

# Lean Six Sigma Green Belt Certification Course

DIGITAL  
OPERATIONS





## Lean Tools for Process Control



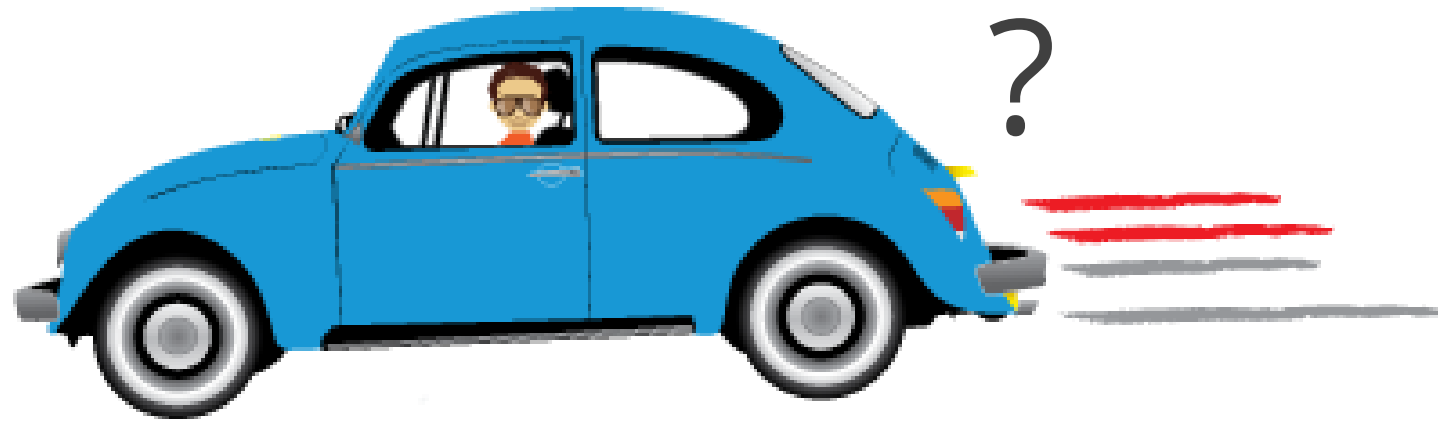
# Learning Objectives

By the end of this lesson, you will be able to:

- 👁 Explain the concept of Total Productive Maintenance
- 👁 Describe a Visual Factory
- 👁 Identify the 5S for Lean Six Sigma



