MODULE 1

Project

Project is a great opportunity for organizations and individuals to achieve their business and non-business objectives more efficiently through implementing change. Projects help us make desired changes in an organized manner and with reduced probability of failure.

Projects differ from other types of work (e.g. process, task, procedure). Meanwhile, in the broadest sense a project is defined as a specific, finite activity that produces an observable and measurable result under certain preset requirements.

It is an attempt to implement desired change to an environment in a controlled way. By using projects we can plan and do our activities, for example: build a garage, run a marketing campaign, develop a website, organize a party, go on vacation, graduate from a university with honors, or whatever else we may wish to do.

A **Project** is a temporary, unique and progressive attempt or endeavor made to produce some kind of a tangible or intangible result (a unique product, service, benefit, competitive advantage, etc.). It usually includes a series of interrelated tasks that are planned for execution over a fixed period of time and within certain requirements and limitations such as cost, quality, performance, others.

Key Characteristics

As follows from the given definition, any project can be characterized by these characteristics:

- **Temporary.** This key characteristic means that every project has a finite start and a finite end. The start is the time when the project is initiated and its concept is developed. The end is reached when all objectives of the project have been met (or unmet if it's obvious that the project cannot be completed – then it's terminated).
- **Unique Deliverable(s).** Any project aims to produce some deliverable(s) which can be a product, service, or some another result. Deliverables should address a problem or need analyzed before the project starts.
- **Progressive Elaboration.** With the progress of a project, continuous investigation and improvement become available, and all this allows producing more accurate and comprehensive plans. This key characteristic means that the successive iterations of planning processes result in developing more effective solutions to progress and develop projects.

In addition to the listed characteristics, a conventional project is:

- Purposeful as it has a rational and measurable purchase
- Logical as it has a certain life-cycle
- Structured as it has interdependencies between its tasks and activities
- Conflict as it tries to solve a problem that creates some kind of conflict

- Limited by available resources
- Risk as it involves an element of risk

Portfolio Management

Portfolio management is the art and science of selecting and overseeing a group of investments that meet the long-term financial objectives and risk tolerance of a client, a company, or an institution.

Portfolio management requires the ability to weigh strengths and weaknesses, opportunities and threats across the full spectrum of investments. The choices involve trade-offs, from debt versus equity to domestic versus international and growth versus safety.

Portfolio management may be either passive or active in nature.

- **Passive management** is a set-it-and-forget-it long-term strategy. It may involve investing in one or more exchange-traded (ETF) index funds. This is commonly referred to as indexing or index investing. Those who build Indexed portfolios may use modern portfolio theory (MPT) to help optimize the mix.
- **Active management** involves attempting to beat the performance of an index by actively buying and selling individual stocks and other assets. Closed-end funds are generally actively managed. Active managers may

use any of a wide range of quantitative or qualitative models to aid in their evaluations of potential investments.

Project vs. Program Management

Area	Project Management	Program Management
Focus	Single objective	Business strategy
Scope	Narrow	Wide-ranging, cross-functional
Benefits	Determined in advance Accrue after completion	Used to make decisions Accrue during the programme
Deliverables	Few, clearly defined	Many , many initially undefined
Timescale	Clearly defined	Loosely defined
Change	To be avoided	Regarded as inevitable
Success Factors	Time, budget, specification	Mission, cash-flow, ROI
Plan	Specific, detailed, bounded	High-level and evolving

Project Integration Management

Project Integration Management is all about sustaining stability in all areas of a project like; time, scope, cost, quality, human resource, communication, risk, procurement, stakeholder, among others. These are interconnected processes and cannot be carried out by a single team. It's a vital knowledge area and highly valued aspect in the PMI. It's a process that involves constant monitoring of the procedures undertaken during the life cycle of the project. One crucial feature of project integration management is that it entirely focuses on a given project keeping a watchful eye right from initiation until the completion of the project.

The project integration management has a set of control access points that are

Initiation Process Group

Initiating: The official authorization of the project is handed over during the initiating process group stage. It's a process where the Project Manager receives the necessary information on how to begin the project. The outputs of the initiation process group include creating a project charter, identifying stakeholders and their high-level needs as well as gaining knowledge of the approaches that are necessary for managing those acquired stakeholders.

Inputs to initiating a Process Group

- Business need
- Objectives of the project
- Product Scope and Project Scope
- Budget information
- Schedule information
- Information on the completion of the project
- Associated risk information
- Project acceptance criteria
- Name of the Signatory authority & Project Manager
- Authoritative power of the project manager
- Pre-assigned team members

Planning Process Group

Second on the list is the Planning Process Group. Planning is a stage where the Project Manager creates a blueprint for the project which defines the project objectives, milestones, schedules and initial budget required for the project. It's considered to be a highly recommended process, as it measures all the knowledge areas of the project and helps in creating a roadmap that in turn will assist in completing the project successfully. All these processes are to be activated into a cohesive whole to prepare a final project management plan.

The planning process group has a list of processes listed under it, and they are as follows:-

Develop Project Management Plan	Determine Budget
Plan Scope Management	Plan Quality Management
Collect Requirements	Plan Resource Management
Define Scope	Estimate Activity Resources
Create WBS	Plan Communications Management
Plan Schedule Management	Plan Risk Management
Define Activities	Identify Risks
Sequence Activities	Perform Qualitative Risk Analysis

Estimate Activity Durations	Perform Quantitative Risk Analysis
Develop Schedule	Plan Risk Responses
Plan Cost Management	Plan Procurement Management
Estimate Costs	Plan Stakeholder Engagement

Execution Process Group

The process of initiating and planning are proven worthy only with proper execution. Execution is a stage where the Project Manager needs to assure that the project deliverables and objectives meet the stakeholders' expectations.

Here's a list of some other processes to follow during the Executing Process stage. These processes belong to several knowledge areas ranging from Project Integration Management to Project Human Resource Management to Project Stakeholder Management.

Monitoring and Controlling Process Group

This process addresses the skills needed to review progress and document benchmarks in the project. After successful implementation of the first three

stages, the project is officially underway. Maintaining a bird's eye view of the project performance is vital to preserving positive forward momentum.

The tasks to be covered at this stage are:

This process is mainly known for presenting a detailed set of skills and knowledge directly applicable toward implementing the decisions needed to sustain the most active part of the project.

Closing Process Group

Closing Process Group is the last stage in the process of project management plan. It has equal importance as all the other processes mentioned above. The closing process group includes all the final processes required to complete a project and deliver final products and reports to the stakeholders. The critical feature of this stage is to make sure that all contractual obligations have been completely taken care of from the Project Manager's point of view.

Below is the diagram depicting the project closing process group

- **Close Project or Close Phase**

  This the phase where the project manager looks back and carefully observes the undertakings of the project from the beginning to the end. He/she has to make sure that nothing is left unturned and most importantly everything relating to the project right from small adjustments to more

significant changes must be documented and accounted for to leave a lasting and positive impression.

Project Scope Management

The Project Scope Management is the process to ensure that a particular project includes all the work relevant/appropriate to achieve the project's objectives. Its primary aim is to control what is and is not involved in the project. The Scope Management techniques enable project managers and supervisors to allocate just the right amount of work necessary to complete a project.

Project Scope

Project Scope is the work that needs to be accomplished to deliver a product, service, or result with the specified features and functions. Scope refers to the detailed set of deliverables or elements of a project; these deliverables are derived from a project's requirements.

Project Scope Management consists of three processes namely:

1. **Planning:** The process of getting an overview and defining the work that needs to be done to achieve the deliverables is called Planning.
2. **Controlling:** The process of documenting, tracking, focusing on scope disruption and also continually approving and disapproving the project changes through controlling and monitoring process is called controlling.

3. **Closing:** The process that includes an examination of the project deliverables and an assessment of the outcomes of the project against the original plan is the primary function of Closing.

As projects are taken up to deliver a product, it is highly impossible to achieve the desired objective of the project, if the project and product scope are not adequately explained. The two most widely used terms in Project Management are Project Scope and Product Scope.

1. **Product Scope:** Product scope can be defined as the features or characteristics of a product regardless of the design, function or parts, and the critical point is that product scope refers to the actual tangible product that is finally produced.
2. **Project Scope:** In contrast to product scope, project scope focuses on the various steps taken to deliver a product. Project scope can include, things like assembly lines, budgets, staff training, and supply chains and personnel allocations.

Six main processes that are listed under the Project Scope Management are as follows:

These six processes will be explained in detail in the upcoming articles under a specified topic. For now, here's a brief on each of the processes :

1. **Plan scope management:** The scope management plan describes the project scope and documents how it will be further defined, validated, and controlled throughout the lifecycle of the project.
2. **Collect requirements:** It is the process of defining and documenting stakeholders needs to meet the project activities. The document for collecting requirements is developed in the project planning phase.
3. **Define scope:** This is the process of developing a detailed description of the Project and product. So while Collecting requirements list, all the different requirements of the Project and the resulting product or service are defined.

4. **Create Work Breakdown Structure:** Creating work breakdown structure is done using a technique called decomposition/breakdown. It is the process of subdividing project deliverables and project work into smaller and more manageable components for achieving a better outcome.
5. **Validate scope:** A part of project monitoring and control process group in which the process includes reviewing deliverables with the customer or sponsor to ensure that they are completed satisfactorily and obtaining formal acceptance of deliverables by the customer or sponsor.
6. **Control scope:** Control Scope is the last process group in the project scope management. It is again a part of the project monitoring and control process group. Control scope is the process of monitoring the status of the project and product scope and managing changes to the scope baseline.

Vital is Scope Management for Project Managers

- Communication is considered as the primary tool to adequately define the importance of scope management, to both the stakeholders and team members. This process takes place to ensure and agree as to how the project goals will be met.
- The important features of scope management are that it helps in avoiding the challenges that a project might face when provided with increasing scope and never-ending requirement list. As the project is executed, the project scope filters out the essential and feasible aspects of the project and controls all the aspects mentioned in the project scope. Additionally, the scope management establishes a control mechanism to address factors that may result in changes during the project lifecycle.
- It is highly impossible to estimate the time and cost required for the project without adequately defining the project scope. Due to lack of

communication, the project scope can change drastically, which will, in turn, affect the cost and causes variations in the schedule of the project, causing losses.

The implementation of scope management in a project is considered essential and is never a difficult task; however, it requires effort, time, and patience. Only with the help of scope management, a project manager can define, control and ensure that the project deliverables are met, without any issues/risk occurring during the project lifecycle and that the stakeholders are satisfied with the investments that they have made.

Project Schedule in Project Management

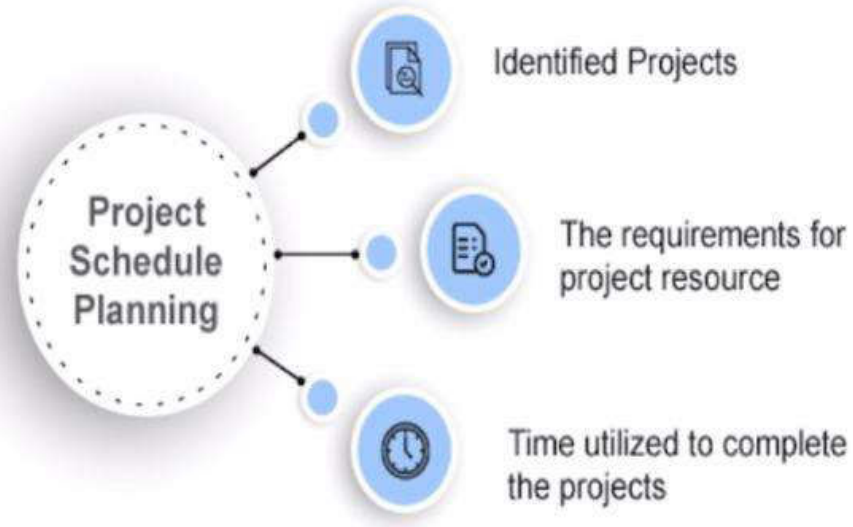
Project Schedule is a technique that imparts what work should be performed, which resource of the organization will perform the work and the time spans in which that work should be performed. The project schedule ought to reflect the majority of the work related to handing over the task on time. Without a complete schedule, the project manager will be not able unable to communicate regarding cost and resources that are important to deliver the project.

Some softwares allows project managers to track project schedules, resources, budgets, and project related assets in real time. The project schedule can be updated and viewed by colleagues related to the task that keeps everyone keeping everybody well informed on the overall project status.

Project Schedule Planning in Project Management

The procedure of building policies, methodology, and project documentation gives direction and guidance on how the task timetable will be overseen all through the project. The intention of a project schedule is organized and focused based on the advancement of the Schedule Management Plan.

The project plans should consider the following aspects,



The planning of the project schedule is an essential activity that incorporates identifying of the project activities, sequencing them and defining objectives for those activities alongside the project schedule management plan. As relevant as the project management scheduling ability is by all accounts, competency ought to obtain with significant experience.

Develop Project Schedule in Project Management

Developing Project Schedule refers to planning the timing and sequence of project activities.

A project schedule assigns work to be done and indicates due dates to complete the tasks and deliverables. The project schedule portrays:

1. Time (duration) estimates for all project tasks
2. Start and finish dates for the tasks
3. Names of staff resources assigned to complete the tasks
4. Sequence of tasks

A noteworthy segment of a project schedule is a work breakdown structure (WBS). The project schedule is built to reflect the work breakdown structure.

Project scheduling is the key to ensuring the original project plan, and the final project outcome is at least close enough to call the project a success. Developing project schedules helps the project team to keep the necessary activities on track. PMBOK's Schedule Management knowledge area explains the critical processes in developing a project schedule.

5 Steps that help to Develop a Schedule in a Project

Project Management has always been fascinating by how things work and how to make things work better. Thus, a project schedule comes through the planning phase of any project. Below mentioned are the means that is expected to schedule a project:

1. **Define activities** lets project managers use the Work Breakdown Structure (WBS) and a deliverables diagram to establish and start the assignments that are essential to finish on time. Thus ensuring they are aware of what activities has to be included in the plan.
2. **Sequence activities** help to determine the relationship between the project activities. The ordering of the tasks and identification of

dependencies (Finish to start, Finish to Finish, Start to Start, Start to Finish) is the next step.

3. **Do Estimates** The project team has the activities defined and the tasks in a breakdown structure; the following stage is to choose the time utilization to complete the project. To calculate schedule, having an estimation of what to do, how to do, and the essential part of the equation is to what extent should a project take to finish.
4. **Determine Dependencies**. Projects aren't simple always. On a regular basis, a project can't be started until the one in the process is finished. This is called task dependencies. Consequently, your schedule will need to reflect on these connected projects. As project supervisors, you can likewise pursue a methodology by monitoring your schedule to suit these related projects.
5. The last step is to **Assign Resources** to finish your planned schedule. It picks what resources you should complete the given assignments on time. As a project management team, you need to have the right resources and their time ought to be considered to plan the assignments.

When you have intended to formulate the schedule for a project, get the feedback from your manager and roll out the essential changes that have to be finished. You'll need to estimate the project plan before you move on to executing the plan. Once the project is in progress, it'll help you compare on the planned versus actual dates. Consider the task's goals that assist you to set up a schedule once you complete the process.

Project Cost Management

This area involves the project budget, which means having good estimating tools to make sure that the funds cover the extent of the project and are being monitored regularly to keep stakeholders or sponsors informed.

Plan cost management will determine the method to establish the budget, which includes how and if it will change and what procedures will be used to control it. Each task will have to be estimated for cost, which means including all resources such as labor, materials, equipment and anything else needed to complete the task.

This will determine the project budget, once you take all the task costs and combine them. Then comes the need to control those cost through an earned value analysis. This is performed regularly throughout the project to make sure the estimated costs are in line with actual expenditures.

Effectively Manage Project Budget

1. **The Perfect Budget Plan:**

   Allocating finances to different parts of the project begins with the accurate and detailed prediction of the total costs that may be incurred during the execution of the project. Perfection is the key here as every minute detail of the project needs to be considered and consultations should be carried out with everyone involved in order to calculate the exact figure. It is always wise to maintain a separate estimation for unforeseen situations which might escalate the budget otherwise the project might end up overshooting its completion date by a huge margin.

The goal here should be to complete the project within the stipulated time and budget.

2. **Periodic Forecasting of Budget:**

If a project is run without periodic forecasting of budget, it is bound to head towards failure. The main reason is that without periodic budget oversight, the odds of the budget getting out of control are quite high. It is much easier to correct a 10% budget overrun than a 50% budget overrun. This increases the chances of keeping the project on track. Therefore, it becomes a necessity for financial forecasting calculations to be conducted to highlight the budgetary constraints well in advance.

3. **Costs of Deliverables:**

One of the main concerns while creating a budget for a project is the cost of deliverables. It has to be made sure that the final deliverables, which basically include the basic materials required for successful competition of the project, is accurately accounted for by the budget.

4. **Using Budgetary Controls:**

One of the principal steps the project manager carries out is to determine the cost of the project. If the project manager overshoots the budget by even a small margin, it might result in the demise of the project. Some of the budgetary control methods that can be utilized to keep a check on the finances include variance analysis, financial forecasting calculations and payback period. These can come in handy if project managers want to ensure the timely completion of projects. If there is mismanagement of resources, the projects can procure no returns on their investments.

5. **Keeping an Eye on the Usage of Resources:**

The cost of the project also depends on the people working on it. Therefore, even this aspect has to be checked upon to keep it on track. Constant review of the number of people working on the project and the

future resource needs has to be reviewed by the project manager. By doing so, how much resources have been fully utilized and how much is remaining for future use can be easily estimated.

6. **Considering Budget Creep:**

   One of the major causes of project overrun is scope or budget creep. Increase in unplanned work can lead to an out of control project budget. This can be anything from a change in the quality of the resource material to a change in the cost of supplies. They can have a huge impact on the functioning of the project and consequently the project budget.

7. **An Informed Team:**

   The project team has to be kept well informed regarding the forecast of the project budget. An informed team can take educated decisions. By keeping the team members in the loop about the budget status, they are more likely to watch out for loose ends in the project which might lead to unwanted expenses thus preventing budget overrun.

Project Communications Management

Processes required to ensure prompt and appropriate generation, collection, distribution, storage, retrieval, and ultimate disposition of project information.

Project managers spend most of their time communicating with team members and other project stakeholders — internal (at all organizational levels) or external to the organization.

The project communications management processes include the following:

- Identify Stakeholders
- Plan Communications
- Distribute Information
- Manage Stakeholder Expectations
- Report Performance

Importance of Communications Management

- Project managers spend more than 90% of their time communicating with team members and other project stakeholders — internal (at all organizational levels) or external to the organization.
- The project manager should effectively and efficiently communicate with stakeholders.
- Managing communications is very vital for any project.
- Although the project manager should pay a lot of attention to managing communications, he cannot control all the communications, because there are just too many channels. The formula used to calculate the total number of communications channels is n(n-1)/2, where n refers to the number of stakeholders.
- The project manager uses a variety of communication methods to share information among stakeholders. He or she should decide what, how, and when to use each communication method.
- A failure in communication can have a negative impact on the project.

Communications Management Plan

- Communications management plan can be formal or informal, highly detailed or broadly framed – based on project needs.
- This is contained in or is a subsidiary of the project management plan.
- Usually includes:
  - Stakeholder Communication requirements
  - Description of the information to be communicated, including reason for distribution, time frame, frequency, format, content, level of detail, etc.
  - Person responsible for communicating information, for authorizing release of confidential information, and persons going to receive information
  - Technologies/methods used to convey information
  - Resources allotted for communication activities
  - Escalation process, identifying the time frames and management chain
  - Flow charts of the information flow, workflows with possible sequence of authorization, list of reports, and meeting plans, etc.
  - Communication constraints derived from legislation, regulation, technology, etc.
  - Method of updating and refining the communications management plan as project progresses and develops

Risk Management Tools & Techniques for Project Management

Mentioned below are some of the most widely used tools and techniques by project managers to ensure that they implement risk management along with their project management strategies successfully. This will help in protecting projects against the many risks they could face as well as other issues and challenges.

Brainstorming

Before any project begins, the first step is to plan a strategy. For this, the team members conduct brainstorming sessions with the project manager. This brainstorming session needs to include all the risks that could impact the project's completion and success.

The steps involved in this brainstorming process are:

- Reviewing all project documentation
- Overseeing all historic data and information about risks from previous projects that are similar to the current one
- Reading over articles related to the risks involved
- Understanding all organizational process assets
- Any information available that will give insight into the issues that might occur while the project is going on

The project manager can also get in touch with experts, team members and other stakeholders who might have experience with handling risk in similar projects.

Root Cause Analysis

This is a technique to help project members identify all the risks that are embedded in the project itself. Conducting a root cause analysis shows the responsiveness of the team members in risk management. It is normally used once a problem arises so that the project members can address the root cause of the issue and resolve it instead of just treating its symptom. It answers questions such as: What happened? Why did it happen? How? Once these questions are answered, it becomes easier to develop a plan of action so that it does not happen again in the future.

SWOT Analysis

SWOT is an analysis to measure the strengths, weaknesses, opportunities, and threats to a project. This tool can be used to identify risks as well. The first step is to start with the strengths of the project. Then team members need to list out all the weaknesses and other aspects of the project that could be improved. Here is where the risks of the project will surface. Opportunities and threats can also be used to identify positive risks and negative risks respectively.

All findings need to be put on a grid to make analysis and cross-referencing easier.

Probability and Impact Matrix

Project managers can also use the probability and impact matrix to help in prioritizing risks based on the impact they will have. It helps with resource allocation for risk management. This technique is a combination of the probability scores and impact scores of individual risks. After all the calculations are over, the risks are ranked based on how serious they are. This technique helps put the risk in context with the project and helps in creating plans for mitigating it.

Risk Data Quality Assessment

When project managers use the risk data quality assessment method, they utilize all the collected data for identified risks and find details about the risks that could impact the project. This helps project managers and team members understand the accuracy and quality of the risk based on the data collected.

The data quality assessment is used to improve the project manager's understanding of the risks the project could face as well as collect all the information about the risk possible. By examining these parameters, they can come up with an accurate assessment of the risk.

