer satisfaction due to better quality, expanded capacity in terms of productivity without spending on additional resources, accelerated improvement processes by leveraging the "prescriptive" approach of Lean, leveraged data analysis and statistical tools of Six Sigma for making process improvements and sustaining these improvements, and leveraged Six Sigma methodologies for better results.

What do you think are the most significant goals of Six Sigma?

Answers will vary, but may include aligning the organization to customer needs, improving profitability, and reducing variations and defects and by identifying Six Sigma Methodologies.

What do you understand by TQM?

Total Quality Management (TQM) is a structured system focused on satisfying customers by involving all members of an organization in improving the quality of products, processes, and resources. Sustained customer satisfaction, its main objective, is accomplished through systematic methods for problem solving, breakthrough achievement, and standardization derived from teaching quality leaders such as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, and Joseph M. Juran. There are no hard-line procedures for implementing TQM. The PDCA cycle, also known as the Shewhart Cycle or the Deming Cycle, is a popular TQM problem-solving tool.

Describe PDCA cycle of TQM?

PDCA (The Plan-Do-Check-Act) cycle involves four basic steps for carrying out continuous improvement in a process. Four basic steps of PDCA:

- **Plan** recognize the opportunity for process improvement and identify the plan for improvement.
- **Do** the plan is implemented. Simultaneously, employees are trained, and activities such as scheduling and follow-up happen. If the desired process improvement is not achieved, the plan is abandoned and the improvement effort will start from the planning stage.
- **Check** the implementation of the action plan will yield results. These results are then compared with the planned results. Deviations are recorded and an improvement plan is proposed to achieve results.

- **Act** on the results of the check step, and a decision is made whether to restart PDCA or standardize on the results.

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Describe Project Selection and Organizational Goals

In the previous topic, you identified organizational drivers and metrics and determined their impact on the entire organization. You also need to be able to evaluate Six Sigma projects and align them to your organizational goals.

Identifying suitable Six Sigma projects and determining when to deploy them are important for an organization's sustainability and eventual success. Consequently, implementing Six Sigma on an ineffective project will impact the success of the project but bring little change to the organization's bottom line. Therefore, it is important for you to identify the right project and understand the degree of its impact on the organization.

Project selection process will be covered in Lesson 3 in detail along with Define tools.

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Describe Lean

In the earlier topic, you described the project selection process and the key Six Sigma methodologies. The Lean manufacturing methodology has made significant contributions to the Six Sigma approach. In this topic, you will identify the elements of Lean. While implementing Six Sigma, the key concepts, applications, and principles of Lean are important because various line positions have specific responsibilities. Along with an understanding of the Six Sigma principles, an awareness of Lean manufacturing principles will provide you with a holistic view of the Six Sigma implementation.

What are the goals of Lean?

Lean manufacturing has a few important goals, which have led many industries to implement. Lean in their production processes. The goals include:

- Improving quality to stay ahead of competition in the market. This is done by capturing customer requirements and redesigning operational processes to meet those requirements.
- Eliminating waste to make processes more efficient. This is done by eliminating activities that do not add any value to the product or service.
- Reducing variabilities and inconsistencies by standardizing processes and outputs.
- And, reducing costs by ensuring that production does not exceed customer demands. By preventing overproduction, organizations can also make sure that inventory costs do not increase.

Describe the key principles of Lean?

The implementation of Lean techniques in an organization is guided by a few important principles.

Principle	Description
Value	Defining the value
Value stream	Identifying the value stream
Flow	Creating flow in the value stream
Pull	Creating pull in the value stream
Perfection	Creating a continuous improvement culture
Leveling	Creating a balanced workflow
Standardized processes	Developing standards and following them
Kanban	Using a visual signaling system
Visual control	Using visual control methods
Quick changeover	Enabling the reduction of time
Defect prevention	Reducing the cost of poor quality

What is Kaizen?

Kaizen is an approach that focuses on continuous, simple, and small improvements to business processes rather than a few major and complex improvements or re-engineering initiatives. It is a combination of two words in Japanese—"kai," which means "change," and "zen," which means "good." In simple terms, it means "change for the better" and in a business context, it signifies "improvement."

Kaizen is applied in different processes across different industries. It involves all employees in an organization—managers and workers alike. Teamwork, personal discipline, improved morale, quality circles, and suggestions for improvement are regarded as the five major elements of Kaizen.

Share an example of Kaizen in detail?

A tool and die department has been receiving several complaints about delays in the delivery of tools and even missing dies. Upon investigation, it was found that they were often misplaced and considerable time was spent searching for them, leading to delays and missing items. To set things right, management decided to adopt Kaizen.