# Introduction

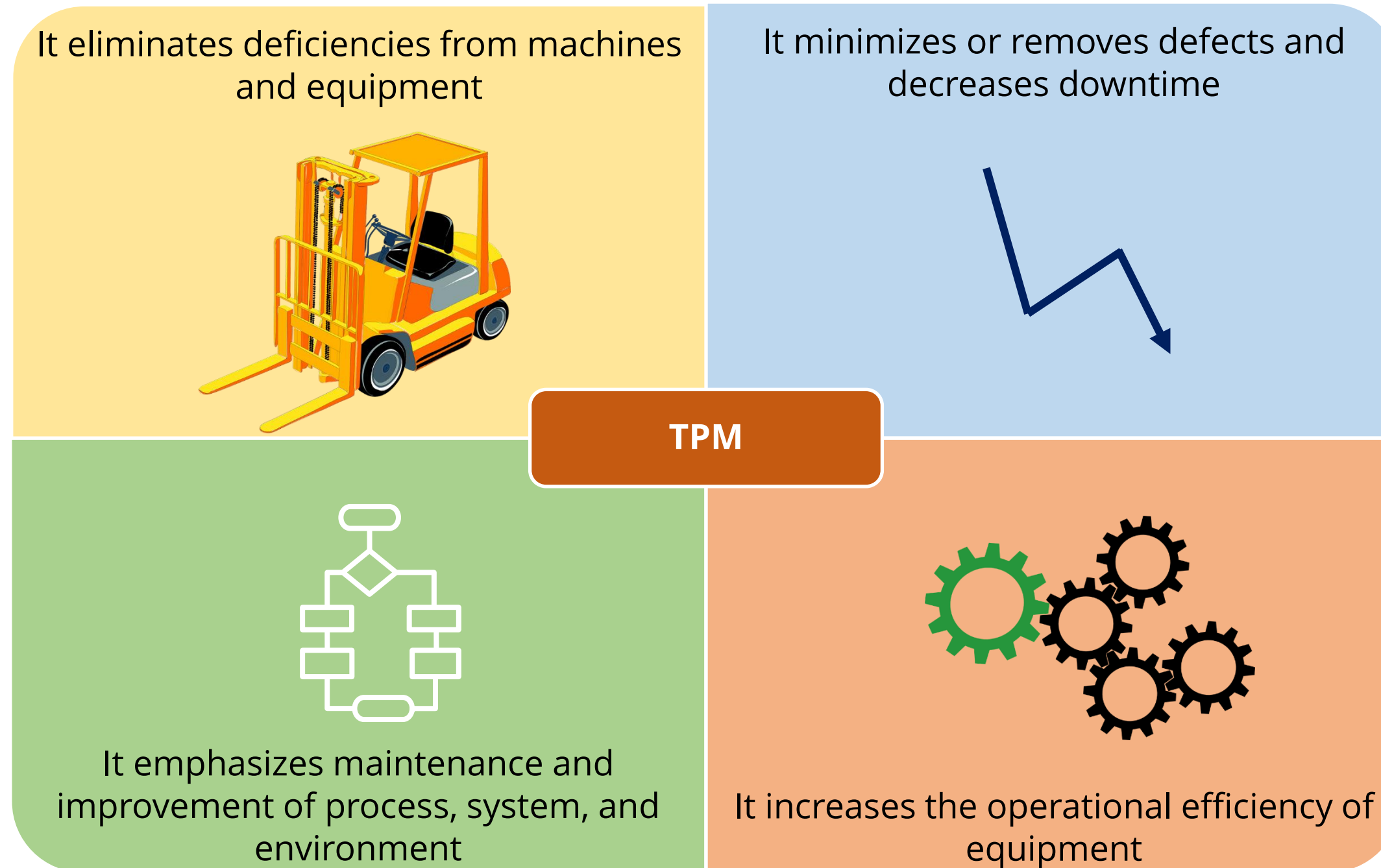




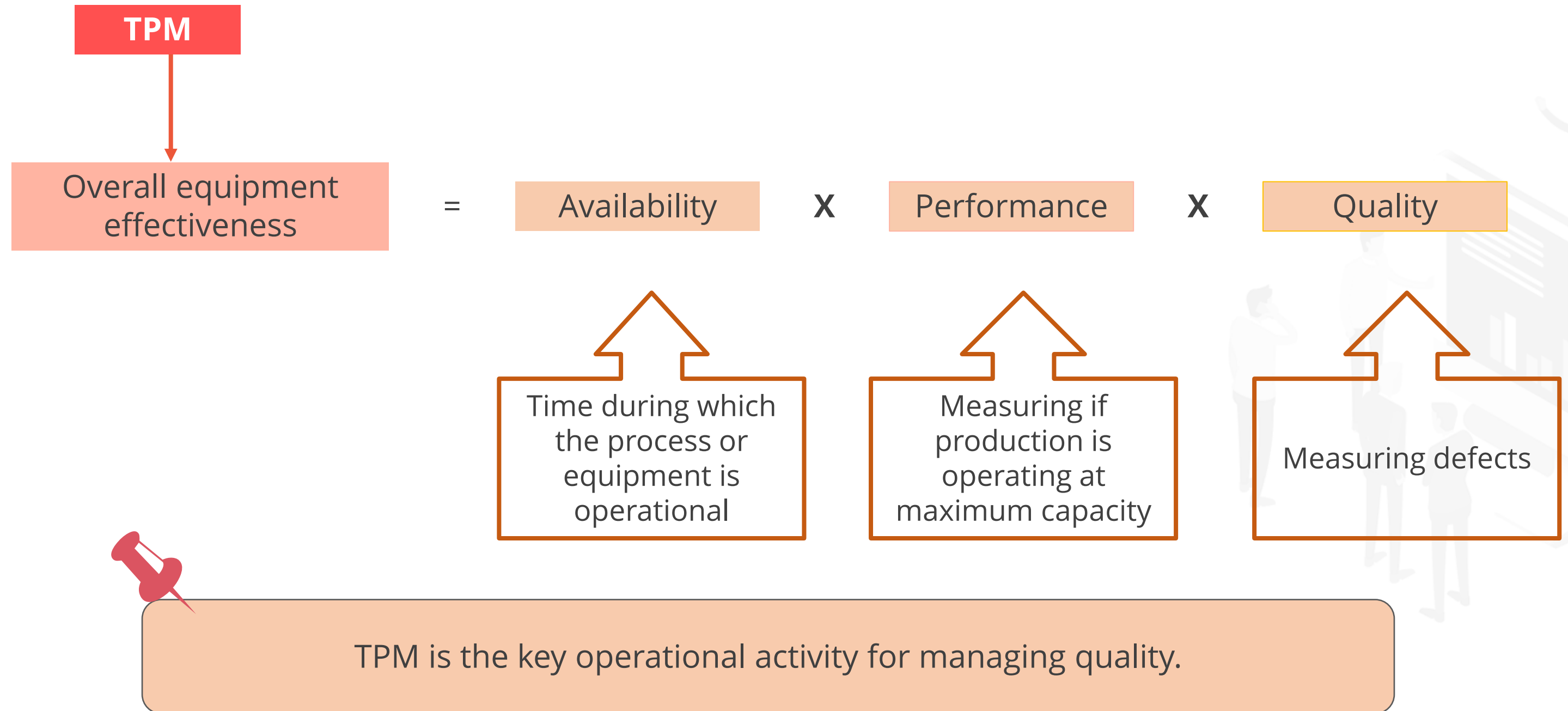
## Total Productive Maintenance

# Total Productive Maintenance (TPM)

TPM is a holistic approach to equipment maintenance and is commonly used in manufacturing industries.



# Total Productive Maintenance (TPM)



# Eight Elements of TPM

**Autonomous  
Maintenance**

**Planned Maintenance**

**Equipment  
Improvement**

**Education and  
Training**

**Equipment design  
Excellence**

**Quality Maintenance**

**Safety, Health, and  
Environment**

**TPM in  
Administrations**



# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

Includes maintenance of machines and equipment by greasing, cleaning, general inspection, and minimum preventive maintenance by the production operators

# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

Includes developing and executing planned maintenance activities based on factors such as time, cost, and productivity

# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

- Includes measures to improve the performance and efficiency of the equipment
- Measures are taken using different methods such as 5S, 5-Why analysis, or Kaizen activities



# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

Includes providing systematic training to all the employees to maintain the equipment and increase productivity

# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

Includes new equipment design and identification of equipment that requires less maintenance

# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

Includes designing error detection and prevention methods into production processes



# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

**Safety, Health, and  
Environment**

TPM in Administrations

Targets the goal of an accident-free workplace

# Total Productive Maintenance

Autonomous Maintenance

Planned Maintenance

Equipment Improvement

Education and Training

Equipment design Excellence

Quality Maintenance

Safety, Health, and  
Environment

TPM in Administrations

Includes applying TPM techniques to administrative functions

# Total Productive Maintenance

The main applications of TPM for controlling the improved process are:



Spare parts management

Helps maintain and store spare parts of the equipment using 5S method



Measures for downtime

Helps collect data for downtime and conduct Root Cause Analysis (RCA)



Support and guidance

Helps maintain SOPs and train employees to maintain the equipment



## Visual Factory

# Introduction

Highway



Airport



What is common between the two images?