Variance and Trend Analysis

Just like other control processes in the project, it helps when project managers look for variances that exist between the schedule of the project and cost and compare them with the actual results to see if they are aligned or not. If the variances rise, uncertainty and risk also rise simultaneously. This is a good way

of monitoring risks while the project is underway. It becomes easy to tackle problems if project members watch trends regularly to look for variances.

Reserve Analysis

While planning the budget for the project, contingency measures and some reserves should be in place as a part of the budget. This is to keep a safeguard if risks occur while the project is ongoing. These financial reserves are a backup that can be used to mitigate risks during the project.

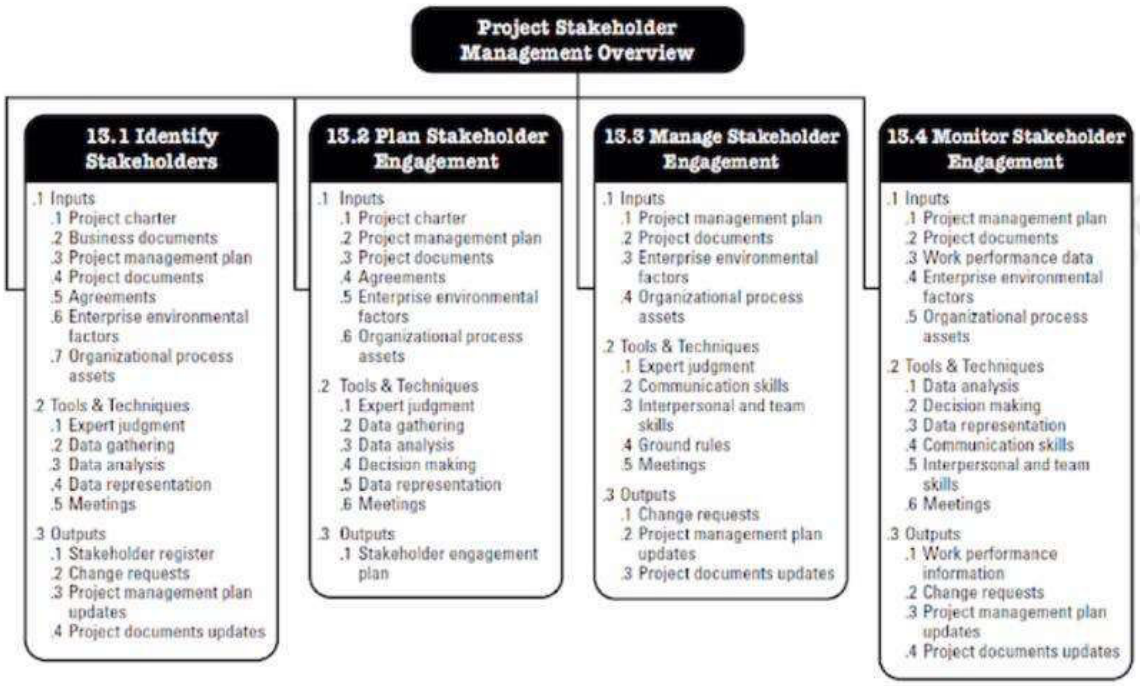
Projects Stakeholders Management

All projects have stakeholders. If they didn't, the project wouldn't exist. As a minimum, the project sponsor is a stakeholder who is expecting to receive the project's deliverables. Usually there are expectations to receive them at a certain time, cost, quality level, or other criteria as well.

The project manager must know who the stakeholders are and actively manage their expectations.

The Project Stakeholder Management knowledge area has four processes:

1. Identify Stakeholders
2. Plan Stakeholder Engagement
3. Manage Stakeholder Engagement
4. Monitor Stakeholder Engagement


Project Stakeholder Management Overview
13.1 Identify Stakeholders
.1 Inputs
.1 Project charter
.2 Business documents
.3 Project management plan
.4 Project documents
.5 Agreements
.6 Enterprise environmental factors
.7 Organizational process assets
.2 Tools & Techniques
.1 Expert judgment
.2 Data gathering
.3 Data analysis
.4 Data representation
.5 Meetings
.3 Outputs
.1 Stakeholder register
.2 Change requests
.3 Project management plan updates
.4 Project documents updates
13.2 Plan Stakeholder Engagement
.1 Inputs
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.3 Outputs
.1 Stakeholder engagement plan
13.3 Manage Stakeholder Engagement
.1 Inputs
.1 Project management plan
.2 Project documents
.3 Enterprise environmental factors
.4 Organizational process assets
.2 Tools & Techniques
.1 Expert judgment
.2 Communication skills
.3 Interpersonal and team skills
.4 Ground rules
.5 Meetings
.3 Outputs
.1 Change requests
.2 Project management plan updates
.3 Project documents updates
13.4 Monitor Stakeholder Engagement
.1 Inputs
.1 Project management plan
.2 Project documents
.3 Work performance data
.4 Enterprise environmental factors
.5 Organizational process assets
.2 Tools & Techniques
.1 Data analysis
.2 Decision making
.3 Data representation
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.3 Outputs
.1 Work performance information
.2 Change requests
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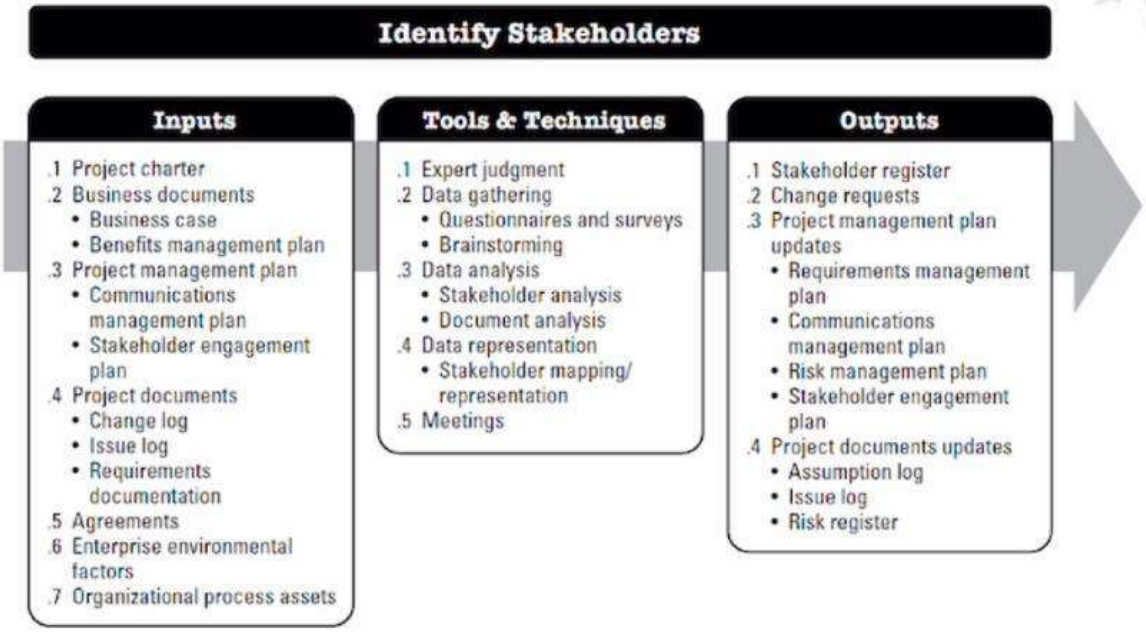
.4 Project documents updates


Identify Stakeholders
Inputs
.1 Project charter
.2 Business documents
• Business case
• Benefits management plan
.3 Project management plan
• Communications management plan
• Stakeholder engagement plan
.4 Project documents
• Change log
• Issue log
• Requirements documentation
.5 Agreements
.6 Enterprise environmental factors
.7 Organizational process assets
Tools & Techniques
.1 Expert judgment
.2 Data gathering
• Questionnaires and surveys
• Brainstorming
.3 Data analysis
• Stakeholder analysis
• Document analysis
.4 Data representation
• Stakeholder mapping/ representation
.5 Meetings
Outputs
.1 Stakeholder register
.2 Change requests
.3 Project management plan updates
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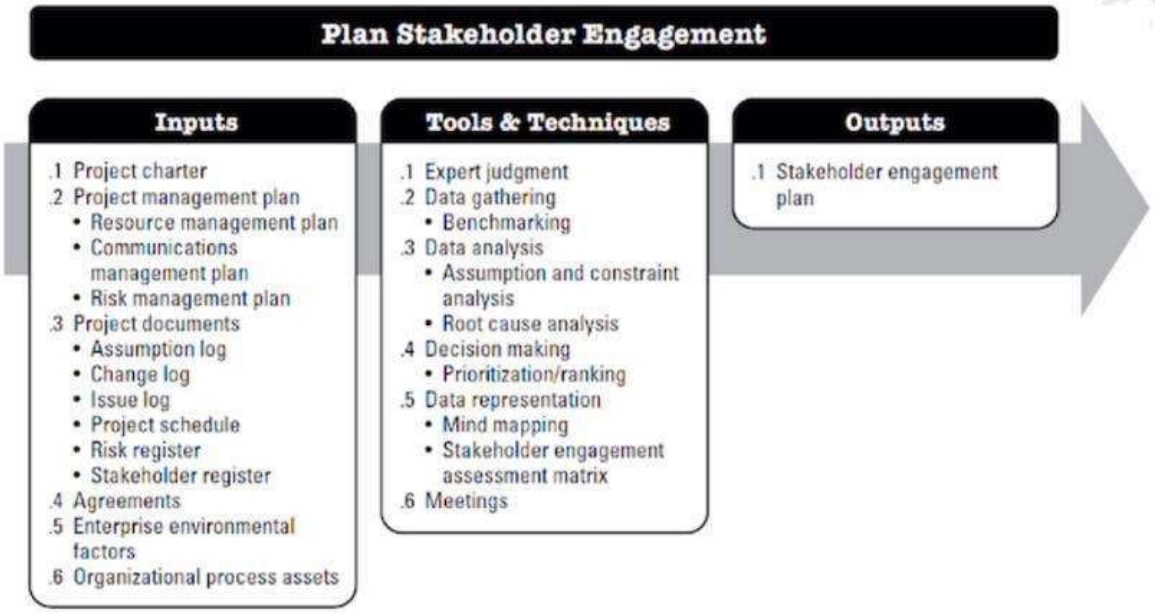
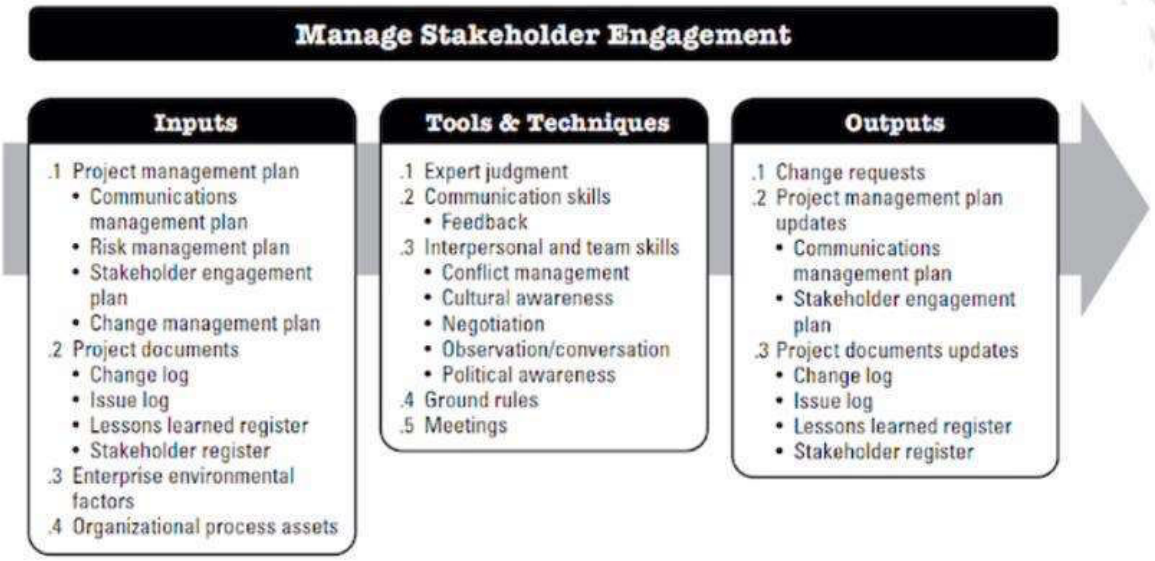
• Communications management plan
• Risk management plan
• Stakeholder engagement plan
.4 Project documents updates
• Assumption log
• Issue log
• Risk register


Plan Stakeholder Engagement
Inputs
.1 Project charter
.2 Project management plan
• Resource management plan
• Communications management plan
• Risk management plan
.3 Project documents
• Assumption log
• Change log
• Issue log
• Project schedule
• Risk register
• Stakeholder register
.4 Agreements
.5 Enterprise environmental factors
.6 Organizational process assets
Tools & Techniques
.1 Expert judgment
.2 Data gathering
• Benchmarking
.3 Data analysis
• Assumption and constraint analysis
• Root cause analysis
.4 Decision making
• Prioritization/ranking
.5 Data representation
• Mind mapping
• Stakeholder engagement assessment matrix
.6 Meetings
Outputs
.1 Stakeholder engagement plan


Manage Stakeholder Engagement
Inputs
.1 Project management plan
• Communications management plan
• Risk management plan
• Stakeholder engagement plan
• Change management plan
.2 Project documents
• Change log
• Issue log
• Lessons learned register
• Stakeholder register
.3 Enterprise environmental factors
.4 Organizational process assets
Tools & Techniques
.1 Expert judgment
.2 Communication skills
• Feedback
.3 Interpersonal and team skills
• Conflict management
• Cultural awareness
• Negotiation
• Observation/conversation
• Political awareness
.4 Ground rules
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Outputs
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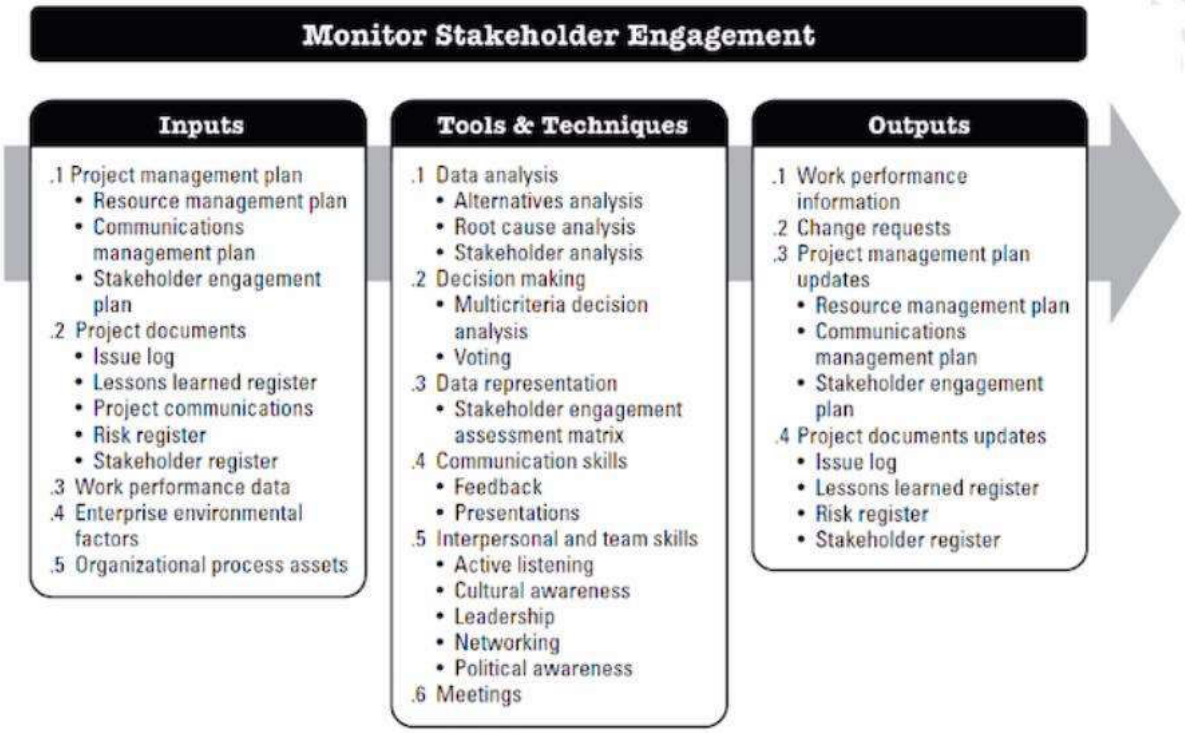
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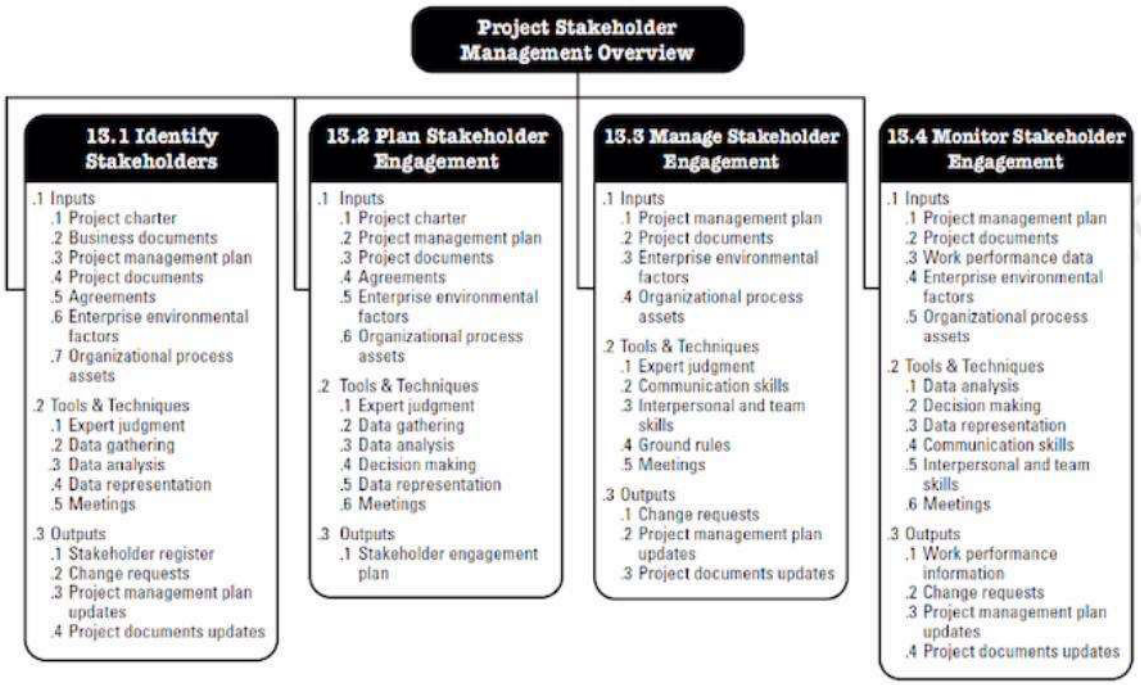
• Communications management plan
• Stakeholder engagement plan
.2 Project documents
• Issue log
• Lessons learned register
• Project communications
• Risk register
• Stakeholder register
.3 Work performance data
.4 Enterprise environmental factors
.5 Organizational process assets
Tools & Techniques
.1 Data analysis
• Alternatives analysis
• Root cause analysis
• Stakeholder analysis
.2 Decision making
• Multicriteria decision analysis
• Voting
.3 Data representation
• Stakeholder engagement assessment matrix
.4 Communication skills
• Feedback
• Presentations
.5 Interpersonal and team skills
• Active listening
• Cultural awareness
• Leadership
• Networking
• Political awareness
.6 Meetings
Outputs
.1 Work performance information
.2 Change requests
.3 Project management plan updates
• Resource management plan
• Communications management plan
• Stakeholder engagement plan
.4 Project documents updates
• Issue log
• Lessons learned register
• Risk register
• Stakeholder register


Project Stakeholder Management Overview
13.1 Identify Stakeholders
.1 Inputs
.1 Project charter
.2 Business documents
.3 Project management plan
.4 Project documents
.5 Agreements
.6 Enterprise environmental factors
.7 Organizational process assets
.2 Tools & Techniques
.1 Expert judgment
.2 Data gathering
.3 Data analysis
.4 Data representation
.5 Meetings
.3 Outputs
.1 Stakeholder register
.2 Change requests
.3 Project management plan updates
.4 Project documents updates
13.2 Plan Stakeholder Engagement
.1 Inputs
.1 Project charter
.2 Project management plan
.3 Project documents
.4 Agreements
.5 Enterprise environmental factors
.6 Organizational process assets
.2 Tools & Techniques
.1 Expert judgment
.2 Data gathering
.3 Data analysis
.4 Decision making
.5 Data representation
.6 Meetings
.3 Outputs
.1 Stakeholder engagement plan
13.3 Manage Stakeholder Engagement
.1 Inputs
.1 Project management plan
.2 Project documents
.3 Enterprise environmental factors
.4 Organizational process assets
.2 Tools & Techniques
.1 Expert judgment
.2 Communication skills
.3 Interpersonal and team skills
.4 Ground rules
.5 Meetings
.3 Outputs
.1 Change requests
.2 Project management plan updates
.3 Project documents updates
13.4 Monitor Stakeholder Engagement
.1 Inputs
.1 Project management plan
.2 Project documents
.3 Work performance data
.4 Enterprise environmental factors
.5 Organizational process assets
.2 Tools & Techniques
.1 Data analysis
.2 Decision making
.3 Data representation
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.5 Interpersonal and team skills
.6 Meetings
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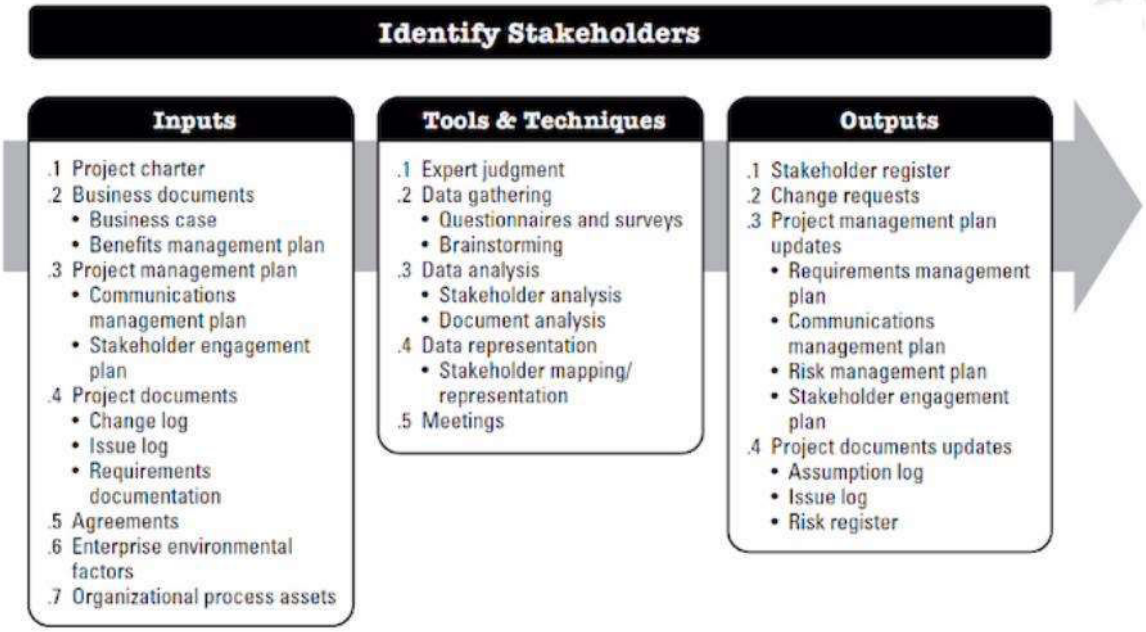
.2 Change requests
.3 Project management plan updates
.4 Project documents updates