As part of the Kaizen initiative, the following steps were taken:

- Old and outdated tools and dies were removed and placed in storage.
- New pieces were sorted and arranged in different racks based on the part numbers.
- Every store keeper was given a kit of necessary tools so that he or she did not have to waste time searching for the items.

- And, the entire office layout was redesigned to provide a better workspace for tool and die makers.

What is 5S?

The 5S methodology includes five steps that help organizations create and maintain an organized, clean, and safe work environment as part of their initiative to implement Lean.

- Sort - Involves determining necessary and unnecessary tasks, raw materials, finished goods, and tools in a process. As a result of this step, all unnecessary tasks in the process are discarded.
- Set in place - Involves arranging and labelling necessary tasks, raw materials, finished goods, and tools in a process so that they are easy to locate and use.
- Shine - Focuses on keeping machines and work environments clean.
- Standardize - Focuses on extending cleanliness and continuously practicing the first three steps of the 5S methodology.
- Sustain - Encourages implementing the 5S methodology on an ongoing basis by establishing required standards and strategies.

Describe Error Proofing.

Error proofing is a tool, also referred to as *mistake proofing* or *poka-yoke,* used to prevent the occurrence of defects and ensure that mistakes are accurately detected when problems occur. Error proofing allows a process to proceed further only when all issues are resolved. Thus, error proofing helps to improve process throughout and quality and reduce defect and rework rates.

Example: Error Proofing in Turn Signals of Cars.

Turn signals of cars are automatically cut off when the driver completes the turn. This method of error proofing in cars helps prevent major accidents because drivers tend to forget to turn off the turn signal. When a turn signal is left on, it can send the wrong message to other drivers on the road and lead to accidents.

What do you understand by Value Stream Mapping?

Value stream mapping is the process of evaluating different activities that exist in the production process and identifying value-adding and non-value -adding activities. This is done by creating a current state map that visually represents the existing workflow of the manufacturing process from start to finish. A future state map is created to represent how value will flow in an improved process, where non-value-adding activities are eliminated and optimized value adding activities are drawn. Value stream mapping is often referred to as VSM. Usually, value stream maps are read from right to left.

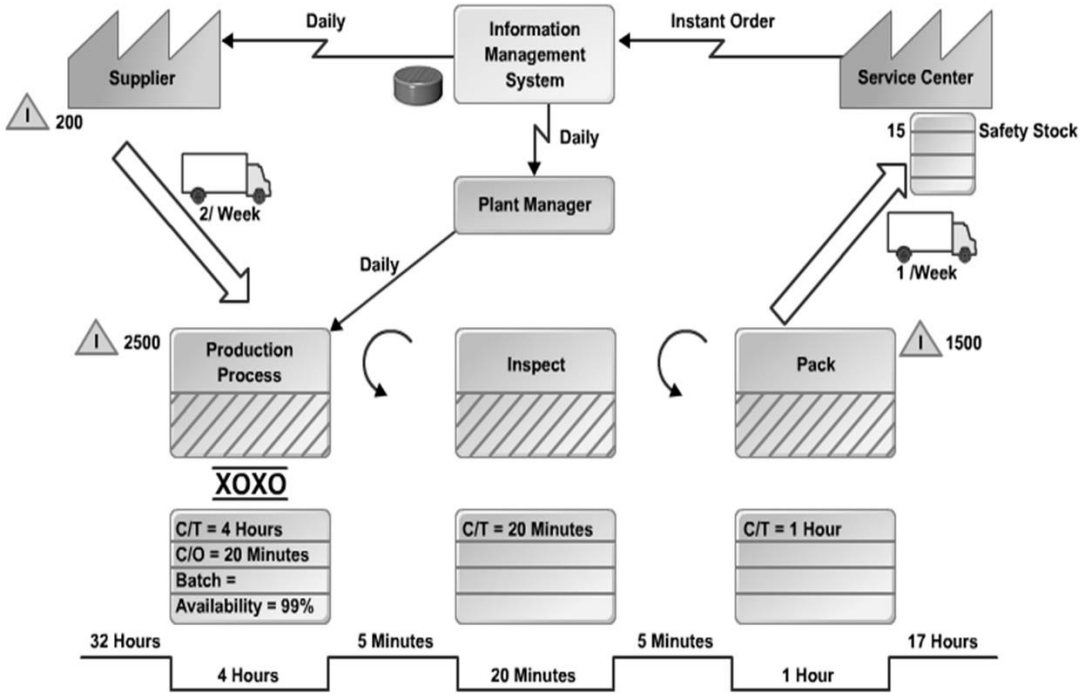

Fig: Example of value stream mapping

What is the difference between Current State & Future State Value Stream Maps?