# Visual Factory

A visual factory is a Lean production environment where charts and signs are used to display information

Makes the immediate status of activities clear to all.

Enables the people involved to understand how each plant works.

Makes the work area self-explanatory at a glance.

Displays real-time information to the workforce.

Helps standardize the processes and to eliminate waste.





# Visual Factory

Organizing and standardizing the work place

Sharing Information

Visual Controls



# Visual Factory

Organizing and  
standardizing the work  
place

Sharing Information

Visual Controls

To understand the system at a glance, the work place is organized and standardized using

## 5S

5S stands for

- Sort
- Set in order
- Shine
- Standardize
- Sustain

## Specified Regions and Areas

- Specified regions and areas are defined for specific purposes.

## Color Coding

- Colors are defined for specific activities.

# Visual Factory

Organizing and  
standardizing the work  
place

Sharing Information

Visual Controls

One of the important elements in a visual factory is information sharing.

## 3-Minute Management Approach

Issues, progress, and information are communicated to the workforce in three minutes using graphics.

## Signaling System

Visual elements, audio, or both are used to signal the status of the process, sub-process, or machines.

# Visual Factory

Organizing and  
standardizing the work  
place

Sharing Information

Visual Controls

In a visual factory, visual methods are used for communication. The types of visual controls used:

## Control Board

Helps people to read the complete process at a glance and analyze how the process is working

## SOP

Is a set of rules and regulations that must be mandatorily followed in a particular process

## Control Chart

Provides information on process performance, helps to understand if the process is in control, and helps sustain the improvements made


## Control Plans

Are plans that are displayed to evaluate the performance of the process on a timely basis




# Visual Factory


## A visual factory



Displays the real-time scenario




Keeps the workforce well-informed of the process




Aids in solving issues and bottlenecks immediately



Highlights the support required, when needed



Improves process performance



Monitors, maintains, and controls inventory



5S

# 5S

Techniques that help in improving the workspace, productivity, and maintenance:

Sort or Seiri

Seiton or Stabilize

Seiso or Sweep

Seiketsu or Standardize

Shitsuke or Sustain



# 5S

## Sort or Seiri

Seiton or Stabilize

Seiso or Sweep

Seiketsu or Standardize

Shitsuke or Sustain

Seiri is focused on sorting and getting organized:

- Sorting necessary and unnecessary items
- Keeping items based on requirement
- Preventing accumulation of items by assigning them tags

Seiri helps in:

- Simplifying tasks
- Effectively using the workplace
- Purchasing items carefully



# 5S

Sort or Seiri

Seiton or Stabilize

Seiso or Sweep

Seiketsu or Standardize

Shitsuke or Sustain

Seiton is for Straighten or Stabilize

- Classify and set items in order to:
  - Improve efficiency
  - Prevent loss and wastage of time
- Choose the correct place, position, or holder for tools, items, and material to:
  - Make workflow smooth and efficient
  - Organize storage for all items
  - Identify frequently and non-frequently used items
- Mark or color code items so that they can be visually located



# 5S

Sort or Seiri

Seiton or Stabilize

**Seiso or Shine**

Seiketsu or Standardize

Shitsuke or Sustain

Seiso or Shine involves keeping the workplace shiny and clean by:

- Eliminating clutter and organizing items
- Making the workplace clean so that it is easy to identify malfunctioning equipment
- Preventing mess
- Finding the root cause of contamination



# 5S

Sort or Seiri

Seiton or Stabilize

Seiso or Shine

Seiketsu or Standardize

Shitsuke or Sustain

Seiketsu is for Standardize

- Standardizing best practices across the work place
- Performing tasks in a standard manner
- Ensuring personal and environmental cleanliness

Tools used include

- Job cycle charts
- Visual cues
- Scheduling 5 minutes of 5S activity
- Checklists
- Visual management with color coding

# 5S

Sort or Seiri

Seiton or Stabilize

Seiso or Shine

Seiketsu or Standardize

Shitsuke or Sustain

Shitsuke is for Sustain. It helps

- Maintain a discipline and commitment
- Maintain orderliness
- Define a new status quo and standard for work place organization