Identify Stakeholders
Inputs
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.2 Business documents
• Business case
• Benefits management plan
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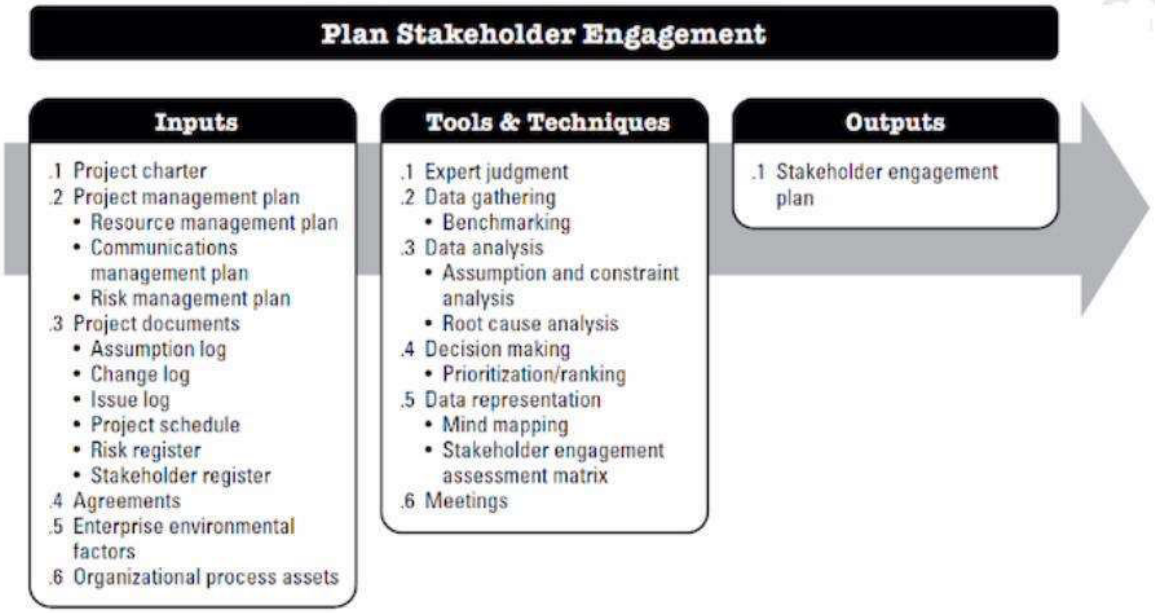
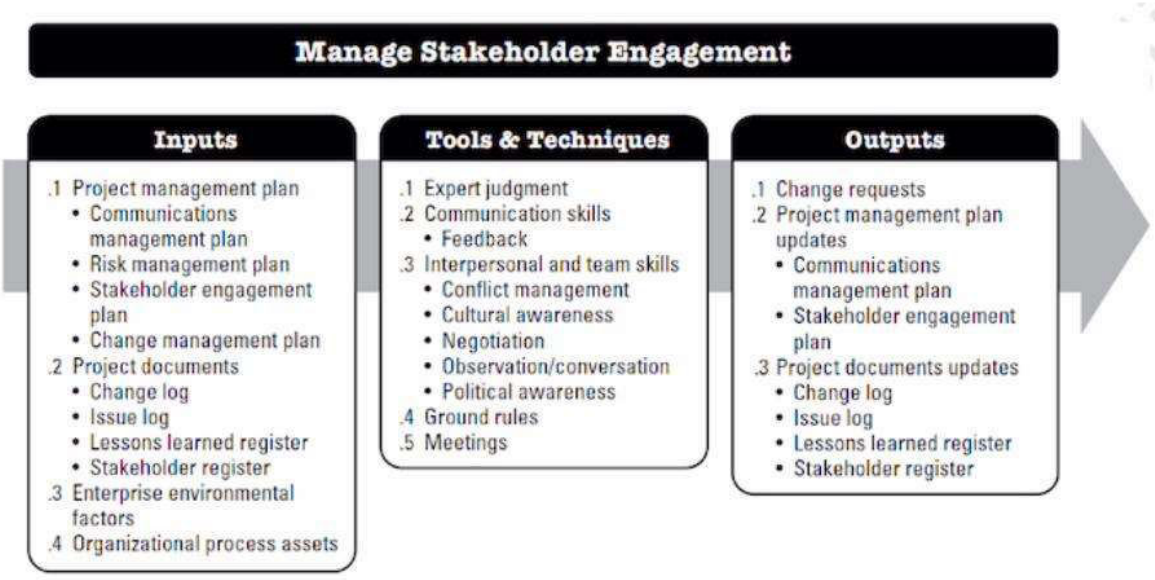
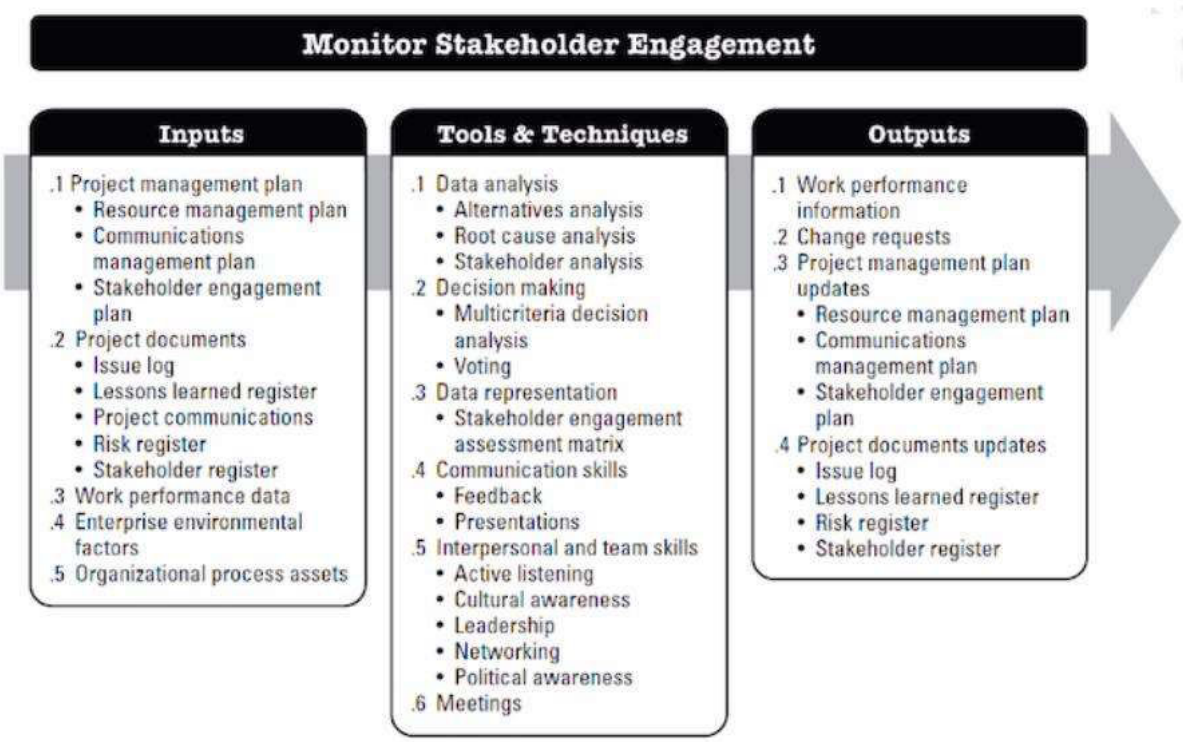
• Communications management plan
• Stakeholder engagement plan
.4 Project documents
• Change log
• Issue log
• Requirements documentation
.5 Agreements
.6 Enterprise environmental factors
.7 Organizational process assets
Tools & Techniques
.1 Expert judgment
.2 Data gathering
• Questionnaires and surveys
• Brainstorming
.3 Data analysis
• Stakeholder analysis
• Document analysis
.4 Data representation
• Stakeholder mapping/ representation
.5 Meetings
Outputs
.1 Stakeholder register
.2 Change requests
.3 Project management plan updates
• Requirements management plan
• Communications management plan
• Risk management plan
• Stakeholder engagement plan
.4 Project documents updates
• Assumption log
• Issue log
• Risk register


Plan Stakeholder Engagement
Inputs
.1 Project charter
.2 Project management plan
• Resource management plan
• Communications management plan
• Risk management plan
.3 Project documents
• Assumption log
• Change log
• Issue log
• Project schedule
• Risk register
• Stakeholder register
.4 Agreements
.5 Enterprise environmental factors
.6 Organizational process assets
Tools & Techniques
.1 Expert judgment
.2 Data gathering
• Benchmarking
.3 Data analysis
• Assumption and constraint analysis
• Root cause analysis
.4 Decision making
• Prioritization/ranking
.5 Data representation
• Mind mapping
• Stakeholder engagement assessment matrix
.6 Meetings
Outputs
.1 Stakeholder engagement plan


Manage Stakeholder Engagement
Inputs
.1 Project management plan
• Communications management plan
• Risk management plan
• Stakeholder engagement plan
• Change management plan
.2 Project documents
• Change log
• Issue log
• Lessons learned register
• Stakeholder register
.3 Enterprise environmental factors
.4 Organizational process assets
Tools & Techniques
.1 Expert judgment
.2 Communication skills
• Feedback
.3 Interpersonal and team skills
• Conflict management
• Cultural awareness
• Negotiation
• Observation/conversation
• Political awareness
.4 Ground rules
.5 Meetings
Outputs
.1 Change requests
.2 Project management plan updates
• Communications management plan
• Stakeholder engagement plan
.3 Project documents updates
• Change log
• Issue log
• Lessons learned register
• Stakeholder register



Project Procurement Management

Procurement is the act of obtaining goods, supplies, and/or services. Therefore, project procurement is obtaining all of the materials and services required for the project. Project procurement management encompasses the processes used for making sure project procurement is successful.

Project procurement management includes three primary processes. These are:

1. Plan procurements
2. Conduct procurements
3. Administer (or control) procurements

Plan procurements

The first step in successful project procurement management is making a plan. This includes planning for the following:

- What are all the materials and services you will require for the project? This includes all specifications of the materials and services, such as minimum quality requirements.
- What can be provided by your company, and what should you purchase elsewhere? This is called the make vs. buy decision. Even when your company can do something in-house, there may be a benefit of outsourcing such as cost savings, faster delivery, etc.
- What are your contract requirements for outside purchases?

- Do you have the required delivery dates?
- Do you want a fixed price contract or cost-reimbursable?
- Are there key milestones to be included?
- What about legal terms and conditions that must be met?
- How will you search for suppliers of the materials or services you need?
- Will you release a request for proposal (RFP)?
- Do you have a preferred supplier?
- What are the criteria for who will win the work?
- Will it be based on price if all contract requirements are met?

Is there another way to evaluate bidders? For example, will their Better Business Bureau ranking be taken into account?

During the planning stage, it's also important to determine how changes will be handled once a contract is awarded.

Conduct procurements

This is the execution phase of project procurement management. It's when the RFPs are released, bids are gathered, and selections are made. Any vendor negotiations will occur during this phase, and then the agreed-upon contracts are signed. Conducting procurements also includes the actual receipt of and payment for goods and services.

The control or administer procurements process is focused on monitoring and controlling project procurements to ensure all requirements are met. Two key steps included in this process are:

1. Status or progress updates from vendors
2. Quality checks of products or services delivered

Schedule and cost monitoring for procurements are also part of this process. Any changes and their impact on the overall project schedule and budget are monitored here. It's important to consider that if a piece of material is going to be two weeks late, how will it impact the rest of the project schedule?

Administer Procurements

The planning process: As the project manager, you will not create the plan in isolation. It will likely be undertaken with the input of your entire project team, including the procurement team, legal team (if you have one), and any other relevant subject matter experts within the company. This may include estimators, finance, scheduling, design or engineering, operations, etc.

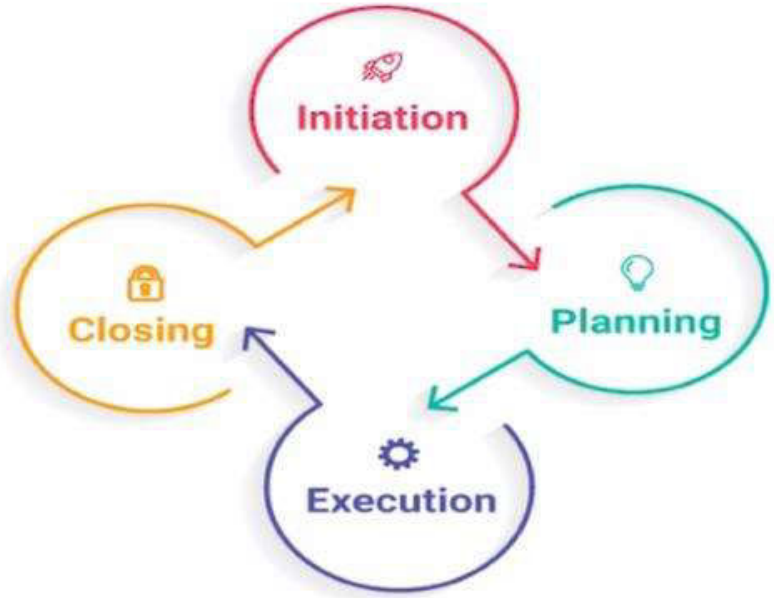
Controlling procurements: The project manager does not generally conduct the procurements. However, you are still responsible for ensuring they are conducted appropriately. This means you need to be aware of the status of procurements. If something is late, you need to know how it impacts the rest of your project schedule and mitigate it appropriately. If there is a conflict between department requirements, it will be up to you to resolve it. For example, imagine that you are told a key material has a 10-week lead time. Unfortunately, your schedule shows you

need it in eight weeks. You're told they can get it in eight weeks if you pay an extra 15% for air transport. Do you allow the two-week delay, or do you accept the cost overrun? Is there a third option, such as finding a different supplier? As the project manager, the decision will be your responsibility.

MODULE 2

PROJECT LIFE CYCLE

The Project Life Cycle refers to a logical sequence of activities to accomplish the project's goals or objectives. Regardless of scope or complexity, any project goes through a series of stages during its life. There is first an initiation or Birth phase, in which the outputs and critical success factors are defined, followed by a Planning phase, characterized by breaking down the project into smaller parts/tasks, an Execution phase, in which the project plan is executed, and lastly a Closure or Exit phase, that marks the completion of the project. Project activities must be grouped into phases because by doing so, the project manager and the core team can efficiently plan and organize resources for each activity, and also objectively measure achievement of goals and justify their decisions to move ahead, correct, or terminate. It is of great importance to organize project phases into industry-specific project cycles. Why? Not only because each industry sector involves specific requirements, tasks, and procedures when it comes to projects, but also because different industry sectors have different needs for life cycle management methodology. And paying close attention to such details is the difference between doing things well and excelling as project managers.



- **Initiation**
  - In this first stage, the scope of the project is defined along with the approach to be taken to deliver the desired outputs. The project manager is appointed and in turn, he selects the team members based on their skills and experience. The most common tools or methodologies used in the initiation stage are Project Charter, Business Plan, Project Framework (or Overview), Business Case Justification, and Milestones Reviews.
- **Planning**
  - The second phase should include a detailed identification and assignment of each task until the end of the project. It should also include a risk analysis and a definition of a criteria for the successful completion of each deliverable. The governance process is defined, stakeholders identified and reporting frequency and channels agreed. The most common tools or methodologies used in the planning stage are Business Plan and Milestones Reviews.

- **Execution and controlling**
  - The most important issue in this phase is to ensure project activities are properly executed and controlled. During the execution phase, the planned solution is implemented to solve the problem specified in the project's requirements. In product and system development, a design resulting in a specific set of product requirements is created. This convergence is measured by prototypes, testing, and reviews. As the execution phase progresses, groups across the organization become more deeply involved in planning for the final testing, production, and support. The most common tools or methodologies used in the execution phase are an update of Risk Analysis and Score Cards, in addition to Business Plan and milestones Reviews.
- **Closure**
  - In this last stage, the project manager must ensure that the project is brought to its proper completion. The closure phase is characterized by a written formal project review report containing the following components: a formal acceptance of the final product by the client, Weighted Critical Measurements (matching the initial requirements specified by the client with the final delivered product), rewarding the team, a list of lessons learned, releasing project resources, and a formal project closure notification to higher management. No special tool or methodology is needed during the closure phase.

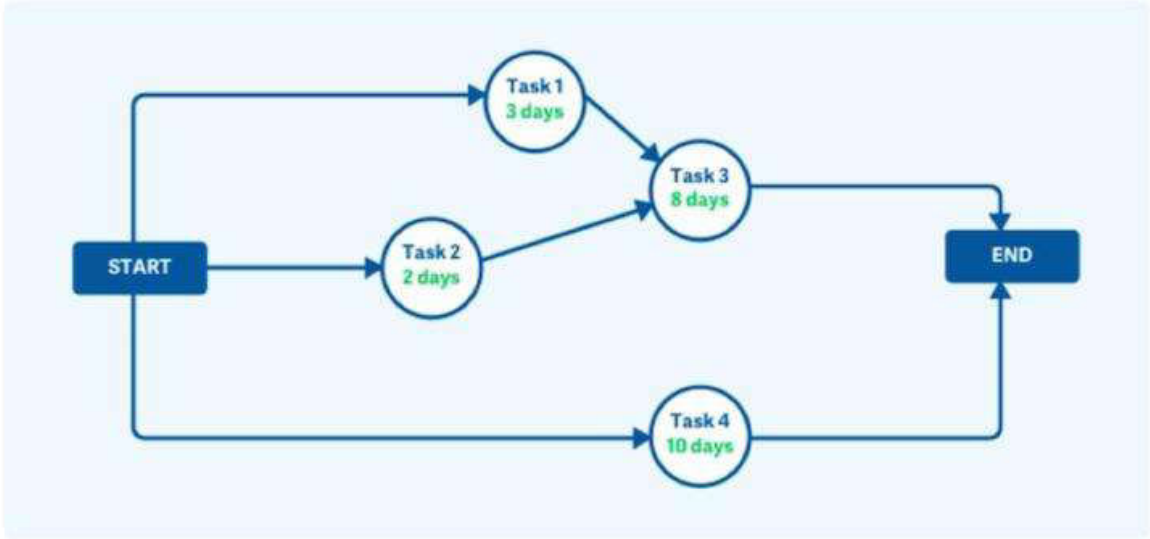
PERT

The Program Evaluation and Review Technique (PERT) is a network model that allows for randomness in activity completion times. PERT was developed in the

late 1950's for the U.S. Navy's Polaris project having thousands of contractors. It has the potential to reduce both the time and cost required to complete a project.

The Network Diagram

In a project, an activity is a task that must be performed and an event is a milestone marking the completion of one or more activities. Before an activity can begin, all of its predecessor activities must be completed. Project network models represent activities and milestones by arcs and nodes. PERT is typically represented as an activity on arc network, in which the activities are represented on the lines and milestones on the nodes



There are three times have to be calculated:

1) Most likely times
2) Optimistic times
3) Pessimistic time

steps in PERT Technique.

PERT planning involves the following steps:

1. Identify the specific activities and milestones.
2. Determine the proper sequence of the activities.
3. Construct a network diagram.
4. Estimate the time required for each activity.
5. Determine the critical path.
6. Update the PERT chart as the project progresses.

Estimated times in PERT Technique.

Estimate activity times

Weeks are a commonly used unit of time for activity completion, but any consistent unit of time can be used.

A distinguishing feature of PERT is its ability to deal with uncertainty in activity completion times. For each activity, the model usually includes three time estimates:

Optimistic time (OT) - generally the shortest time in which the activity can be completed.

Most likely time (MTj - the completion time having the highest probability. This is different from expected time. Seasoned managers have an amazing way of estimating very close to actual data from prior estimation errors.

Pessimistic time (PT) - the longest time that an activity might require. The expected time for each activity can be approximated using the following weighted average:

$$\text{Expected time} = (OT + 4 \times MT + PT) / 6$$

This expected time might be displayed on the network diagram.

Variance for each activity is given by:

$$[(PT - OT) / 6]^2$$

Benefits of PERT

Expected project completion time.

Probability of completion before a specified date.

The critical path activities that directly impact the completion time.

The activities that have slack time and that can lend resources to critical path activities.