Current State Value Stream Maps - A current state value stream map shows business processes as they currently exist. It helps identify areas where wastes occur and opportunities for improvement exist.

Future State Value Stream Maps - A future state value stream map shows improvements that need to be made in a value stream to eliminate waste in the process. It helps Lean teams in developing improvement strategies to be applied in their business processes.

Explain the concept of Kanban?

Lean organizations use visual inventory cues, such as Kanban, to pull the required amount of materials to produce a specific number of products at the right time.
Kanban can be either a card or a reusable container. Production line operators produce components when they receive a card or an empty container. An empty Kanban card indicates the need to produce parts, and in case there is a change in specifications, steps are taken to ensure that each line operator produces just enough and then stops.

Kanban differs from other inventory management and planning processes because production or component delivery is pulled through the production line, rather than against it, which is the push method. The push method is used in the traditional forecast-oriented manufacturing process.

What is Visual Factory?

In a Lean manufacturing process, time and resources spent on conveying data and information are regarded as waste. Visual factory tools—such as signs, charts, check sheets, and more— simplify information and reduce resources and time consumed to make

it accessible. Clear and concise real-time information and feedback regarding the status of a plant or a process is provided to shop floor employees using visual cues and tools. The visual cues provide unambiguous information needed to perform their jobs at a glance. Simple visual cues—such as color-coded pipes, wires, or flags; painted floor areas; and indicator lights—are simple to use and understand. The type of tool and the location used are determined by identifying the relevance and the information recipient.

What is TPM?

Total Productive Maintenance (TPM) is a maintenance management system where every employee, from top management to the production equipment operator, maximizes the effectiveness of the production system by preventing accidents, defects, and breakdowns. TPM improves overall effectiveness by maximizing equipment effectiveness and establishing a system of *preventive maintenance (PM)* across the lifespan of a piece of equipment. TPM is by autonomous groups or individuals and by departments such as engineering, operations, and maintenance.

Narrate with an example the benefits of TPM?

A steel furniture manufacturer faced production losses and rejections because of the frequent breakdowns and feeding defects of an automated coil feed fabrication line. The manufacturer decided to implement TPM, and as a first step, a 15-member team was chosen for TPM training. After completing the training in spring, the team set about implementing TPM. The team discovered that although the automated coil feed fabrication line was supposed to run 90 percent of the time; 40 percent of the time was spent in idling, minor stoppages, breakdowns, setups, and adjustments. Upon completing the TPM project, daily maintenance and productive maintenance caught problems before they happened and reduced the emergency maintenance of the machine. Consequently, there was significant reduction in setup time, stoppages, and idling time.

The summary of the results is as follows:

- Overall equipment effectiveness up by 25-65 percent.
- Quality defects down by 25-50 percent.
- Maintenance expenditures down by 10-50 percent.
- And, percent planned versus unplanned maintenance increased by 10-60 percent.

What is PM (Preventive Maintenance)?

PM is a schedule of planned maintenance actions aimed at preventing machinery breakdowns and failures. The primary goal of preventive maintenance is to improve equipment reliability and prevent equipment failure by proactively replacing worn components before they fail.

Explain the term Standard Work that is used in Lean?

Standard work is the systematic method of identifying, improving, and standardizing the most efficient method for performing work in a Lean environment by using available resources, namely people, equipment, and materials. It provides the person performing a task the impetus to complete the task using the most efficient method every time without fail. Standard work assures predictability through reducing variations, and synchronizing various

processes, and providing a baseline for continuous improvement. It also highlights the critical points in a process; defines operator procedures; and describes the production sequence, safety issues, and quality checks.

Share an example of standard work in an Automobile Manufacturing Plant?

Recently, there were complaints about defective parts produced by the crank shaft grinding department. Management concluded that the defects were due to the lack of a standardized work procedure. They identified a machine as a detection mechanism and used it to measure the parts as they were manufactured to find out whether they were within a given tolerance. The data collected by the detection mechanism was analysed and used as a starting point to establish standard work. All the line operators were instructed to follow the procedures set in the standard work manual. This resulted in a reduced number of defects. However, management continued using the detection machine to generate a new set of data and monitored the work for continual improvement of work procedures.

What are Value-Added Activities

A *value-added activity* is any activity that increases the worth of a product or service. It directly contributes to meeting customer requirements, and customers are willing to pay for it. Value-added activities also generate a positive ROI for an organization. Without these activities, the process will be affected. A lean team should analyze if activities in a process actually add value to a product or service. They should also determine if activities in a process can be performed in parallel or be merged. This will help organizations deliver outputs more efficiently.