Tools used for Sustaining 5S include:

- Signs and posters
- Newsletters
- Check sheets
- Pocket manuals
- Team and management check-ins
- Performance reviews
- Department tours

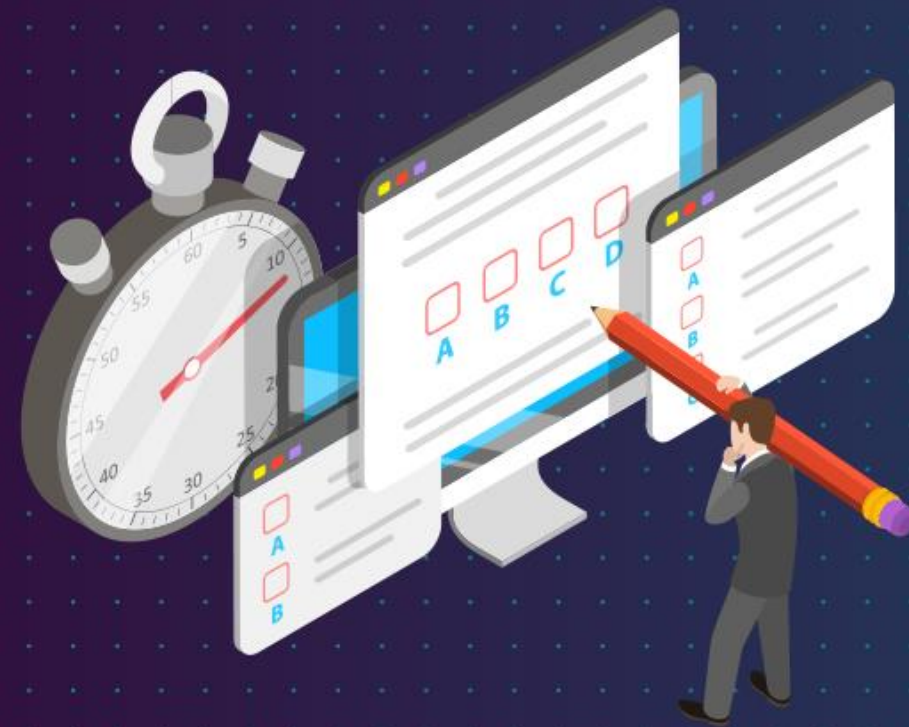


## Key Takeaways

- The TPM method is commonly used in manufacturing industries.
- TPM is calculated as Overall Equipment Effectiveness = Availability x Performance x Quality.
- Visual factory is a lean production environment where charts and signs are used to display information.
- The core elements of visual factory are organizing and standardizing the work place, sharing information, and visual controls.
- 5S in Lean Six Sigma stands for Seiri or Sort, Seiton or Stabilize, Seiso or Sweep, Seiketsu or Standardize, and Shitsuke or Sustain.
- The 5S techniques help in improving the workplace, productivity, and maintenance.







## Knowledge Check



**Knowledge  
Check  
1**

**What is the overall equipment effectiveness of an area that has 95% Availability, 90% Performance, and 98% Quality?**

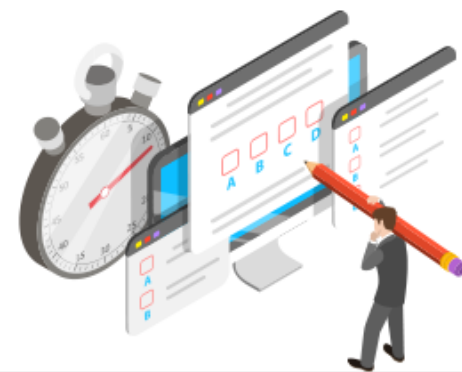
- A. 95%
- B. 73%
- C. 84%
- D. 94%



**Knowledge  
Check  
1**

What is the overall equipment effectiveness of an area that has 95% Availability, 90% Performance, and 98% Quality?