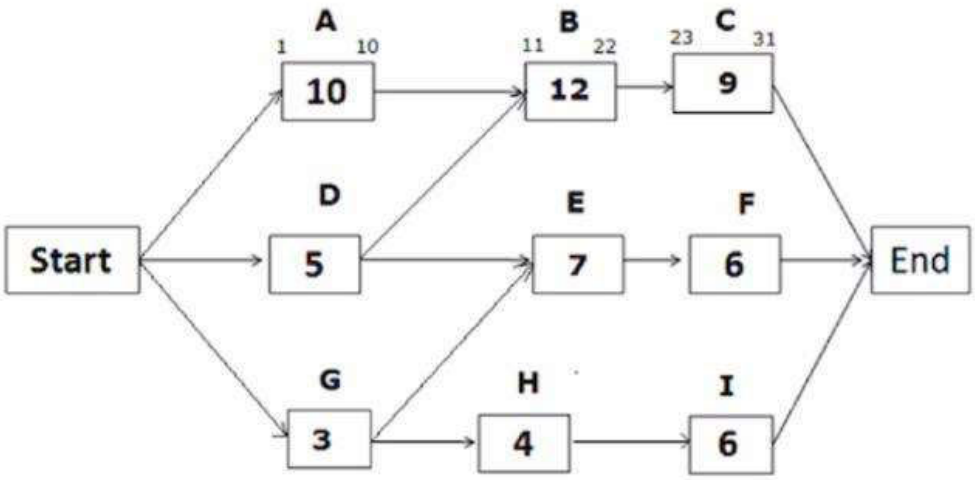
Activities start and end dates.

Limitations of PERT

The activity time estimates are somewhat subjective and depend on judgment. In cases where there is little experience in performing an activity, the numbers may be only a guess. In other cases, if the person or group performing the activity estimates the time there may be bias in the estimate.

CPM

DuPont developed a **Critical Path Method** (CPM) designed to address the challenge of shutting down chemical plants for maintenance and then restarting the plants once the maintenance had been completed.Complex project, like the above example, require a series of activities, some of which must be performed sequentially and others that can be performed in parallel with other activities. This collection of series and parallel tasks can be modeled as a network. CPM models the activities and events of a project as a network. Activities are shown as nodes on the network and events that signify the beginning or ending of activities are shown as arcs or lines between the nodes



CPM Benefits

Provides a graphical view of the project.

Predicts the time required to complete the project.

Shows which activities are critical to maintaining the schedule and which are not.

CPM Limitations

While CPM is easy to understand and use, it does not consider the time variations that can have a great impact on the completion time of a complex project. CPM was developed for complex but fairly routine projects with minimum uncertainty in the project completion times. For less routine projects there is more uncertainty in the completion times, and this uncertainty limits its usefulness.

SCHEDULING

Scheduling is a method that is used to distribute valuable computing resources, usually processor time, bandwidth and memory, to the various processes, threads, data flows and applications that need them. Scheduling is done to balance the load on the system and ensure equal distribution of resources and give some prioritization according to set rules. This ensures that a computer system is able to serve all requests and achieve a certain quality of service. Scheduling is also known as process scheduling

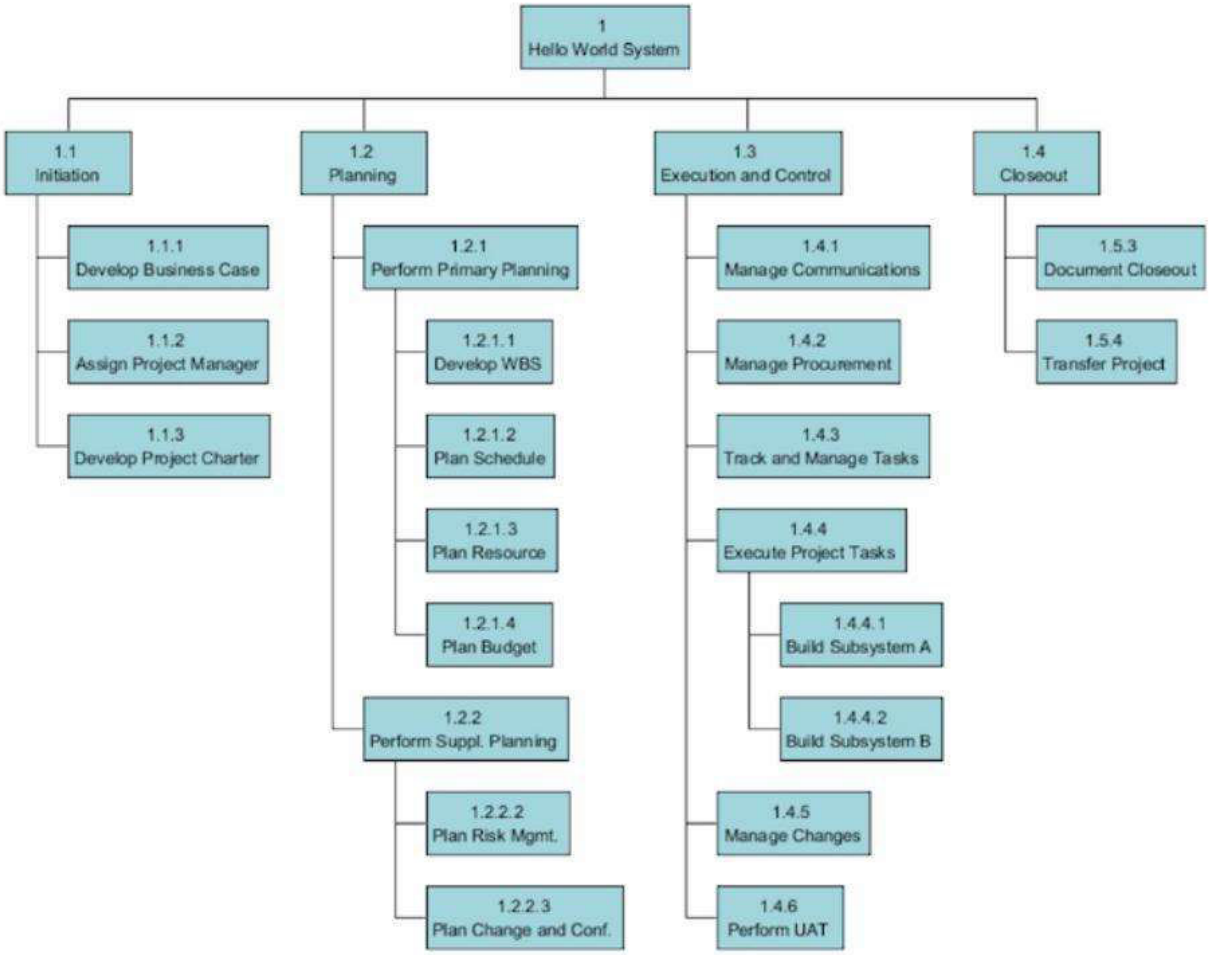
Types of scheduling include:

- First come, first served — The most straightforward approach and may be referred to as first in, first out; it simply does what the name suggests.
- Round robin — Also known as time slicing, since each task is given a certain amount of time to use resources. This is still on a first-come-first-served basis.

- Shortest remaining time first — The task which needs the least amount of time to finish is given priority.
- Priority — Tasks are assigned priorities and are served depending on that priority. This can lead to the starvation of the least important tasks as they are always preempted by more important ones.

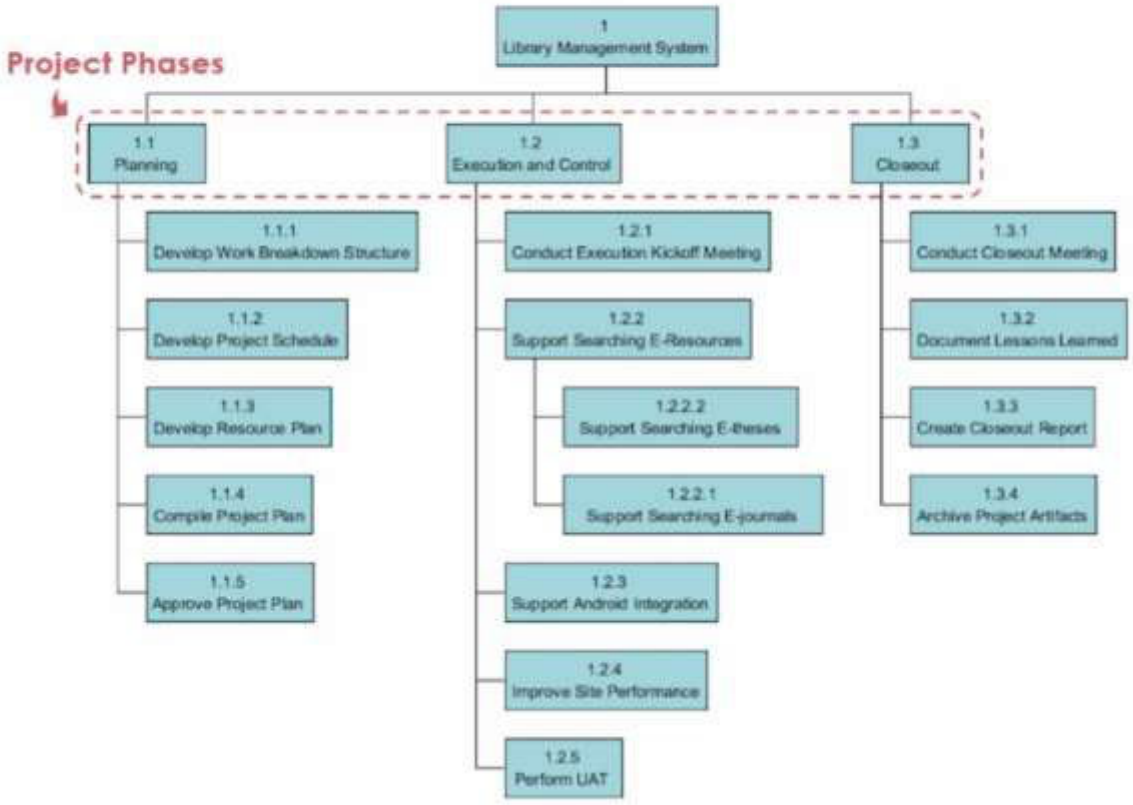
work breakdown structure

A work breakdown structure (WBS) in project management and systems engineering, is a tool used to define and group a project's discrete work elements in a way that helps organize and define the total work scope of the project. A work breakdown structure element may be a product, data, a service, or any combination. A WBS also provides the necessary framework for detailed cost estimating and control along with providing guidance for schedule development and control. Additionally the WBS is a dynamic tool and can be revised and updated as needed by the project manager.

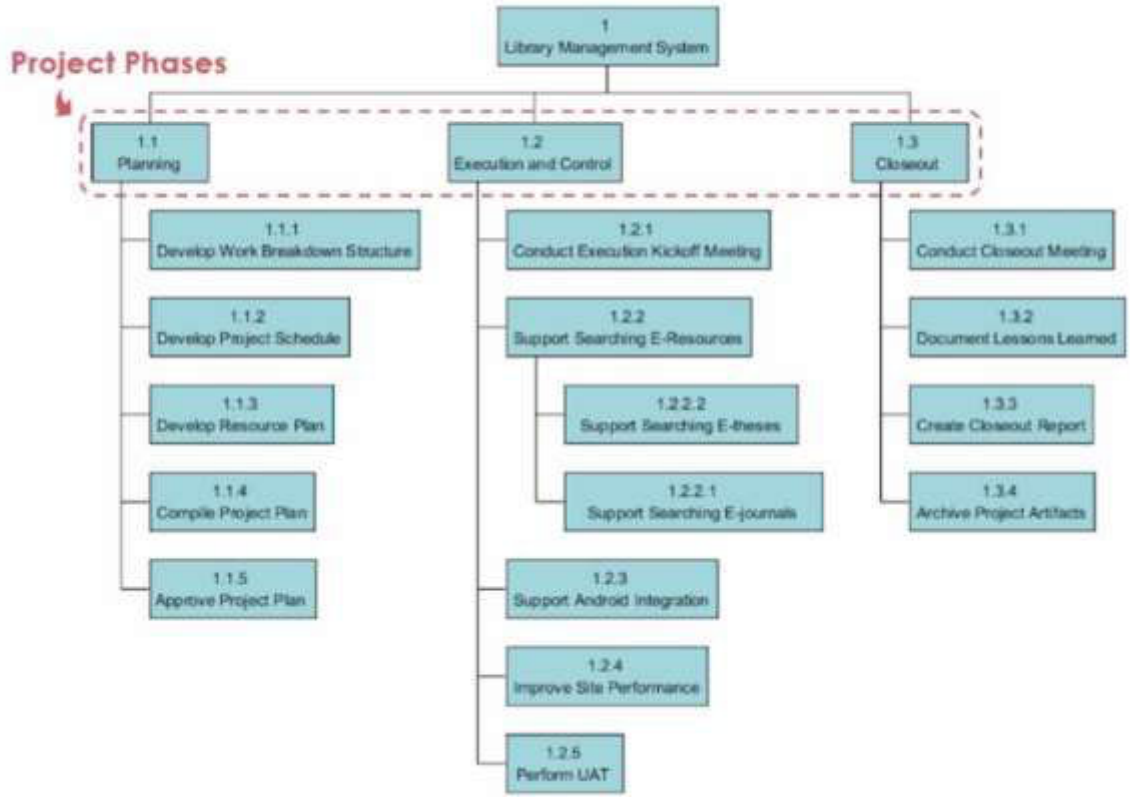

1
Hello World System
1.1
Initiation
1.2
Planning
1.3
Execution and Control
1.4
Closeout
1.1.1
Develop Business Case
1.1.2
Assign Project Manager
1.1.3
Develop Project Charter
1.2.1
Perform Primary Planning
1.2.1.1
Develop WBS
1.2.1.2
Plan Schedule
1.2.1.3
Plan Resource
1.2.1.4
Plan Budget
1.2.2
Perform Suppl. Planning
1.2.2.2
Plan Risk Mgmt.
1.2.2.3
Plan Change and Conf.
1.4.1
Manage Communications
1.4.2
Manage Procurement
1.4.3
Track and Manage Tasks
1.4.4
Execute Project Tasks
1.4.4.1
Build Subsystem A
1.4.4.2
Build Subsystem B
1.4.5
Manage Changes
1.4.6
Perform UAT
1.5.3
Document Closeout
1.5.4
Transfer Project

Types of WBS:

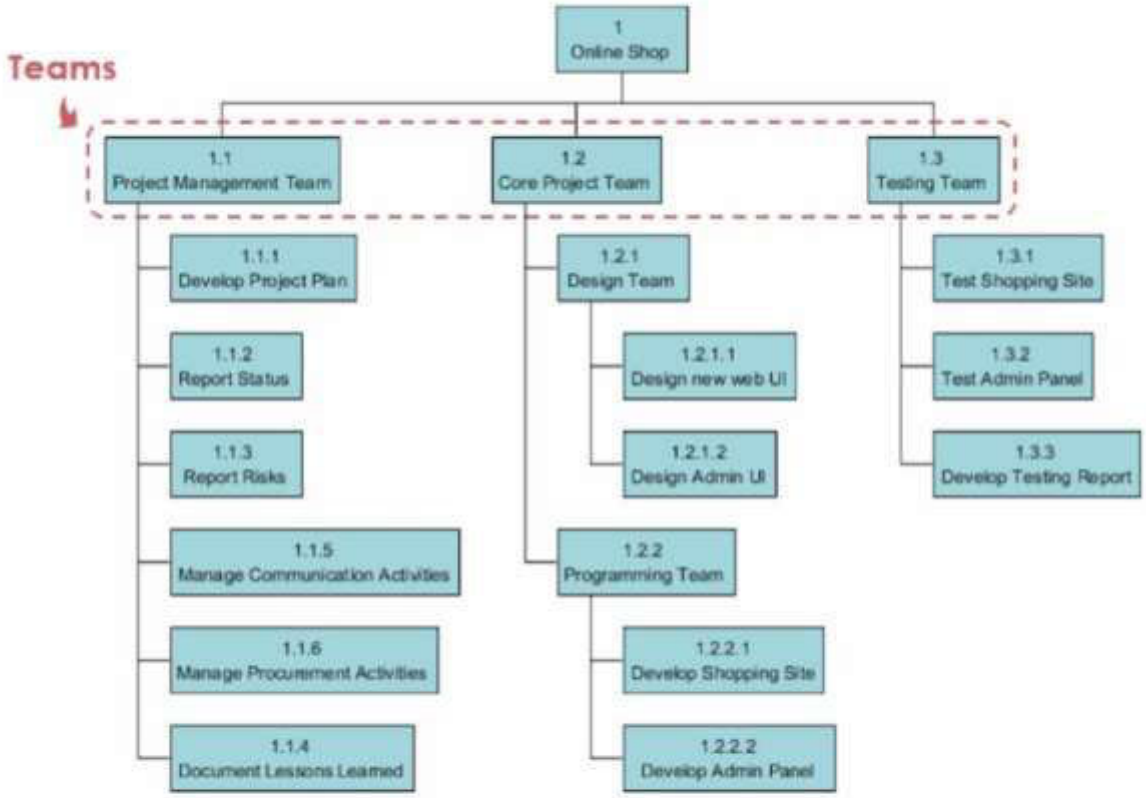
1) Deliverable-Based



2) Phase-Based.



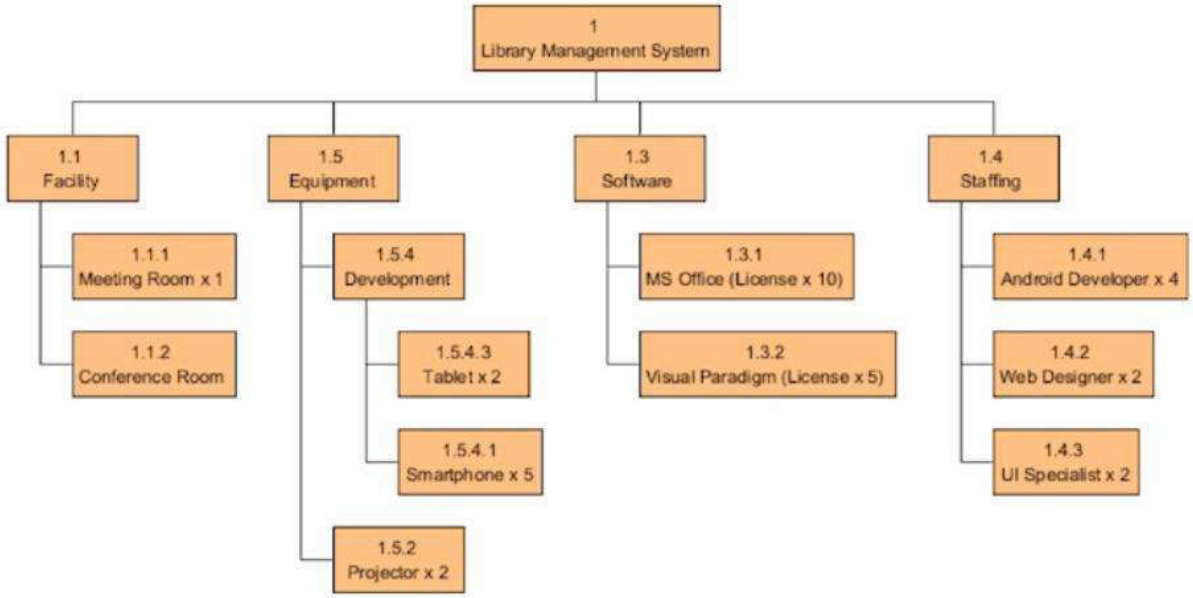
3) Responsibility-based structure.



Resource Breakdown Structure

Resource Breakdown Structure (RBS) is a project management tool that provides a hierarchical decomposition of resources, either structured by resource category, types or by IT/business function that has resource needs.

Here is a Resource Breakdown Structure example:

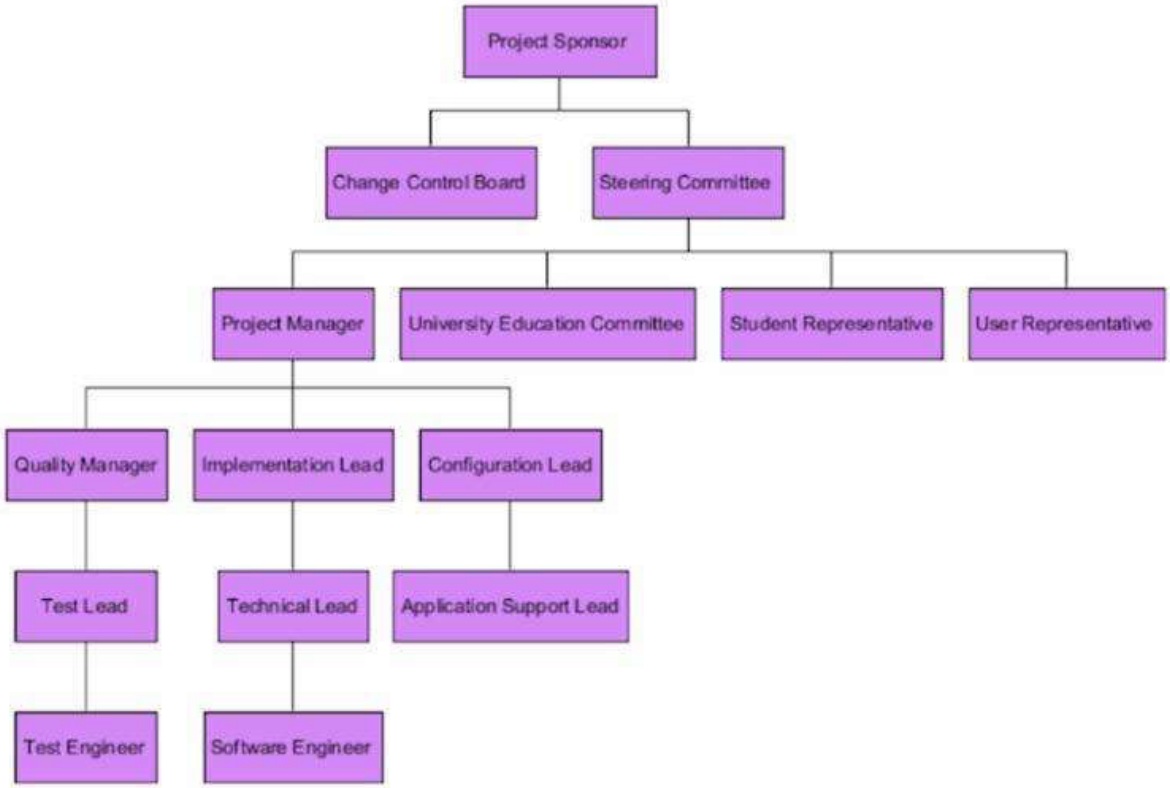


Organizational Breakdown Structure

Organizational Breakdown Structure, or sometimes known as Organization Chart, is a widely used project management tool for representing project organization. It typically begins with the project sponsor, and with all key stakeholders included. In presenting the organization structure, consider the

organization or group that is requesting the project and the level of their sponsorship and authority.