Example: In a manufacturing process, value-added activities can include: receiving a part request, preparing an internal request for a part from production, finding a relevant plant for issuing a request, finding production availability, updating part request information, and the manager processing the part request information and updating the request.

What are Non-Value-Added Activities?

Non-value-added activities are activities that consume resources and time without adding any value to a service or product. Non-value-added activities do not contribute to customer satisfaction and, therefore, customers are not willing to pay for these activities. They are not important to the production and delivery of a product or service and eliminating them will not affect a process. Because non-value-added activities do not generate any positive ROI but incur only expenditures, organizations should focus on eliminating them.

Example: In the manufacturing process, non-value-added activities can include: sorting and organizing requests, searching for relevant part production locations, checking locations for availability and delivery, generating production requests, and reviewing the status of requests.

What are types of wastes in processes?

Organizations strive to eliminate three basic categories of waste in their business processes.

Basic Waste Category are:

- **Wasteful activity** - Work that adds no value to a product or service. Eliminating such activities from business processes will help organizations cut cost.
- **Unevenness** - This denotes inconsistencies that exist in a business process. Unevenness and inconsistencies can be avoided by eliminating inventory and supplying items to the production process only when they are needed.
- **Overburden** - This is caused by an unreasonable or excessive strain on resources. It can be eliminated by simplifying and standardizing processes.

Among these three basic categories of wastes, Lean focuses on eliminating activities that do not add any value. These activities are further classified into seven types of wastes: transport, inventory, motion, waiting, overproduction, over processing, and defects.

What do you understand by Theory of Constraints (ToC)?

The *Theory of Constraints (TOC)* is a management approach to managing the weakest link in a process. A process can have one or more weak links, called constraints, that can be anything that prevents the process from performing to its maximum potential. TOC contends that a few constraints control the performance of a process, and therefore provide a mixture of related processes and interrelated concepts to increase the throughput.

What do you mean by throughput and Drum-Buffer-Rope in TOC?

Throughput - Throughput is the rate at which a process generates money through sales, not through production.
Drum-Buffer-Rope - Drum-buffer-rope is a TOC production planning technique that maximizes the flow of materials in a plant for which there is an immediate customer demand.

What the 5 steps followed in theory of constraints approach?

Theory of constraints has five steps. They are;

1. **Identify the constraint** : The constraint must be identified before an attempt is made to improve the throughput.
2. **Exploit the constraint** : If a constraint is responsible for reducing the output, then it should be pushed to yield the maximum output.
3. **Subordinate to the constraint** : The rest of the process should provide maximum support to the constraint to maximize its throughput.
4. **Elevate the constraint** : Improve performance by adding more capacity by way of additional resources.
5. **Do not let inertia set in** : If the weak link has been strengthened, go back to step one and implement TOC on the new weakest link.

Can you give an example for how TOC can be used in real life?

An automobile manufacturer discovered that his die casting machines were manufacturing just 25 shots per hour against an industry average of 60 shots per hour. Management decided to make 60 shots per hour the goal and sets about to achieve this using the five focusing steps described by TOC. To identify the constraint, the “shot per hour data” was analysed. The data identified the second shift start-ups on Wednesday as the lowest shift and the die cast machines as the constraint resource. This made Wednesday’s the lowest in terms of production and the highest in terms of scrap.

Management decided to increase the throughput on the constraint resource on Wednesday's. Once the constraint was identified, management decided to exploit the constraint. Stuck parts, operator absenteeism, and a lack of space in the trimming line were identified as some of the causes for low-producing start-ups. The solutions to these problems were:

1. Perform difficult start-up jobs at shut-down and when experienced operators can start them up on the second shift.
2. Have first shift operators cover for absent second shift operators.
3. Clear trim lines prior to shut down and ensure that the second shift has room in the trimming line.

Once the solutions were implemented, management conducted a process meeting on how to subordinate the constraint by giving the second shift start-ups full support in terms of resources. Simultaneously, an action plan was put in place and steps were taken to ensure that the second shift had extra machines and operators to increase productivity. The constraint was removed as evidenced by the fact that the second shift produced an average of 62 shots per hour against the 25 shots per hour before the start of the TOC project. This is a 60 percent improvement on start-ups, which indicates the process has succeeded in elevating the constraint. Because they succeeded in overcoming one constraint, management decided to focus on other constraints in the process and applied TOC to the next weakest link in the process. By turning their attention to the other constraints, they prevented inertia from setting in.

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