- A. 95%
- B. 73%
- C. 84%
- D. 94%



The correct answer is **C**

**OEE or Overall Equipment Effectiveness is the product of Availability (95%), Performance (90%), and Quality (98%). Here, this product is 84%.**

## Knowledge Check

2

**Which is NOT a benefit of a Visual Factory?**

- A. Displays real-time scenario
- B. Keeps the work force uninformed of the process
- C. Highlights support required when needed
- D. Improves process performance



## Knowledge Check

2

Which is NOT a benefit of a Visual Factory?

- A. Displays real-time scenario
- B. Keeps the work force uninformed of the process
- C. Highlights support required when needed
- D. Improves process performance



The correct answer is **B**

All of the choices are benefits of a visual factory except option b because a visual factory keeps the work force informed of the process.

## Knowledge Check

3

### In TPM, what is Equipment Improvement?

- A. Maintenance of machines and equipment by greasing, cleaning, general inspection, and minimum preventive maintenance, which is taken care of by the production operators.
- B. Developing and executing planned maintenance activities based on factors like time, cost, and productivity.
- C. Measures to improve the performance and efficiency of the equipment are taken using different methods such as 5S, 5 Why analysis, or Kaizen activities.
- D. Design error detection and prevention into production processes



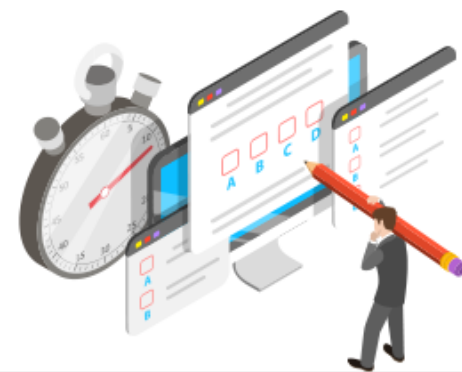


## Knowledge Check

3

In TPM, what is Equipment Improvement?

- A. Maintenance of machines and equipment by greasing, cleaning, general inspection, and minimum preventive maintenance, which is taken care of by the production operators.
- B. Developing and executing planned maintenance activities based on factors like time, cost, and productivity.
- C. Measures to improve the performance and efficiency of the equipment are taken using different methods such as 5S, 5 Why analysis, or Kaizen activities.
- D. Design error detection and prevention into production processes



The correct answer is **C**

**Equipment Improvement is the measures to improve the performance and efficiency of the equipment are taken using different methods such as 5S, 5 Why analysis, or Kaizen activities.**

**Knowledge  
Check**  
**4**

**Which type of visual control is a set of rules and regulations that has to be mandatorily followed in a particular process?**

- A. SOP
- B. Control Board
- C. Control Chart
- D. Control Plan



**Knowledge  
Check**  
**4**

**Which type of visual control is a set of rules and regulations that has to be mandatorily followed in a particular process?**

- A. SOP
- B. Control Board
- C. Control Chart
- D. Control Plan



The correct answer is **A**

**SOP or Standard Operating Procedures are a set of rules and regulations that must be mandatorily followed.**

**Knowledge  
Check**  
**5**

**Which 5S step is focused on cleaning?**

- A. Straighten
- B. Sort
- C. Sustain
- D. Shine

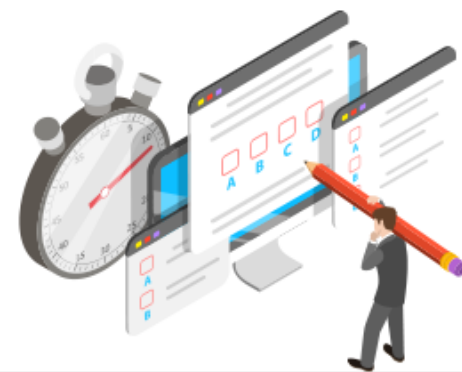


**Knowledge  
Check**

**5**

**Which 5S step is focused on cleaning?**

- A. Straighten
- B. Sort
- C. Sustain
- D. Shine



The correct answer is **D**

**The focus of Shine is to make sure the work area is clean. In a clean environment, issues can be seen better.**

# Lean Six Sigma Activities and Tools - Control

## Activities

- Review Project Charter
- Validate High-Level Value Stream Map and Scope
- Validate Voice of the Customer & Voice of the Business
- Validate Problem Statement and Goals
- Validate Financial Benefits
- Create Communication Plan
- Select and Launch Team
- Develop Project Schedule
- Complete Define Tollgate