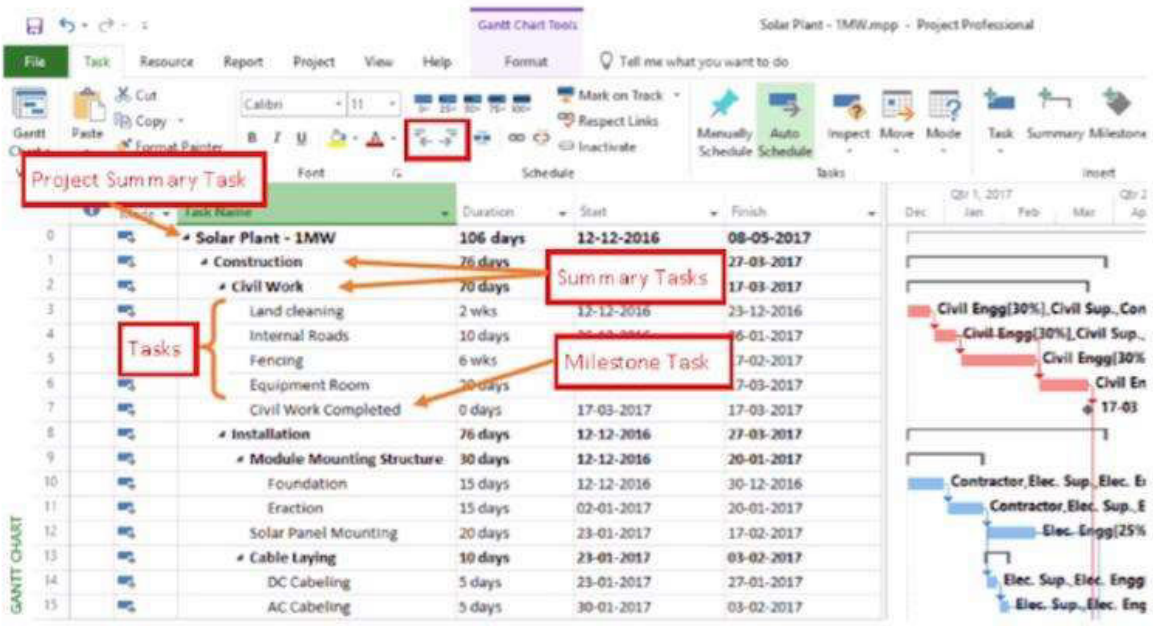
Here is an Organizational Breakdown Structure example:



WBS in MS Projects

Task

A task is an activity to be performed by a resource. It is last node in the WBS hierarchy. Project is broken down into planning packages, planning packages are broken down into further planning or work packages as needed. Work packages are broken down into activities also called tasks. Task is not broken down further. Please refer to figure 1.



In MS Project, go to Gantt Chart view. Any entry in the left hand side table is a task until we convert it into a summary task, project summary task or milestone. If task is manually scheduled, it give a free hand to write anything in the table but if task is auto scheduled, MS Project fill duration as 1 day with a question mark and start and finish date as today or project start date (as set in project options). MS Project always provides a task id for us to identify the task with an id. It also create a horizontal bar (of 1 day) on the right hand side graph area.

Milestone task

A milestone is a point in time and introduced in WBS to denote important events during the project. A milestone is a significant stage or event in the development of projects. There is no work involved in the milestone and therefore milestones have no duration. To convert a task into a milestone, please change the duration of task as zero. MS Project shows a milestone as diamond on the right hand side

chart area in Gantt Chart view. You can also use Milestone feature under Insert group on Task tab to create a milestone.

Summary task

A summary task is basically a planning package or work package. All the tasks above activity and below project name in a WBS Hierarchy are called summary tasks in MS Project. A summary task contains one or more tasks under it.

To create a summary task in MS Project, we first create a task with a name we want to give to the summary task. Then just below this task, we will create a list of tasks we like to club under the summary task. Now we will select all the tasks except the summary task and press the Indent command (available in the schedule group on Task tab on the ribbon). The tasks will be indented under summary task and summary task become bold. Now each task in the list has become a task under summary task. Refer figure 2. One summary task could be part of another summary task or project summary task. Refer figure .

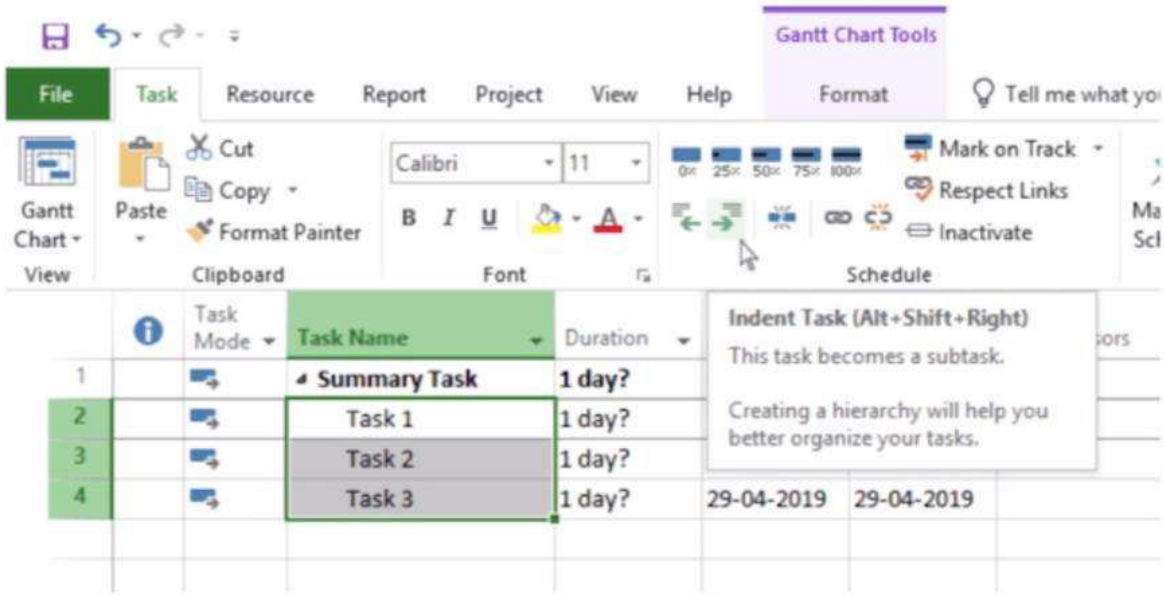


Figure 2 – Creating a summary task

Project Summary task

A project summary task is the top level task named the same as project name. Refer 1st task in figure 1. Its id is 0. To create a project summary task, go to Format tab and tick the check box "Project Summary task" under Show/Hide group. A project summary task is inserted at the top. It is named the same as the project file name and its id is 0. All the tasks in the project become sub tasks of this summary tasks. Refer figure

3. You can change the name to any name you like.

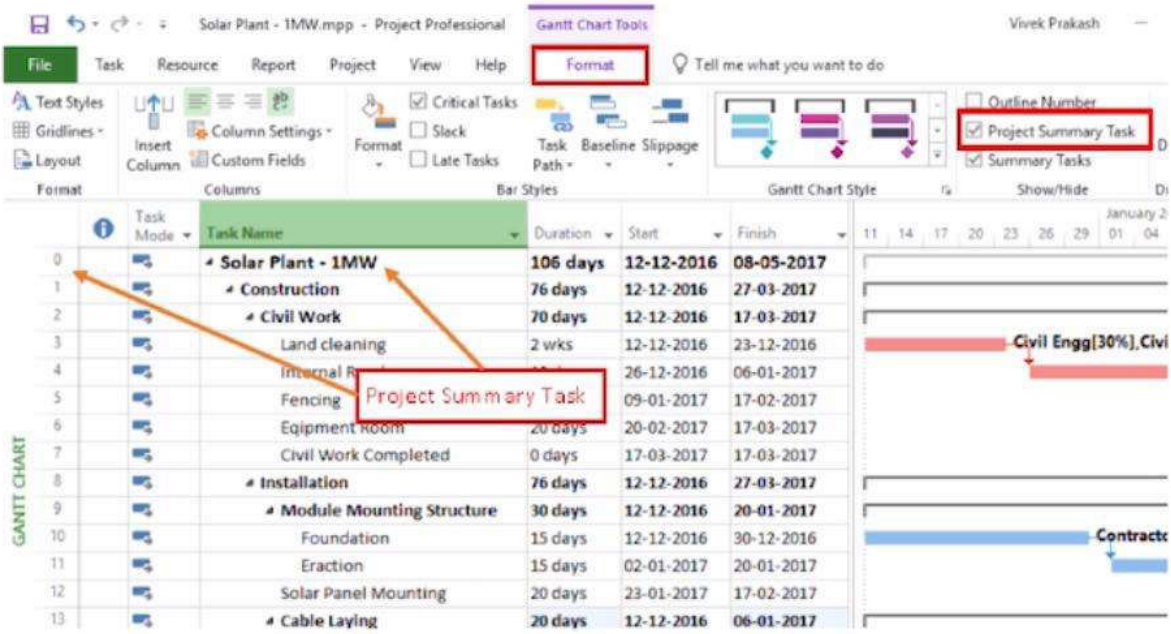


Figure 3 – Creating a project summary task

These four essential components and Indent/Outdent features on Task tab help create a WBS in MS Project. Remember a meticulous plan is necessary for success of a project and a detailed WBS is necessary for a meticulous plan.

MODULE - 3

BUDGETING

BUDGET

Budget represents the objectives of any organization that is based on the implication of forecast and related to planned activities.

Budget is neither an estimate nor a forecast because an estimation is a predetermination of future events, may be based on simple guess or any scientific principles

Similarly, a forecast may be an anticipation of events during a specified period of time. A forecast may be for a specific activity of the company. We normally forecast likely events such as sales, production, or any other activity of the organization.

On the other hand, budget relates to planned policy and program of the organization under planned conditions. It represents the action according to a situation which may or may not take place

BUDGETING

Budgeting represents the formation of the budget with the help and coordination of all or the various departments of the firm.

BUDGETARY CONTROL

Budgetary control is a tool for the management to allocate responsibility and authority in planning for the future and to develop a basis of measurement to evaluate the efficiency of operations.

A budget is a plan of the policy to be pursued during a defined time period. All the actions are based on planning of budget because the budget is prepared after studying all the related activities of the company. Budget gives a communication ground to the top management with the staff of the firm who are implementing the policies of the top management.

Budgetary control helps in coordinating the economic trends, financial position, policies, plans, and actions of an organization.

Budgetary control also helps the management to ensure and control the plan and activities of the organization. Budgetary control makes it possible by continuous comparison of actual performance with that of the budgets.

Types of Budgets

FUNCTIONAL BUDGETS

It relates to any function of the firm such as sales, production, cash, etc. Following budgets are prepared in functional budgets:

- Sales Budget
- Production Budget
- Material Budget
- Manufacturing Budget
- Administrative Cost Budget
- Plant Utilization Budget

- Capital Expenditure Budget
- Research and Development Cost Budget
- Cash Budget

Master Budget or Summarized Budget or Finalized Profit plan

This budget is very useful for the top management of the company because it covers all the information in a summarized manner.

FIXED BUDGET

It is a rigid budget and is drawn on the assumption that there will be no change in the budget level.

FLEXIBLE BUDGET

It is also called a sliding scale budget. It is useful in:

- the new organizations where it is difficult to foresee,
- the firms where activity level changes due to seasonal nature or change in demand,
- the industries based on change of fashion,
- the units which keep on introducing new products, and
- the firms which are engaged in ship-building business.

ZERO BASE BUDGETING

Zero base budgeting is not based on the incremental approach; previous year figures are not adopted as base.

CIMA has defined it as:As a method of budgeting, where all activities are revaluated each time a budget is set, discrete levels of each activity are valued and combination is chosen to match the funds available.

Flexible Budget Vs. Fixed Budget

Points	Flexible Budget	Fixed Budget
Flexibility	Due to its nature of flexibility, it may be quickly re-organized according to the level of production.	After the commencement of a period, fixed budget cannot change according to actual production.
Condition	Flexible budget may change according to change in conditions.	Fixed budget is based on the assumption that conditions will remain unchanged.
Cost Classification	Classification of costs is done according to the nature of their variability.	It is suitable for fixed costs only; no classification is done in fixed budget.
Comparison	Comparisons of actual figures with revised standard figures are done according to change in the production level of a concern.	If there is change in production level, then it is not possible to do a correct comparison.
Ascertainment of cost	It is easy to ascertain costs even at different levels of activity.	If there is change in the production level or circumstances, it is not possible to ascertain

		costs correctly.
Cost Control	It is used as an effective tool to control costs.	Due to its limitations, it is not used as cost control tool.

Cash Budget

Cash budget comes under the category of financial budget. It is prepared to calculate budgeted cash flows (inflows and outflows) during a specific period of time. Cash budget is useful in determining the optimum level of cash to avoid excessive cash or shortage of cash, which may arise in future.

With the help of a cash budget, we can arrange cash through borrowing funds in case of shortage, and we may invest cash if it is present in excess.

It is necessary for every business to keep a safe level of cash. Being a part of master budget, the following tasks are included in a cash budget:

- Collection of Cash
- Cash Payments

Fundamental Principles of Budgeting

1. **Management Support:**

   Top management's support and cooperation is essential for successful implementation of the budget. It should take interest not only in setting the targets and finalising the budgets but also constantly monitoring the actual performance to find out the deviations if any and take curative steps, motivate the personnel and reward the good performers.

2. **Employees Involvement:**

   The budget should be established on the highest possible level of

motivation. All levels of management should participate in setting targets and preparing budgets. This will result in defining realistic targets.

Participation of employees in the budgeting process will not only make them carefully think about the likely development in the forthcoming period and prepare the budget accordingly, but will also motivate them to strive hard to achieve budget levels of efficiency and activity.

3. **Statement of Organizational Goal:**

The organizational goal should be quantified and clearly stated. These goals should be set within the framework of corporate objectives and strategies. A well defined corporate policy and strategy is a prerequisite for budgeting.

4. **Responsibility Accounting:**

Individual employees should be informed about expectations of the management. Only those costs over which an individual has predominant control should be used in evaluating performance of that individual. Responsibility reports often contain budget to actual comparisons.

5. **Organizational Structure:**

There should be well-planned organizational structure with clearly defined authority and responsibility of different levels of management. Role and responsibilities of the Budget Committee and its President must be made known to the people in the organization.

6. **Flexibility:**

If the basic assumptions underlying the budget change during the year, the budget should be restated. This will enable the management to

compare the actual level of operations with the expected performance at that level.

7. **Communication of Results:**

Proper communications systems should be established for management reporting and information service so that information pertaining to actual performance is presented to the concerned manager timely and accurately so that remedial action is taken wherever necessary.

8. **Sound Accounting System:**

Organization should have good accounting system so as to generate precise, accurate, reliable and prompt information which is essential for successful implementation of budget system

COSTING

Costing is the classifying, recording and appropriate allocation of expenditure for the determination of the costs of products or services; and for presentation of suitably arranged data for the purposes of control, and guidance of management

It is the determination of an actual cost of an article, after adding different expenses incurred in various departments.

It may also be defined as the system, which systematically records all the expenditure to determine the cost of manufactured products.

It differs from the estimating that costing is a determination of cost after knowing the expenditure incurred in various departments on the product, while estimating is the pre-determination of cost based on the assumptions and previous experiences.

Aims of costing

The important aims and object s of costing are:

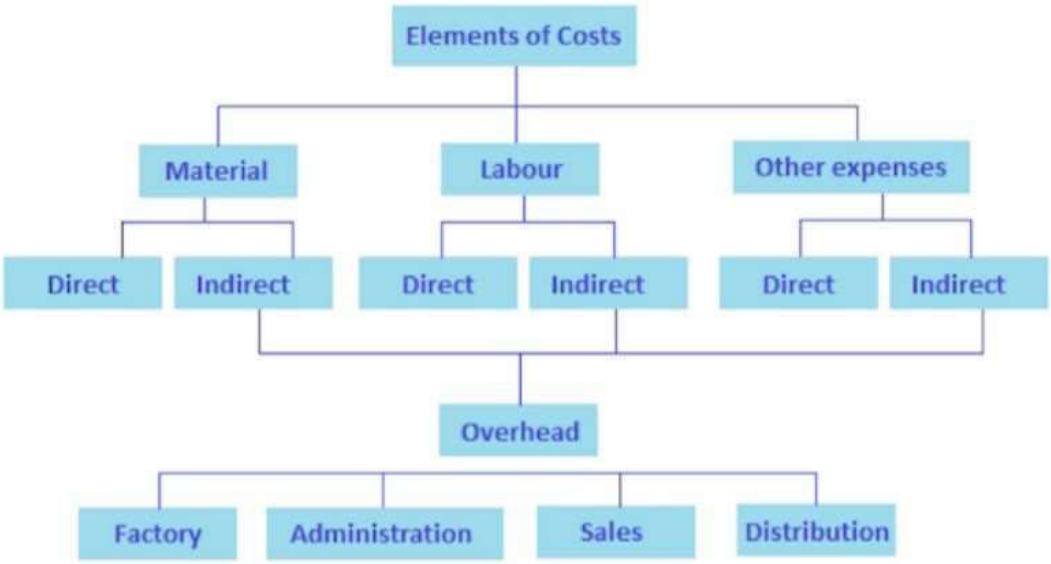
- To determine the cost of each article.
- To determine the cost incurred during each operation, to keep control over workers wages.
- To provide information to ascertain the selling price of the product.
- To supply information for detection of wastages.

- It helps in reducing the total cost of manufacture.
- It suggests changes in design, when the cost is higher.
- To help in formulating the policies for charging the prices of the products.
- To provide information for economic consideration for purchasing new machines.
- To help the management in decision making.
- To facilitate preparation of estimates for submitting in tenders or quotations.
- To compare the actual cost with the estimated cost of the component.

Types of Costs

- **Fixed costs** are costs that don't vary depending on the level of production. These are usually things like the mortgage or lease payment on a building or a piece of equipment that is depreciated at a fixed monthly rate. An increase or decrease in production levels would cause no change in these costs.
- **Variable costs** are costs tied to a company's level of production. For example, a floral shop ramping up their floral arrangement inventory for Valentine's Day will incur higher costs when it purchases an increased number of flowers from the local nursery or garden center.
- **Operating costs** are costs associated with the day-to-day operations of a business. These costs can be either fixed or variable depending on the unique situation.
- **Direct costs** are costs specifically related to producing a product. If a coffee roaster spends five hours roasting coffee, the direct costs of the finished product include the labor hours of the roaster and the cost of the coffee beans.
- **Indirect costs** are costs that cannot be directly linked to a product. In the

coffee roaster example, the energy cost to heat the roaster would be indirect because it is inexact and difficult to trace to individual products.



Cost Control Techniques

Costs can be controlling by employing the following methods:

- Material Control
- Labor Control
- Overheads Control
- Standard costing
- Budgetary Control
- Capital Expenditure Control
- Productivity and Accounting Ratios

Requirements for Successful Cost Control

The following requirements are to be fulfilled to implement successful cost control:

- A plan and a set of well-defined responsibilities to all executives are essential.
- Clear definition of tasks for performance and cost to execute those tasks.
- A fixed responsibility, in case of deviation between targeted and actual.
- Prompt collection of performance data from each department of an organization as the delay in information equals no information and the management is unable to make correct decisions due to lack of complete information.
- Highlights of good and bad, both performances to enable the management to take corrective steps.
- Reward for good performances and Punishment for the poor ones.

The Concept of Earned Value

Earned Value (EV) is a method for measuring project performance.; it combines three parameters: scope, schedule and cost in a single integrated system. Earned Value provides you with a factual way of measuring project performance and predicting project outcomes. It enables you to report progress with greater accuracy and forecast any issues/risks ahead of time. This helps upper management to make cost and time based decisions.

Earned Value is sometimes known as Performance Measurement, Management by Objectives, Budgeted Cost of Work Performed and Cost Schedule Control Systems.

Formula for Earned Value (EV)

The formula to calculate Earned Value is also simple. Take the actual percentage of the completed work and multiply it by the project budget and you will get the Earned Value.

Earned Value = % of completed work X BAC (Budget at Completion).

Application of Earned Value (EV)

Earned Value is used to calculate Schedule Variance, Cost Variance, Schedule Performance Index, Cost Performance Index, Estimate at Completion, and To Complete Performance Index.

CONCEPT OF COST PERFORMANCE INDEX

The Cost Performance Index helps you to analyze the cost efficiency of the project. It measures the value of the work completed compared to the actual cost spent.

The Cost Performance Index specifies how much you are earning for each dollar spent on the project. It shows how well the project is sticking to the budget.

The Formula for the Cost Performance Index (CPI)

You can calculate the Cost Performance Index by dividing the earned value by actual cost.

Cost Performance Index = (Earned Value) / (Actual Cost)

CPI = EV / AC

ESTIMATE AT COMPLETION (EAC) – A PROJECT FORECASTING TOOL

Forecasting helps predict the future performance of projects. It is based on the past performance of the project and objective data. With this information in hand, you can guess future progress and find early indications of a deviation.

We have **three** forecasting techniques in project management:

1. **Estimate at Completion (EAC)**
2. **Estimate to Complete (ETC)**
3. **To Complete Performance Index (TCPI)**

In this blog post we will discuss Estimate at Completion (EAC) in detail and the other two techniques briefly.

Estimate at Completion (EAC)

Estimate at Completion is "The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete."

Estimate at Completion allows the project manager to see the final project cost estimate.

Estimate to Complete (ETC)

Estimate to Complete is the second forecasting technique. It is the cost of completing the remaining work.

Estimate to Complete = Estimate at Completion – Actual Cost

$$ETC = EAC - AC$$

To Complete Performance Index (TCPI)

The To Complete Performance Index estimates how fast you have to move to achieve the target.

It is the estimate of the future cost that you may need to complete the project within the approved budget. This budget may be the BAC or an updated budget, i.e., Estimate at Completion (EAC).

TCPI = (Remaining Work) / (Remaining Funds)

TCPI = (BAC – EV) / (BAC – AC)

Or

TCPI = (BAC – EV) / (EAC – AC)

Risk Management

Risk management is the process of identifying, assessing and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from

a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents and natural disasters.

Importance

By implementing a risk management plan and considering the various potential risks or events before they occur, an organization can save money and protect their future. This is because a robust risk management plan will help a company establish procedures to avoid potential threats, minimize their impact should they occur and cope with the results. This ability to understand and control risk enables organizations to be more confident in their business decisions. Furthermore, strong corporate governance principles that focus specifically on risk management can help a company reach their goals.

Other important benefits of risk management include:

- Creates a safe and secure work environment for all staff and customers.
- Increases the stability of business operations while also decreasing legal liability.
- Provides protection from events that are detrimental to both the company and the environment.
- Protects all involved people and assets from potential harm.
- Helps establish the organization's insurance needs in order to save on unnecessary premiums.

The importance of combining risk management with patient safety has also been revealed. In most hospitals and organizations, the risk management and patient safety departments are separated; they incorporate different leadership, goals and scope. However, some hospitals are recognizing that the ability to provide safe, high-quality patient care is necessary to the protection of financial assets and, as a result, should be incorporated with risk management.

Risk management strategies and processes

All risk management plans follow the same steps that combine to make up the overall risk management process:

- **Establish context.** Understand the circumstances in which the rest of the process will take place. The criteria that will be used to evaluate risk should also be established and the structure of the analysis should be defined.
- **Risk identification.** The company identifies and defines potential risks that may negatively influence a specific company process or project.
- **Risk analysis.** Once specific types of risk are identified, the company then determines the odds of them occurring, as well as their consequences. The goal of risk analysis is to further understand each specific instance of risk, and how it could influence the company's projects and objectives.
- **Risk assessment and evaluation.** The risk is then further evaluated after determining the risk's overall likelihood of occurrence combined with its overall consequence. The company can then make decisions on whether the risk is acceptable and whether the company is willing to take it on based on its risk appetite.
- **Risk mitigation.** During this step, companies assess their

highest-ranked risks and develop a plan to alleviate them using specific risk controls. These plans include risk mitigation processes, risk prevention tactics and contingency plans in the event the risk comes to fruition.

- **Risk monitoring.** Part of the mitigation plan includes following up on both the risks and the overall plan to continuously monitor and track new and existing risks. The overall risk management process should also be reviewed and updated accordingly.
- **Communicate and consult.** Internal and external shareholders should be included in communication and consultation at each appropriate step of the risk management process and in regards to the process as a whole.

Risk management approaches

- **Top down-approach:** the decision-making process is centralized at governance level. This approach can show two modes: a) Full top-down mode, where the business units' risks are listed at department level, meaning that heads of unit cannot add risks themselves at unit level. There is no need of risk escalation, except at departmental level. b) Prevailing top-down mode, where a corporate risk register is directly created from a detailed operational risk register.
    - **Advantage**
        - Can be used from project commencement
        - Supports fundamental project decisions
        - Underpins a rational approach to the process
        - Efficient identification of key insights
- **Bottom-up approach:** the decision-making process is done at

management level. Operational risks are identified by any staff member while performing his or her daily work (e.g., in order to encourage the staff to be more active in defining non-conformities, an opportunity to register them online has been provided).

- **Mixed approach:** the board entity states the criteria (top-down) by which the heads of unit identify and manage risks (bottom-up). Risks may be viewed and assessed throughout the organization at any level (e.g., group, program, office, project, etc.). In order to set the framework, the hierarchy of risks on which attention is focused corresponds to the enterprise, operational and project levels.

Risk Analysis & Risk Management in Project Management

Risk Analysis

Risk Analysis is defined as the sequence of processes of risk management planning, analysis of risks, identification and controlling risk on a project.

Proper risk management is control of possible future events that may have a negative effect on the overall project. It is more of proactive then reactive process.

Qualitative Analysis

A Qualitative Analysis allows the main risk sources or factors to be identified. This can be done, for example, with the aid of checklists, interviews or brainstorming sessions. This is usually associated with some form of assessment which could be the description of each risk and its impacts or a subjective labelling of each risk (e.g high/low) in terms of both its impact and its probability of occurrence. A sound aim is to identify the key risks, perhaps between five and ten, for each project (or part-project on large projects) which are then analysed and managed in more detail.

Quantitative Analysis

A Quantitative Analysis often involves more sophisticated techniques, usually requiring computer software. To some people this is the most formal aspect of the whole process requiring:

- measurement of uncertainty in cost and time estimates
- probabilistic combination of individual uncertainties.

Such techniques can be applied with varying levels of effort ranging from modest to extensively thorough. It is recommended that new users start slowly, perhaps even ignoring this 'sub-stage', until a climate of acceptability has been developed for Project Risk Analysis and Management in the organisation. An

initial qualitative analysis is essential. It brings considerable benefit in terms of understanding the project and its problems irrespective of whether or not a quantitative analysis is carried out. It may also serve to highlight possibilities for risk 'closure' i.e. the development of a specific plan to deal with a specific risk issue. Experience has shown that qualitative analysis - Identifying and Assessing Risks - usually leads to an initial, if simple, level of quantitative analysis. If, for any reason - such as time or resource pressure or cost constraints - both a qualitative and quantitative analysis are impossible, it is the qualitative analysis that should remain. It should be noted that procedures for decision making will need to be modified if risk analysis is adopted. An example which illustrates this point is the sanction decision for clients, where estimates of cost and time will be produced in the form of ranges and associated probabilities rather than single value figures.

Manage Risk

1. Plan risk management

It is the procedure of defining how to perform risk management activities for a project.

2. Risk Identification

It is the procedure of determining which risk may affect the project most. This process involves documentation of existing risks.

The input for identifying risk will be

- Risk management plan
- Project scope statement
- Cost management plan
- Schedule management plan
- Human resource management plan
- Scope baseline
- Activity cost estimates
- Activity duration estimates
- Stakeholder register
- Project documents
- Procurement documents
- Communication management plan
- Enterprise environmental factor
- Organizational process assets
- Perform qualitative risk analysis
- Perform quantitative risk analysis
- Plan risk responses
- Monitor and control risks

The output of the process will be a

- Risk register

3. Perform qualitative risk analysis

It is the process of prioritizing risks for further analysis or action by combining

and assessing their probability of occurrence and impact. It helps managers to lessen the uncertainty level and concentrate on high priority risks.

Plan risk management should take place early in the project, it can impact on various aspects for example: cost, time, scope, quality and procurement.

The inputs for qualitative risk analysis includes

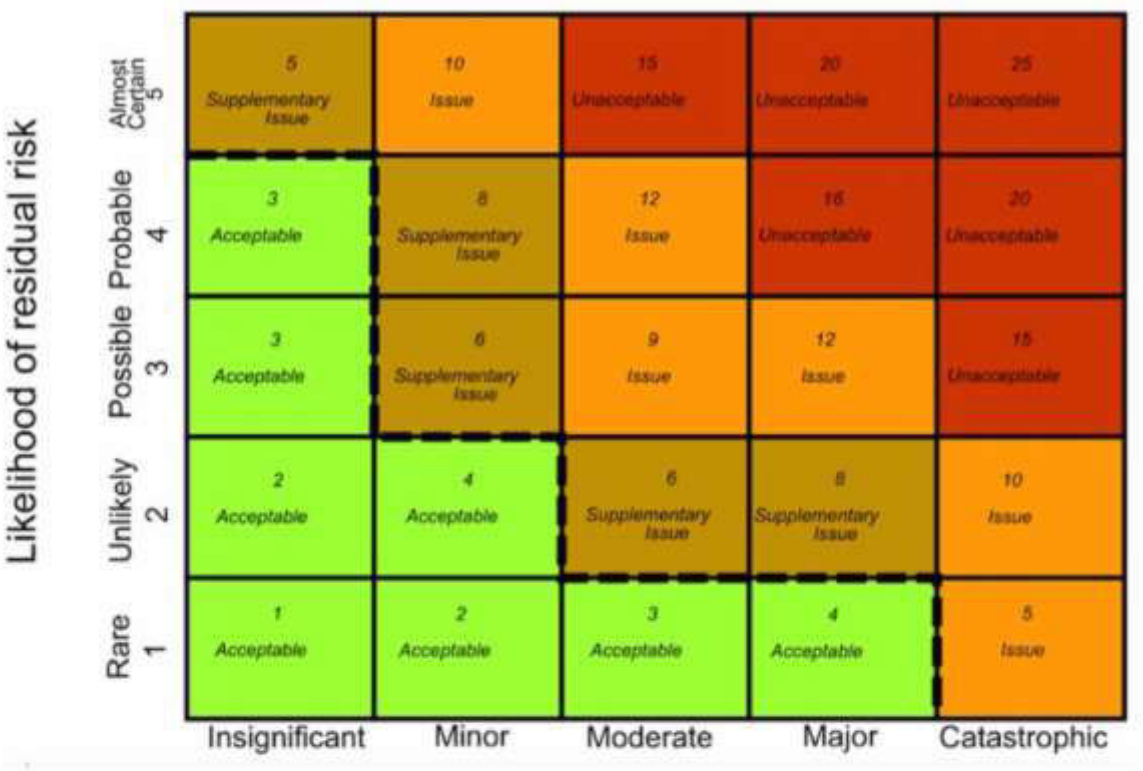
- Risk management plan
- Scope baseline
- Risk register
- Enterprise environmental factors
- Organizational process assets

The output of this stage would be

- Project documents updates

4. Quantitative risk analysis

It is the procedure of numerically analyzing the effect of identified risks on overall project objectives. In order to minimize the project uncertainty, this kind of analysis are quite helpful for decision making.



Risk Management Matrix

The input of this stage is

- Risk management plan
- Cost management plan
- Schedule management plan
- Risk register
- Enterprise environmental factors
- Organizational process assets

While the output will be

- Project documents updates

5. **Plan risk responses**

To enhance opportunities and to minimize threats to project objectives plan risk response is helpful. It addresses the risks by their priority, activities into the budget, schedule, and project management plan.

The inputs for plan risk responses are

- Risk management plan
- Risk register

While the output are

- Project management plan updates
- Project documents updates

6. **Control Risks**

Control risk is the procedure of tracking identified risks, identifying new risks, monitoring residual risks and evaluating risk.

The inputs for this stage includes

- Software Project management plan
- Risk register
- Work performance data
- Work performance reports

The output of this stage would be

- Work performance information
- Change requests
- Project management plan updates
- Project documents updates
- Organizational process assets updates

Project Risk Analysis And Management

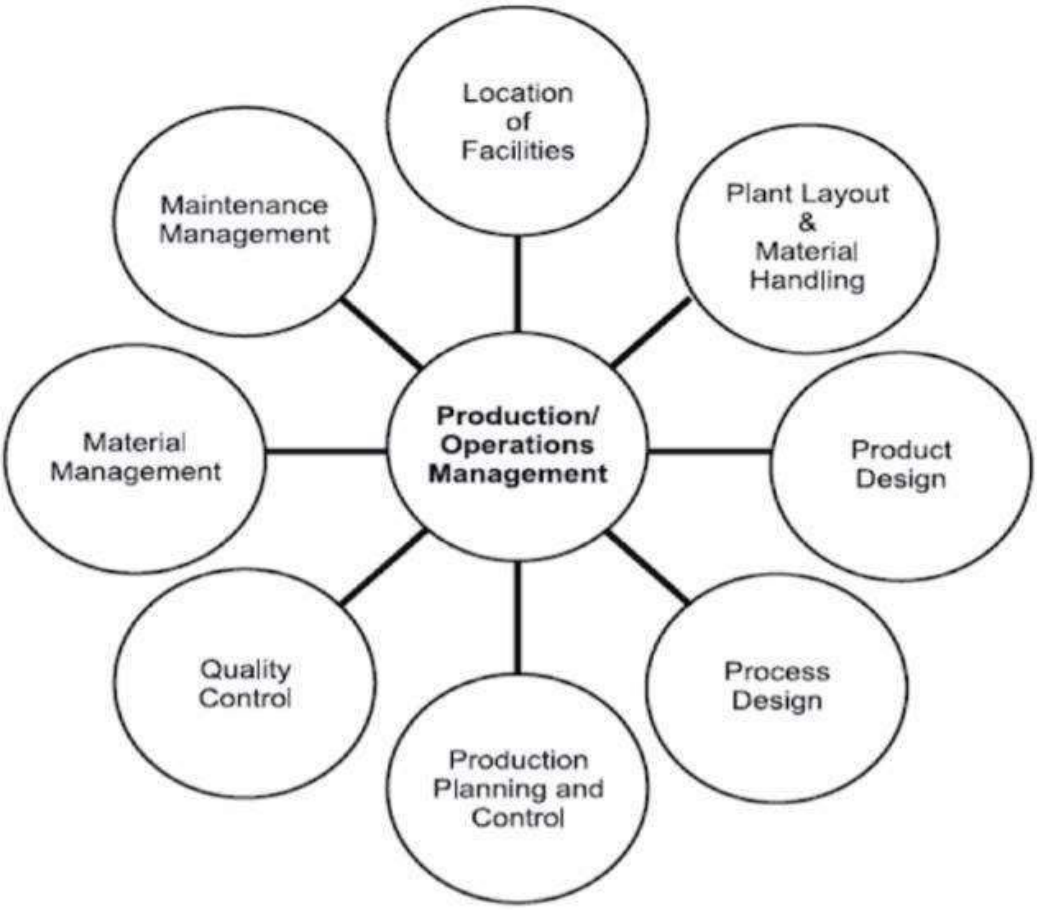
Project Risk Analysis and Management is a process which enables the analysis and management of the risks associated with a project. Properly undertaken it will increase the likelihood of successful completion of a project to cost, time and performance objectives. Risks for which there is ample data can be assessed statistically. However, no two projects are the same. Often things go wrong for reasons unique to a particular project, industry or working environment. Dealing with risks in projects is therefore different from situations where there is sufficient data to adopt an actuarial approach. Because projects invariably involve a strong technical, engineering, innovative or strategic content a systematic process has proven preferable to an intuitive approach. Project Risk Analysis and Management has been developed to meet this requirement.

MODULE 4

Nature And Scope of Production And Operation Management

1. **E.S.Buffa** defines production management as follows: 'Production management deals with decision-making related to production processes so that the resulting goods or services are produced according to specifications, in the amount and by the schedule demanded and out of minimum cost'.

2. **Joseph G** .Monks defines Operations Management as the process whereby resources, flowing within a defined system, are combined and transformed by a controlled manner to add value in accordance with policies communicated by management.



Objectives of Production/Operations Management

- Maximum customer satisfaction through quality, reliability, cost and delivery time.
- Minimum scrap/rework resulting in better product quality.
- Minimum possible inventory levels (i.e.,optimum inventory levels).
- Maximum utilisation of all kinds of resources needed.
- Minimum cash outflow.
- Maximum employee satisfaction.
- Maximum possible production (i.e., outputs).

- Higher operating efficiency.
- Minimum production cycle time.
- Maximum possible profit or return on investment.
- Concern for protection of the environment.
- Maximum possible productivity.

Nature of Production/Operations:

The nature of production or operations can be better understood by viewing the manufacturing function as :

- Production/operations as a system,
- Production/operations as an organisational function,
- Production/operations as a conversion or transformation process and
- Production/operations as a means of creating utility.

These distinct views are discussed in the following section.

Production/Operations as a System:This view is also known as "systems concept of production". A system is defined as the collection of interrelated entities. The systems approach views any organisation or entity as an arrangement of interrelated parts that interact in ways that can be specified and to some extent predicted. Production is viewed as a system which converts a set of inputs into a set of desired outputs. A production system has the following elements or parts:

- Inputs,
- Conversion process or transformation process,
- Outputs
- Transportation subsystem,

- Communication subsystem and
- Control or decision making subsystem.

Production/Operations as a Conversion/Transformation Process

The conversion or transformation sub-system is the core of a production system because it consists of processes or activities wherein workers, materials, machines and equipment are used to convert inputs into outputs. The conversion process may include manufacturing processes such as cutting, drilling, machining, welding, painting, etc., and other processes such as packing, selling, etc. Any conversion process consists of several small activities referred to as "operations" which are some steps in the overall process of producing a product or service that leads to the final output.

Production/Operations as a Means of Creating Utility:

Production is defined as the process of adding to the value of outputs or the process of creating utility in outputs. "Utility" is the power of satisfying human needs. During the process of converting the raw materials into finished goods, various types of utilities are created while adding value to the outputs. These

Types of utilities are:

a) **Form utility:**This is created by changing the size, shape, form, weight, colour, smell of inputs in order to make the outputs more useful to the customers. For example, iron ore is changed to steel, wood is changed to furniture, etc.

b) **Place utility:**This is created by changing the places of inputs or transporting the inputs from the source of their availability to the place of their use to be converted into outputs. For example the iron ore and coal are transported from the mines to the steel plant to be used in the conversion process.

c) **Time utility:**This is created by storage or preservation of raw materials or finished goods which are in abundance sometime, so that the same can be used at a later time when they become scarce due to higher demand exceeding the quantity available.

d) **Possession utility:** This is created by transferring the possession or ownership of an item from one person to another person. For example, when a firm purchases materials from a supplier, the possession utility of the materials will increase when they are delivered to the buying firm.

e) **Service utility:** Which is the utility created by rendering some service to the customer. For example, a doctor or a lawyer or an engineer creates service utility to a client/customer by rendering service directly to the client/customer.

f) **Knowledge utility:**This is created by imparting knowledge to a person. For example, a sales presentation or an advertisement about some product communicates some information about the product to the customer, thereby imparting knowledge.

Scope of Production and Operation Management

Production and operations management concern with the conversion of inputs into outputs, using physical resources, so as to provide the desired utilities to the customer while meeting the other organizational objectives of effectiveness, efficiency and adaptability. It distinguishes itself from other

functions such as personnel, marketing, finance, etc., by its primary concern for 'conversion by using physical resources.' Following are the activities which are listed under production and operations management functions:

1. Location of facilities
2. Plant layouts and material handling
3. Product design
4. Process design
5. Production and planning control
6. Quality control
7. Materials management
8. Maintenance management.

Location of facilities for operations is a long-term capacity decision which involves a long term commitment about the geographically static factors that affect a business organization. It is an important strategic level decision-making for an organization. It deals with the questions such as 'where our main operations should be based?'

Plant layout refers to the physical arrangement of facilities. It is the configuration of departments, work centers and equipment in the conversion process. The overall objective of the plant layout is to design a physical arrangement that meets the required output quality and quantity most economically.

According to James Moore, "Plant layout is a plan of an optimum arrangement of facilities including personnel, operating equipment, storage space, material handling equipments and all other supporting services along with the design of best structure to contain all these facilities".

"Material Handling' refers to the 'moving of materials from the store room to the machine and from one machine to the next during the process of manufacture'. It is also defined as the 'art and science of moving, packing and storing of products in any form'. It is a specialized activity for a modern manufacturing concern, with 50 to 75% of the cost of production.

Product design deals with conversion of ideas into reality. Every business organization have to design, develop and introduce new products as a survival and growth strategy. Developing the new products and launching them in the market is the biggest challenge faced by the organizations.

Process design is a macroscopic decision-making of an overall process route for converting the raw material into finished goods. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities.

Production planning and control can be defined as the process of planning the production in advance, setting the exact route of each item, fixing the starting and finishing dates for each item, to give production orders to shops and to follow up the progress of products according to orders. Planning is deciding in advance what to do, how to do it, when to do it and who is to do it. Planning bridges the gap from where we are, to where we want to go. Routing may be defined as the selection of path which each part of the product will follow, which being transformed from raw material to finished products. Scheduling determines the programmer for the operations. Scheduling may be defined as 'the fixation of time and date for each operation' as well as it determines the sequence of operations to be followed.

Dispatching is concerned with the starting the processes. It gives necessary authority so as to start a particular work, which has already been planned under 'Routing' and 'Scheduling'.

Quality Control (QC) may be defined as 'a system that is used to maintain a desired level of quality in a product or service'. It is a systematic control of various factors that affect the quality of the product. Quality control aims at prevention of defects at the source, relies on effective feed back system and corrective action procedure. Quality control can also be defined as 'that industrial management technique by means of which product of uniform acceptable quality is manufactured'. It is the entire collection of activities which ensures that the operation will produce the optimum quality products at minimum cost.

The main objectives of quality control are: To improve the companies income by making the production more acceptable to the customers i.e., by providing long life, greater usefulness, maintainability, etc. To reduce companies cost through reduction of losses due to defects. To achieve interchange ability of manufacture in large scale production. To produce optimal quality at reduced price. To ensure satisfaction of customers with productions or services or high quality level, to build customer goodwill, confidence and reputation of manufacturer. To make inspection prompt to ensure quality control. To check the variation during manufacturing.

Materials management is that aspect of management function which is primarily concerned with the acquisition, control and use of materials needed and flow of goods and services connected with the production process having some predetermined objectives in view.

The main objectives of materials management are:

- To minimize material cost.

- To purchase, receive, transport and store materials efficiently and to reduce the related cost.
- To cut down costs through simplification, standardization, value analysis, import substitution, etc.
- To trace new sources of supply and to develop cordial relations with them in order to ensure continuous supply at reasonable rates.
- To reduce investment tied in the inventories for use in other productive purposes and to develop high inventory turnover ratios.