### Define

- Project Charter
- Voice of the Customer
- SIPOC Map
- Project Valuation (ROI)
- Stakeholder Analysis
- Communication Plan
- Effective Meeting Tools
- Time Lines, Milestones, and Gantt Charting
- Pareto Analysis

- Process Map Flow
- Identify Key Input, Process and Output Metrics
- Develop Data Collection Plan
- Validate Measurement System
- Collect Baseline Data
- Determine Process Capability
- Complete Measure Tollgate

### Measure

- Process Mapping
- Data Collection Plan
- Statistical Sampling
- Measurement System Analysis (MSA)
- Gage R&R
- Control Charts
- Histograms
- Normality Test
- Process Capability Analysis

- Identify Root Causes
- Reduce List of Potential Root Causes
- Confirm Root Cause to Output Relationship
- Estimate Impact of Root Causes on Key Outputs
- Prioritize Root Causes
- Statistical Analysis
- Complete Analyze Tollgate

### Analyze

- Cause & Effect Matrix
- FMEA
- Hypothesis Tests
- Simple & Multiple Regression
- ANOVA
- Components of Variation

- Develop Potential Solutions
- Evaluate, Select, and Optimize Best Solutions
- Develop 'To-Be' Process Maps
- Develop and Implement Pilot Solution
- Implement 5s Program
- Develop Full Scale Implementation Plan
- Cost/Benefit Analysis
- Complete Improve Tollgate

### Improve

- Process Flow Improvement
- Design of Experiments (DOE)
- Solution Selection Matrix
- Piloting
- Pugh Matrix
- Pull System

- Develop SOP's, Training Plan & Process Controls
- Implement Solution and Ongoing Process Measurements
- Confirm Attainment of Project Goals
- Identify Project Replication Opportunities
- Training
- Complete Control Tollgate
- Transition Project to Process Owner

### Control

- Mistake-Proofing
- Standard Operating Procedures (SOP's)
- Process Control Plans
- Visual Process Control Tools
- Statistical Process Controls (SPC)
- Visual Workplace
- Total Productive Maintenance
- Metrics
- Team Feedback Session

## Tools



# Control Tollgate Questions

- ☐ Has the team prepared all the essential documentation for the improved process, including revised/new Standard Operating Procedures (SOP's), a training plan and a process control system?
- ☐ Has the necessary training for process owners/operators been performed?
- ☐ Have the right measures been selected, and documented as part of the Process Control Plan, to monitor performance of the process and the continued effectiveness of the solution? Has the metrics briefing plan/schedule been documented? Who owns the measures? Has the Process Owner's job description been updated to reflect the new responsibilities? What happens if minimum performance is not achieved?
- ☐ Has the solution been effectively implemented? Has the team compiled results data confirming that the solution has achieved the goals defined in the Project Charter?
- ☐ Has the Benefits Realization Schedule been verified by the Financial Representative?
- ☐ Has the process been transitioned to the Process Owner, to take over responsibility for managing continuing operations? Do they concur with the control plan?
- ☐ Has a final Storyboard documenting the project work been developed?
- ☐ Has the team forwarded other issues/opportunities, which were not able to be addressed, to senior management?
- ☐ Have "lessons learned" been captured?
- ☐ Have replication opportunities been identified and communicated?
- ☐ Has the hard work and successful efforts of our team been celebrated?

**Note: With answers to these questions you are now ready to move to the Measure Phase.**