Nature of Operation Management

a) **Increase Productivity:** Operation management played an important role in increasing the productivity of business. It manages all aspects of production activities to achieve highest efficiency possible. Operation managers are responsible for designing production plans for carrying out the operations. They ensure that all inputs used by organisations are efficiently transformed into outputs that are products or services. It is crucial for all businesses to properly manage their day to day activities and efficient utilisation of all its resources which helps in raising productivity.

- **Raises Revenue:** Operational management directly influences the profitability of the business. It works on reducing the cost of operations to business by reducing the wastage of resources. Operations managers monitor every production activity and take all necessary steps for maintaining efficiency in the organisation. They try to maintain an appropriate balance between cost and revenue. Maintenance of quality of products and delivering them as per customer needs is another function played by these operation

managers. It helps in attracting more and more customers which increase the overall revenue of business.

- **Achievement Of Organisation Goals:** Every organisation strives towards achievement of its desired goals. Proper management of production activities helps businesses to properly implement their strategic plans in their operation. Operation management ensures that all operations of business are going in the desired direction.
  It regularly monitors every activity and takes all corrective measures as required according to prevailing situations. Proper functioning of business as per strategic plans helps in achievement of desired goals.

- **Improve Customer Satisfaction:** Customer satisfaction is necessary for every business to improving its relations with its customers. It helps them in retaining them for the long term. Operation management monitors the quality of products manufactured by organisations. It ensures that high-quality products are produced in accordance with the requirements of customers. When products manufactured by business completely fulfil the needs of customers, their satisfaction level will improve.

- **Reduce Investment Need:** Operation management reduces the additional capital requirements of the business. It ensures that all capital employed in the business are efficiently used. Management of operations ensures that all production activities go uninterrupted without any shortage of capital. By increasing the efficiency and avoiding the wastage of employed resources, it avoids any

deficiency of capital in business. Businesses are not required to invest more in their production activities.

- **Enhance Goodwill:** Maintaining proper goodwill in the market is the goal of every business. Operation management focuses on improving the position of the organisation in the market. It ensures that business works for providing better services to its customers. Business should manufacture durable and high-quality products that may provide better satisfaction to users. Customers will gain confidence in their products which will improve their market image.

- **Improve Innovation:** Operation management helps in implementing innovative changes in organisational activities. All decision regarding production planning is taken by operation managers by doing research and analysis of prevailing market situations. It takes into account all technological changes and builds a strong base of knowledge and operations. This helps in bringing various innovations in operations of the business.

Functions of Production management

Selection Of Products And Its Design

Production management helps the firm in selection of proper products and design. Selection of the right product and its proper design is important for the survival of every business in the market. It performs several research programs to understand the wants of customers. Proper knowledge of customer requirements helps the firm in deciding the right product. After choosing a

product, its proper design is selected to ensure that customer needs are fully satisfied at a lower cost.

Production Planning And Control

Planning and monitoring production activities are quite important for every business. Production management keeps an eye on each and every activities and element associated with production operations. It decides in advance what to produce and in how much quantity, then decides process for production, sets the starting and completion dates for production activities. It designs an exact plan route in advance and implements that in operations to ensure timely delivery of orders. Production managers monitor all production activities and take all necessary activities as and when required.

Location Of Facilities

Selection of proper location for setting production facilities is a must for ensuring smooth functioning. It is a long term capital decision which affects the business organisation in the long run. Production management properly analyse the area before setting up production plants and other facilities of business. It takes into account various geographical and other factors to ensure the availability of raw materials, enough employees and various infrastructural facilities.

Machines Maintenance And Replacement

Production management plays a significant role in the maintenance of machinery and plant. Proper functioning of machinery is important for uninterrupted production. Production management process focuses on continuous routine inspection of machines, performs regular cleaning and oiling, removal and replacement of any obsolete and damaged equipment's. All these

steps taken by production management prevent any machinery breakdown and avoid any production halts.

Enhances Goodwill And Reputation Of Business

Goodwill and image of a business is a key element in attracting and retaining customers. Production management helps the business in improving its goodwill by properly satisfying customer needs. Production management ensures that the right quality products at the right cost are delivered to customers at the right cost. This increase the overall confidence and satisfaction level of customers.

Helps In Facing Competition

Production management helps the business is facing stiff competition in the market. It properly analyzes the market requirements and competitors activities before planning for production activities. All strategies are framed and implemented in accordance with the situations of the market. It ensures that a firm produces the right product in the right quantity, at the right time and provides it to the customer at the right cost. Customers' needs are given prime importance by production management. This will helps in facing the competition easily.

Helps In Expansion And Growth

Expansion and growth are the ultimate aims of every business. Production management supports the business in its expansion and growth. It aims at increasing the profitability of the business by decreasing the overall operating cost. This process ensures optimum utilisation of all resources. Production monitors operations of every department of business and takes all corrective measures as and when required. High-profit earnings by business help in expanding its operations and growing its size.

Functions of material management

The functions of material management have been classified into two categories as well, namely, the primary functions and secondary functions. These functions assist in the accomplishment of the aforesaid basic, and primary and secondary objectives of material management.

Primary Functions

The primary functions of material management are required to meet the primary objectives

a) **Material Requirement Planning (MRP):** Material Requirements Planning (MRP) is a computer-based production planning and inventory Control system. MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required Materials are available when needed. MRP is applicable in situations of multiple items with complex bills of materials. MRP is not useful for job shops or for continuous processes that are tightly linked.

The major objectives of an MRP system are to simultaneously:

- Ensure the availability of materials, components, and products for planned production and for Customer delivery,
- Maintain the lowest possible level of inventory,
- Plan manufacturing activities, delivery schedules, and purchasing activities.

MRP is especially suited to manufacturing settings where the demand of many of the components and subassemblies depend on the demands of items that face external demands. Demands for end items are independent. In contrast, demand for components used to manufacture end items depend on the demands for the end items. The distinctions between independent and dependent demands are important in classifying inventory items and in developing systems to manage items within each demand classification. MRP systems were developed to cope better with dependent demand items. The three major inputs of an MRP system are the master production schedule, the product structure records, and the inventory status records. Without these basic inputs the MRP system cannot function.

b) **Inventory Arrangement and Control:** In the cosmopolitan world of today, the inventory arrangement would mean the purchase of materials to be stored before entering the production stage or sold out, such that the stock cost is zero. There are three kinds of inventories: a) raw material, b) purchased goods, and c) finished components. Their inventory control is the responsibility of the materials management department, production department and the sales department. It is always important to ensure that inventory at different levels is maintained, the raw materials are available at each level and that there is proper flow of materials from one production facility to another at all levels in a manufacturing firm.

c) **Continual and effective flow and supply of materials:** The required material by all production centers and other departments should be ensured for its continuity in flow and supply by the material management department. Many times, low or zero inventories lead to stock-outs and halts in production. Importer or lack of material handling tools can also lead to hurdles in material supplies. Alternately options or emergency supply

systems can be deployed to ensure continuity in production lines. Fluctuations in both demand and production capacity are the critical factors. To keep pace with changing demands and perceptions of consumers, the management needs to maintain continuity in productions and control the flow of materials supply and distributions at different production facilities and other related departments in an organization.

d) **Material Quality Control:** The quality of the finished products manufactured will depend upon the quality of raw material used to manufacture those products. Therefore, the purchase of the right quality of materials is indeed very important. The quality of materials can be measured through proper inspection, specification, quality control, simplification and standardization. The components and parts can be assured for reliability by their size and dimensions within tolerance limits.

e) **System Efficiency:** This function ascertains the efficiency of the system being used. If the system used for materials management is inept of faulty, the above objectives cannot be met, irrespective of the procedure adopted. For things to be maintained in an effective manner as planned for managing materials, an effective control ought to be there for every single process in the department. The Management Information Systems (MIS) and a feedback control mechanism should be adopted at every stage to organise the management and employees' performance and achieve best results.

Secondary Functions

The secondary objectives can only be fulfilled through the following key secondary functions of the materials management:

a) **Standardization and Generalization:** The design and the technical department of an organization, which comes after the production department process, determine the standards and specifications of different types of materials. The term 'standard' encompass the alterations in sizes and variety, the quality and the exchangeability of components and products. Standard and generalization (or simplification) ensures proper utilization of materials and diminishes wastage. Standard materials can also be availed at economic costs. It also aids the purchasing department in selecting the materials and the vendors from whom they need to be purchased. If there is lesser variety of materials to be bought and stored, it saves on both the kinds of investors as well as the costs of transporting those inventories to the stores. Manufacturing a standard product ensures overall cost of production.

b) **Product Design and Development:** The product sales can be boosted with its range and functionality. With the help of the advanced technology such as computer such as Computer Aided Design (CAD), the product can be designed different with a variety of options and yet a fast pace. Another technology development in manufacturing is the computer Aided Manufacturing (CAM) that can bring both a variety as well as flexibility to a product. The materials management department shall then perform as per the use of the ranges of material and produce variety of components and hence, ensure the delivery of such material.

c) **Manufacturing and Purchase Decisions:** The manufacturing and purchase decisions are a part of the management's policy decisions. The organization's capacity and other facilities developed to produce a range of items should be the prime objective and is the most important planning

activity of every organization. However, when an organization grows rapidly, its sales also increases at the same pace and this is when it comes critically important to take a decision on whether the organization must buy the parts or expand its facilities to keep pace with the rising demand and sales. This is also a key decision for the materials management department and aides in the selection of vendors such that the items can be purchased at reduced prices. The manufacturing and buying decisions can be largely influenced by material assessment, its availability, procurement, alternate material selection and inventory control functions, and are taken on the basis of the cost economics and cost-benefit analysis developed by the organization by use of existing and future production capacity of skills, labour and available machines in the factory.

d) **Material Coding and Classification:** One of the important functions of materials management, the material coding and classification provides support to the production and purchasing department of an organization. The materials are classified through a simple yet standard method, such as ABC Analysis, to manufacture the product or sell various goods. This method is used by many organizations for the purposes of classifying and storing materials, which are identified by their codes and nomenclatures. The coding methods should be used by every firm to keep a check on the range of materials, their quantities and costs.

e) **Estimation and Planning:** The MRP can be implemented through accurate estimates of sales and demand for products in the industry. Market fluctuations should be given due consideration to make any production control. The materials management department can make use of one of the methods of forecasting that gives productive results to the

organization. Predicting the future demand of sales helps in the planning of materials supply.

Production

Production can be explained as an act of either manufacturing or mining or growing of goods (commodities) generally in bulk for trade.

Production is a method employed for making or providing essential goods and services for consumers. It is a process that puts intangible inputs like ideas, creativity, research, knowledge, wisdom, etc. in use or action. It is a way that transforms (convert) tangible inputs like raw-materials, semi-finished goods and unassembled goods into finished goods or commodities.

System

System is an arrangement or assembly of inter-dependent processes (activities) that are based on some logic and function. It operates as a whole and is designed (build) with an intention to achieve (fulfill) some objective or do some work. Huge systems are often a collection (assembly) of smaller sub-systems.

Production system consists of three main components viz., Inputs, Conversion

Process and Output.

- Inputs include raw: Materials, machines, man-hours, components or parts, drawing, instructions and other paper works.
- Conversion process includes operations (actual production process). Operations may be either manual or mechanical or chemical. Operations convert inputs into output. Conversion process also includes supporting activities, which help the process of conversion. The supporting activities

include; production planning and control, purchase of raw-materials, receipt, storage and issue of materials, inspection of parts and work-in-progress, testing of products, quality control, warehousing of finished products, etc.

- Output includes finished products, finished goods (parts), and services.

The three components of a production system are depicted in this diagram.

Hence, we can say that, production system is a union or combination of its three main components viz., Inputs, Conversion Process, and Output. In short, everything which is done to produce goods and services or to achieve the production objective is called a production system.

Examples

The examples of a production system are as follows:

Tangible goods: Consider an example of a manufacturing industry like a Sugar Industry. Here, sugarcane is first used as an input, then the juice of sugarcane is processed through a conversion process, finally to get an output known as a refined sugar (used for mass consumption).

Intangible goods: Consider an example from a service industry that of a software-development firm or company. Here, initially, written program codes are used as an inputs. These codes are then integrated in some database and are

provided with a user-friendly interface through a conversion process. Finally, an output is made available in form of an executable application program.

Types of Production System:

There are mainly two main production systems:

Continuous Production System

- Mass Production System
- Process Production System

Intermittent Production System

- Job Production
- Batch Production
- Continuous Production System

This is the first or primary type of production system and it means it involves a continuous or almost continuous physical flow of material. It makes use of special purpose machines and produces standardized items in large quantities.

Such processes are adopted by the concern which produces goods or services continuously by putting them through a series of successive connected operations in anticipation of customer demand and rather than in response to customers or orders.

Examples are: Examples of an industry using such technology are:

- **Petroleum Industry**
- **Chemicals Industry**
- **Steel and Sugar Industry**

Classification of Continuous Production System:

Mass Production System

This system of production is used by concerns where manufacturing is carried on continuously in anticipation of demand through the demand of the product may not be uniform through the year.

Standardization is the keynote of mass production. This system may also be called 'Flow Production System'.

Process Production System

This system is an extended form of mass production where production is carried on continuously through a uniform predetermined sequence of operations.
Generally under this system finished product of one process is used in the next process as a raw material until the last process. Large industries like petroleum refining, heavy chemical industries generally use this system of production.
Under this system, generally, one principal raw material is transformed into several products at different stages of operations. For Example- Crude oil is processed into kerosene, gasoline, and other products.

Intermittent Production System

Intermittent Production System situations are those where the facilities must be flexible enough to handle a wide variety of products and sizes or where the basic nature of activity imposes changes of important characteristics the input.
Under this system of manufacturing production is done in lots rather than on a continuous flow of basis. It is done more often on the basis of customer orders.

The finished product is heterogeneous but within a range of standardized options assembled by the producers.

This type of production system is based on the nature of the proper management system.

Examples of such industries are:

- Auto-Mobile Industry
- Electrical Goods
- Manufacturing plants Printing press etc.

Classification of Intermittent Production System

Intermittent Production System may be divided into two types:

Job Production

In this system, goods are produced according to the orders of the customers. Continuous demand for such items is not assured and therefore production is done only when the orders for the manufacturing of items are produced from the customers.

Batch Production

Under this system, the manufacturing is done in batches or groups or lots either on the basis of customer's order or with a hope of a continuous demand of the product. Under this system, medium scale production is warranted. The best example of this type of production system is the chemical industry where different medicines are produced in batches.

FORECASTING

Forecasting refers to the practice of predicting what will happen in the future by taking into consideration events in the past and present. Basically, it is a decision-making tool that helps businesses cope with the impact of the future's uncertainty by examining historical data and trends. It is a planning tool that enables businesses to chart their next moves and create budgets that will hopefully cover whatever uncertainties may occur.

QUANTITATIVE METHODS

The quantitative forecasting approach can be broken up into 4 different methods:

a) **Naive Approach:** Looking at what happened in the previous sales period and saying that'll happen again. (i.e. I sold 100 widgets last sales period, therefore I'm going to sell 100 widgets again.)
b) **Moving Averages:** Taking the average of previous sales periods and applying it to upcoming periods (i.e. If the average of the last 3 sales periods is 130, then the next period will be in that range.)
c) **Exponential Smoothing:** Taking a weighted average approach when looking at moving averages. (i.e. If i'm selling ice cream I may weight January-March differently than July-September.)
d) **Trend Projection:** What is the trajectory, based on our data, of what will to happen. (i.e. If we are increasing every period we should raise the forecast. Or, maybe we have 2 increases, a small decrease, and another

increase so we should adjust the forecast to gradually increase accordingly.)

We're going to look at each of these methods in individual videos and then we'll talk about linear regression and how to think about it when forecasting.

QUALITATIVE METHODS

The qualitative forecasting approach can also be broken up into 4 different methods:

a) **Executive Opinion:** A group of executives making a decision on what will happen in the next period. (i.e. The CEO, COO, VP of Sales, and VP of marketing meet to decide, based on their experience, where the company sales are headed.)

b) **Delphi Method:** Trusted advisors in the industry give an opinion about what they believe will happen, then another group compiles and interprets the analysis to give to decision makers.(i.e. A group of experts decide how many widgets they would buy or how many they think will be sold in different markets and then sends that to an internal group within a company to interpret and, in turn, relay to the company decision makers.)

c) **Sales Force Estimates:** Individual sales people make their own sales forecasting estimates based on their experience selling the product. (i.e. the sales team believes they will close a deal this month with a large retail company so the forecast is adjusted to reflect that.)

Disciplines involved in Facilities Planning

Facilities Planning (FP) has been very popular. It is a complex and a broad subject. Within the engineering profession:

- civil engineers,
- electrical engineers,
- industrial engineers,
- mechanical engineers are involved in FP.

Additionally,

- Architects,
- Consultants,
- general contractors,
- managers,
- real estate brokers,
- urban planners are involved in FP.

FACILITY LAYOUT PLANNING

For an organization to have an effective and efficient manufacturing unit, it is important that special attention is given to facility layout. Facility layout is an arrangement of different aspects of manufacturing in an appropriate manner as to achieve desired production results. Facility layout considers available space, final product, safety of users and facility and convenience of operations.

An effective facility layout ensures that there is a smooth and steady flow of production material, equipment and manpower at minimum cost. Facility layout

looks at physical allocation of space for economic activity in the plant. Therefore, main objective of the facility layout planning is to design effective workflow as to make equipment and workers more productive.

Facility Layout Objective

A model facility layout should be able to provide an ideal relationship between raw material, equipment, manpower and final product at minimal cost under safe and comfortable environment. An efficient and effective facility layout can cover following objectives:

- To provide optimum space to organize equipment and facilitate movement of goods and to create safe and comfortable work environment.
- To promote order in production towards a single objective
- To reduce movement of workers, raw material and equipment
- To promote safety of plant as well as its workers
- To facilitate extension or change in the layout to accommodate new product line or technology upgradation
- To increase production capacity of the organization

An organization can achieve the above-mentioned objective by ensuring the following:

- Better training of the workers and supervisors.
- Creating awareness about of health hazard and safety standards
- Optimum utilization of workforce and equipment
- Encouraging empowerment and reducing administrative and other indirect work

Factors affecting Facility Layout

Facility layout designing and implementation is influenced by various factors. These factors vary from industry to industry but influence facility layout. These factors are as follows:

- The design of the facility layout should consider overall objectives set by the organization.
- Optimum space needs to be allocated for process and technology.
- A proper safety measure as to avoid mishaps.
- Overall management policies and future direction of the organization

Design of Facility Layout

Principles which drive design of the facility layout need to take into the consideration objective of facility layout, factors influencing facility layout and constraints of facility layout. These principles are as follows:

- **Flexibility:** Facility layout should provide flexibility for expansion or modification.
- **Space Utilization:** Optimum space utilization reduces the time in material and people movement and promotes safety.
- **Capital:** Capital investment should be minimal when finalizing different models of facility layout.

Design Layout Techniques

There are three techniques of design layout, and they are as follows:

1. **Two or Three Dimensional Templates:** This technique utilizes development of a scaled-down model based on approved drawings.
2. **Sequence Analysis:** This technique utilizes computer technology in designing the facility layout by sequencing out all activities and then arranging them in circular or in a straight line.
3. **Line Balancing:** This kind of technique is used for assembly line.

Principles of Plant Layout

1. **Principle of integration:** A good layout is one that integrates men, materials, machines and supporting services and others in order to get the optimum utilization of resources and maximum effectiveness.

2. **Principle of minimum distance:** This principle is concerned with the minimum travel (or movement) of man and materials. The facilities should be arranged such that, the total distance travelled by the men and materials should be minimum and as far as possible straight line movement should be preferred.

3. **Principle of cubic space utilization:** The good layout is one that utilizes both horizontal and vertical space. It is not only enough if only the floor space is utilized optimally but the third dimension, i.e., the height is also to be utilized effectively.

4. **Principle of flow:** A good layout is one that makes the materials to move in forward direction towards the completion stage, i.e., there should not be any backtracking.

5. **Principle of maximum flexibility:** The good layout is one that can be altered without much cost and time, i.e., future requirements should be taken into account while designing the present layout.

6. **Principle of safety, security and satisfaction**: A good layout is one that gives due consideration to workers safety and satisfaction and safeguards the plant and machinery against fire, theft, etc.

7. **Principle of minimum handling:** A good layout is one that reduces the material handling to the minimum

Objectives of Plant Layout

The primary goal of the plant layout is to maximize the profit by arrangement of all the plant facilities to the best advantage of total manufacturing of the product.

The objectives of plant layout are:

1. Streamline the flow of materials through the plant.
2. Facilitate the manufacturing process.
3. Maintain high turnover of in-process inventory.
4. Minimize materials handling and cost.
5. Effective utilization of men, equipment and space.
6. Make effective utilization of cubic space.
7. Flexibility of manufacturing operations and arrangements.
8. Provide for employee convenience, safety and comfort.
9. Minimize investment in equipment.
10. Minimize overall production time.

11. Maintain flexibility of arrangement and operation.
12. Facilitate the organizational structure.

TYPES OF LAYOUT

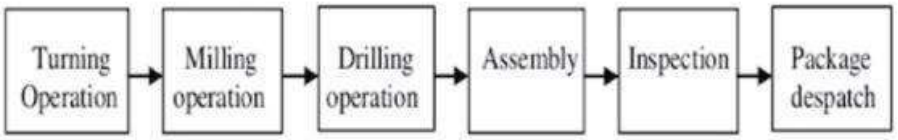
There are mainly four types of plant layout:

(a) Product or line layout
(b) Process or functional layout
(c) Fixed position or location layout
(d) Combined or group layout

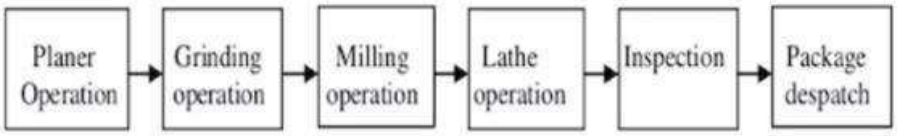
PRODUCT OR LINE LAYOUT

In this type of layout the machines and equipments are arranged in one line depending upon the sequence of operations required for the product. It is also called as line layout. The material moves to another machine sequentially without any backtracking or deviation i.e the output of one machine becomes input of the next machine. It requires a very little material handling. It is used for mass production of standardized products.

Product A



Product B



Advantages of Product layout

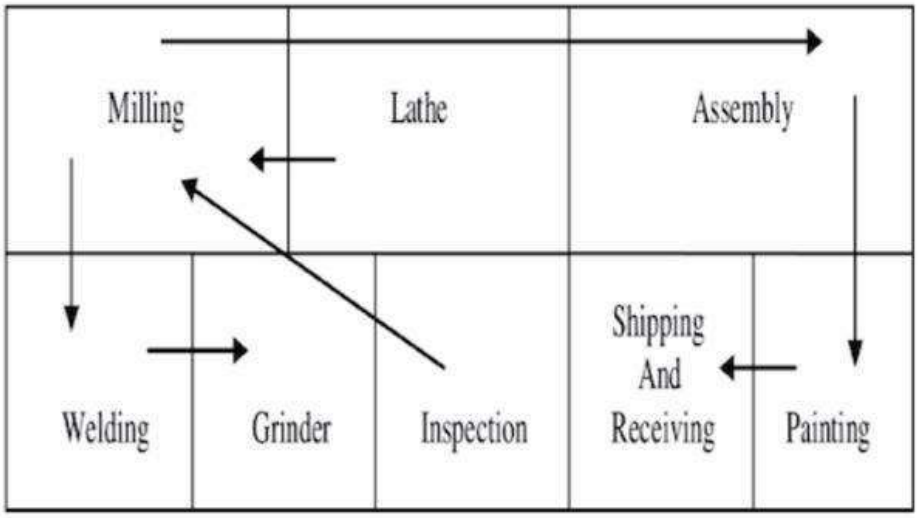
1. Low cost of material handling, due to straight and short route and absence of backtracking
2. Smooth and continuous operations
3. Continuous flow of work
4. Lesser inventory and work in progres
5. Optimum use of floor space
6. Simple and effective inspection of work and simplified production control
7. Lower manufacturing cost per unit

Disadvantages of Product layout

1. Higher initial capital investment in special purpose machine (SPM)
2. High overhead charges
3. Breakdown of one machine will disturb the production process.
4. Lesser flexibility of physical resources.

PROCESS LAYOUT

In this type of layout the machines of a similar type are arranged together at one place. This type of layout is used for batch production. It is preferred when the product is not standardized and the quantity produced is very small.



Advantages of Process layout:

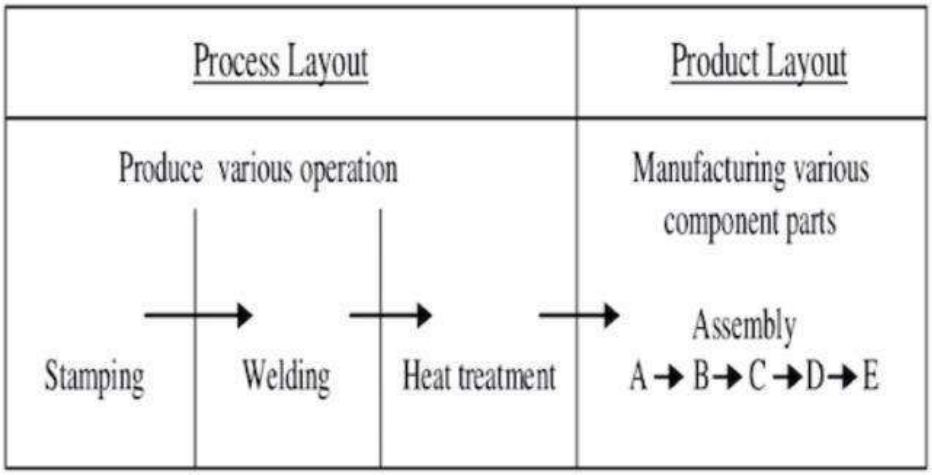
1. Lower initial capital investment is required.
2. There is high degree of machine utilization, as a machine is not blocked for a single product
3. The overhead costs are relatively low
4. Breakdown of one machine does not disturb the production process.
5. Supervision can be more effective and specialized.
6. Greater flexibility of resources.

Disadvantages of Process layout:

1. Material handling costs are high due to backtracking
2. More skilled labour is required resulting in higher cost.
3. Work in progress inventory is high needing greater storage space
4. More frequent inspection is needed which results in costly supervision

COMBINED LAYOUT

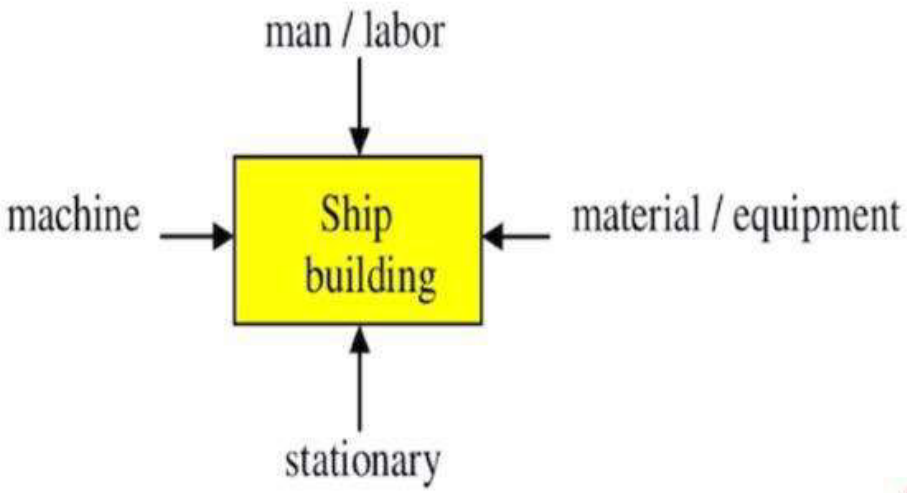
A combination of process & product layout is known as combined layout. Manufacturing concerns where several products are produced in repeated numbers with no likelihood of continuous production, combined layout is followed



FIXED POSITION OR LOCATION LAYOUT

Fixed position layout involves the movement of manpower and machines to the product which remains stationary. The movement of men and machines is advisable as the cost of moving them would be lesser. This type of layout is preferred where the size of the job is bulky and heavy. Example of such type of layout is locomotives, ships, boilers, generators, wagon building, aircraft manufacturing, etc.

The following figure shows a fixed position layout regarding ship building :



CELLULAR MANUFACTURING LAYOUTS

Cellular Manufacturing is a lean manufacturing approach that helps companies build a variety of products for their customers with as little waste as possible. In cellular manufacturing, equipment and workstations are arranged in a sequence that supports a smooth flow of materials and components through the process, with minimal transport or delay.

One piece flow is a condition that exists when products move through a manufacturing process one unit at a time, at a rate determined by the needs of the customer. The opposite of one piece flow is mass production with batches and queues. One piece flow focuses on flow efficiency rather than on resource efficiency.

Applying one piece flow allows to:

- Minimize stocks and thereby reduce transport and inventory wastes
- Deliver quicker
- Minimize damage, deterioration and obsolescence.

Factors influencing layout changes

a) **Nature of the product:** The nature of the product to manufacture will significantly affect the layout of the plant. The stationary layout will be most suitable for heavy products while line layout will be best for the manufacture of light products because small and light products can move from one machine to another very easily and, therefore, more attention can pay to machine locations and handling of materials.

b) **The volume of Production:** The volume of production and the standardization of the product also affect the type of layout. If standardized commodities are to manufacture on a large scale, the line type of layout may adopt. If production is made on the order of the customers, the functional layout is better to adopt.

c) **Basic managerial policies and decisions:** The type of layout depends very much on the decisions and policies of the management to follow in producing a commodity with regard to size of plant, kind and quality of the product; scope for expansion to provide for, the extent to which the plant is to integrate, amount of stocks to carry at any time, the kind of employee facilities to provide, etc.

d) **Nature of plant location:** The size, shape, and topography of the site at which plant is located will naturally affect the type of layout to follow because of the maximum utilization of space available. For example, if a site is near the railway line the arrangement of general layout for receiving and shipping and for the best flow of production in and out the plant may make by the side of the railway line. If space is narrow and the production process is lengthy.

Type of industry process

This is one of the most important factors influencing the choice of the type of plant layout. Generally, the types of layout particularly the arrangement of machines and work centers and the location of workmen varies according to the nature of the industry to which the plant belongs.

For layout, the industry may classify into two broad categories:

Intermittent, and. Continuous.

Intermittent type of industries is those which manufacture different components or different machines. Such industries may manufacture the parts when required according to the market needs. Examples of such industries are shipbuilding plants. In this type of industry functional layout may be the best. The second type of industry in "continuous" industry. In this type of industrial raw materials are fed at one end and the finished goods are received at another end. A continuous industry may either be analytical or synthetically. As the analytical industry breaks up the raw material into several parts during the production process or changes its form, e.g. oil and sugar refineries. A synthetic industry, on the other hand, mixes the two or more materials to manufacture one product along with the process of production or assembles several parts to get the finished product. Cement and automobile industries are examples of such industry. Line layout is more suitable in continuous process industries.

Types of methods of production: Layout plans may be different according to the method of production proposed to adopt. Any of the following three methods may

- adopt for production
- Job order production
- Batch production, and
- Mass Production

Under job production goods are produced according to the orders of the customers and therefore, specifications vary from customer to customer and the production cannot standardize. The machines and equipment can arrange in a manner to suit the need of all types of customers. Batch production carries the production of goods in batches or groups at intervals. In this type of manufacturing the product standardizes and production makes generally in anticipation of sales. Such cases, functional or process layout may adopt. In the case of mass production of standardized goods, line layout is the most suitable

form of plant layout.

Nature of machines: Nature of machines and equipment also affects the layout of the plant. If machines are heavy or create noisy atmosphere, stationary layout may reasonably adopt. Heavy machines are generally fixed on the ground floor. Ample space should provide for complicate machines to avoid accidents.

Climate: Sometimes, temperature, illumination, and air are the deciding factors in deciding the location of machines and their establishments. For example, in the lantern manufacturing industry, the spray painting room is built along the

factory wall to ensure the required temperature control and air expulsion and then the process of spray painting may undertake.

Nature of Materials: Design and specifications of materials, physical and chemical properties of materials, quantity, and quality of materials and combination of materials are probably the most important factors to consider in planning a layout. So, materials storage and materials handling should give due consideration. For materials storage factors such as rate of consumption of raw materials, space, volume and weight of raw materials, floor load capacity, ceiling height method of storing should give special consideration. This will affect the space and the efficiency of the production process in the plant. It will facilitate economic production goods and prompt materials flow and a soundly conceived materials handling system.

Type of machine and equipment:

Machines and equipment may be either a general-purpose or special purpose. Also, certain tools are used. The requirements of each machine and equipment are quite different in terms of their space, speed and material handling process and these factors should give proper consideration while choosing out a particular type of layout. It should also consider that each machine and equipment use to its fullest capacity because machines involve a huge investment. For instance, under product layout, certain machines may not use to their full capacity so care should take to make full use of the capacity of the machine and equipment.

Human factor and working conditions: Man is the most important factor of production and therefore special consideration for their safety and comforts

should give while planning a layout, specific safety items like the obstruction-free floor, workers not exposed to hazards, exit, etc. should provide for. The layout should also provide for the comforts to the workers such as the provision of restrooms, drinking water, lavatory, and other services, etc. Sufficient space is also to provide for the free movement of workers. For this, provisions of the Factories Act should follow strictly.

Characteristics of the building: The shape of building, covered and open area, number of stories, facilities of elevators; parking area, storing place and so on also influence the layout plan. In most of the cases where the building hires. The layout is to adjust within the space available in the building. Although minor modifications may finish suiting the needs of the plant and equipment. But if the new building is to construct, proper care should give to construct it according to the layout plan drawn by experts. The special type of construction needs to accommodate huge or technical or complex or sophisticated machines and equipment. It is clear from the above description that several factors are considered while choosing out a plan for plant layout. Because they affect the production and its cost to a great extent.

LEAN OPERATIONS

Lean operations is a business strategy driven by the principle of doing more with less. It is a minimalist approach to running a business and improving day-to-day operations.

In other words, lean operations is all about putting a little Marie Kondo-like efficiency into your workflows.

Importance of Lean Operations Important

Running a business as efficiently as possible may seem like an obvious goal, but even the more prolific business leaders can easily get bogged down in the day-to-day operations. It's easy to forget to take a step back and take stock of the organization on a more holistic level.

Without a deep dive into an organization's supply chain, companies often fall into one of five operational "traps" that can be difficult to overcome:

- Overproduce items
- Hold onto too much inventory
- Incur cost overages
- Experience unproductive downtime
- Have employees duplicating tasks

By improving internal processes, a company is better positioned to offer value to its customers through its products or services.

Optimizing internal functions has a number of business benefits:

- Improves workflow efficiency
- Creates an agile workforce able to pivot and adapt to new models of operating
- Eliminates waste
- Reduces operating expenditures and yields greater profits
- Enables long term operational viability
- Facilitates more sustainable solutions
- Boosts value proposition

Two Lean Operations Examples

Henry Ford first coined the phrase "flow production." He was a pioneer in linear production, creating steps that followed a sequence that came to be known as the assembly line. Since then, companies have adopted that strategy to achieve higher quality production with a simpler, more efficient lean systems operations management approach.

Toyota

The Japanese automobile manufacturer might be the most famous lean operations case study out there, driven by the principle of kaizen—a belief in continuous improvement. Since the company was founded, leadership has sought ways to constantly evolve and better workflows that result in a quality vehicle. They called it the Toyota Production System.

Toyota's workflows do not expend excess energy or use materials unnecessarily. Instead, driven by the "Just in Time" method, production lines make only what they need, as they need it, allowing workers to focus on one car at a time.

Toyota has become so well known for its TPS approach that they created the Toyota Production System Support Center, a non-profit that helps small businesses benefit from the same lean principles they operate by.

Nike

While Nike's brand recognition is unparalleled in the athletic shoe world, its quest to deliver a great product hinges on its dedication to creating value through continuous improvement of its internal structure and processes.

Nike achieves lean operations through specific goal-setting that aligns its entire enterprise to its mission and products. From supply chain management to HR

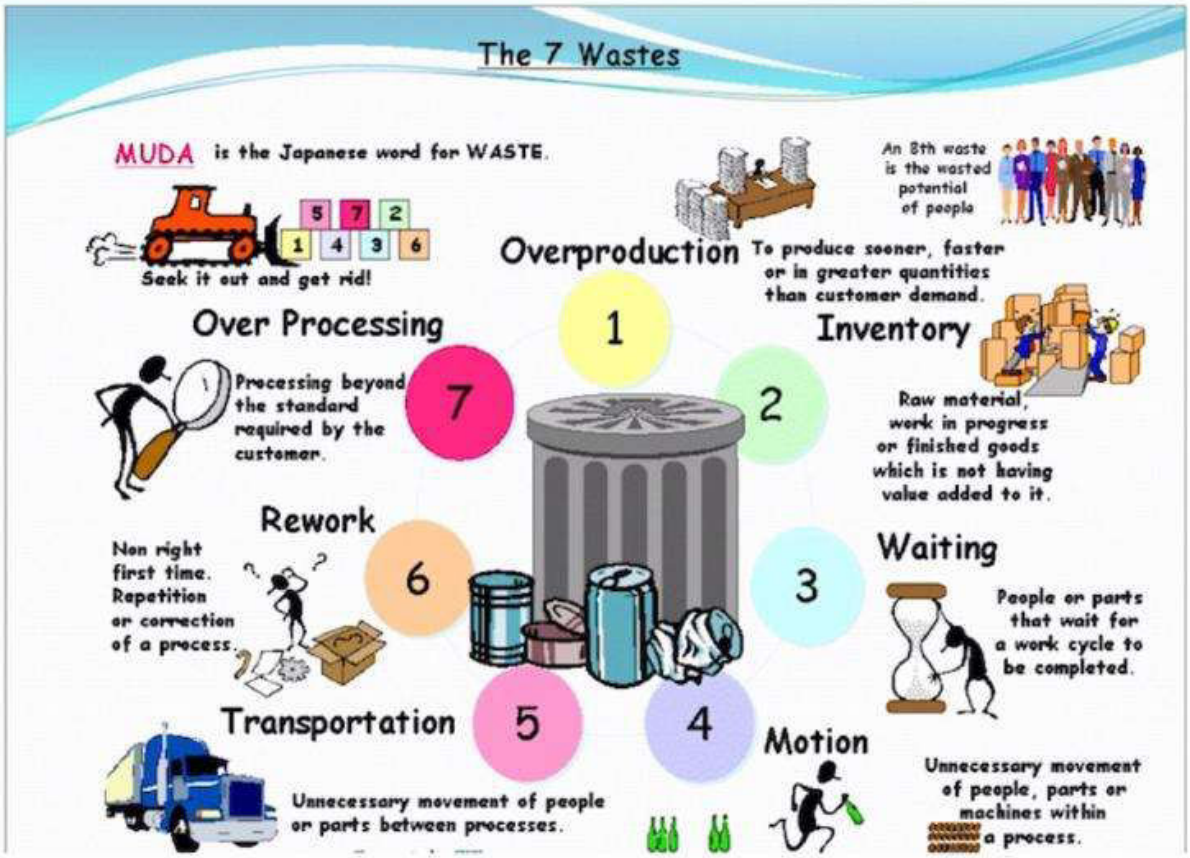
processes, Nike regularly audits its various internal components. As a result Nike has decreased CO2 emissions 6% while increasing output by 20%. Through lean operations, Nike has created long term marketplace stability and decreased product defects by 50%.

7 Wastes of Lean Manufacturing

The seven wastes of Lean Manufacturing are what we are aiming to remove from our processes by removing the causes of Mura and Muri as well as tackling Muda directly. But what exactly are the seven wastes of Lean Manufacturing (or 7 Mudas)

The Seven Wastes of Lean Manufacturing are;

- Transport
- Inventory
- Motion
- Waiting
- Over-Processing
- Overproduction
- Defects

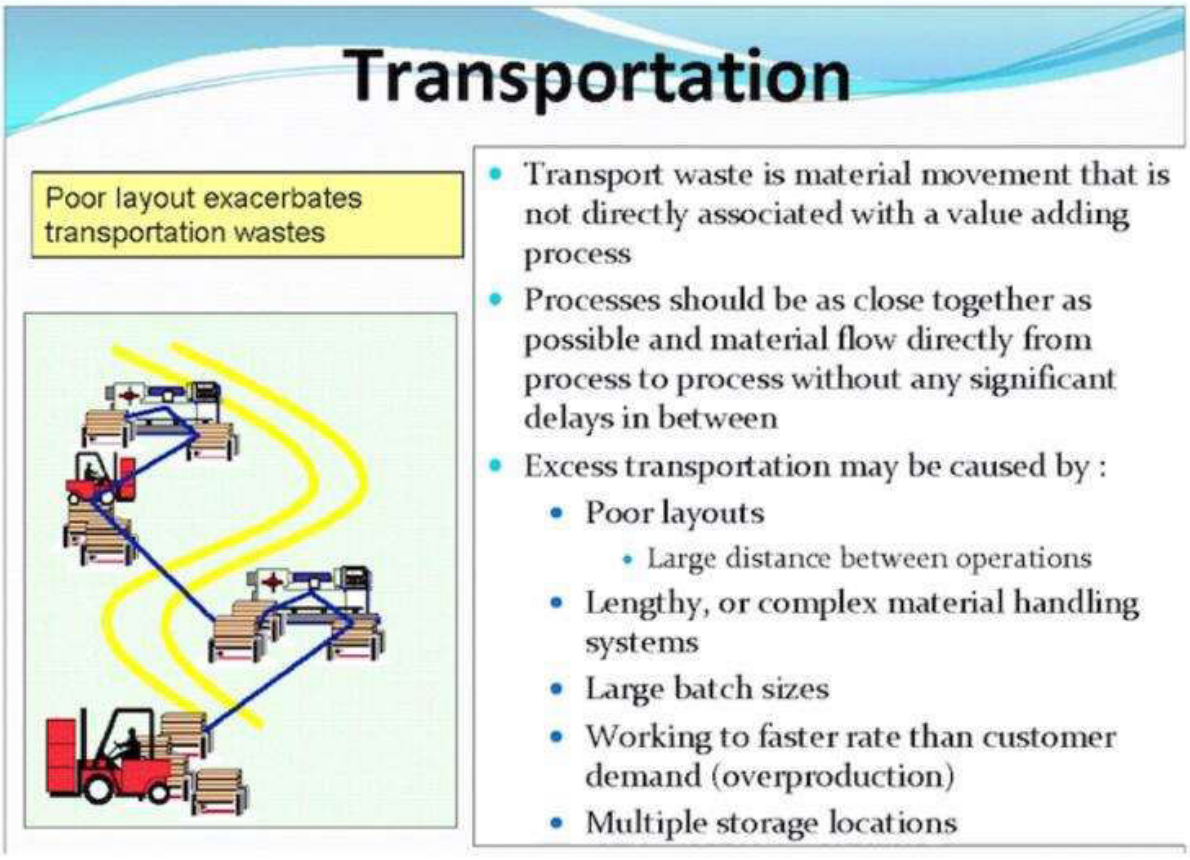


Waste

Waste can be defined as any production activity that utilizes resources but does not add any value for the customer. Since these wastes add to the cost of products, they either reduce the profit the manufacturer makes or inflate the price that the customer needs to pay. In general, customers are not willing to pay for these activities because they do not benefit from them. Therefore, eliminating waste presents a great opportunity for businesses to cut costs and improve efficiency. When speaking about waste, lean experts usually refer to seven specifically. These include: transportation, inventory, motion, waiting, over processing, overproduction, and defects. Elimination of these seven kinds of waste can help companies reduce costs, increase employee engagement and

customer happiness, and increase profits. The lean management and continuous improvement philosophy (Kaizen) attempt to decrease as much waste as possible.

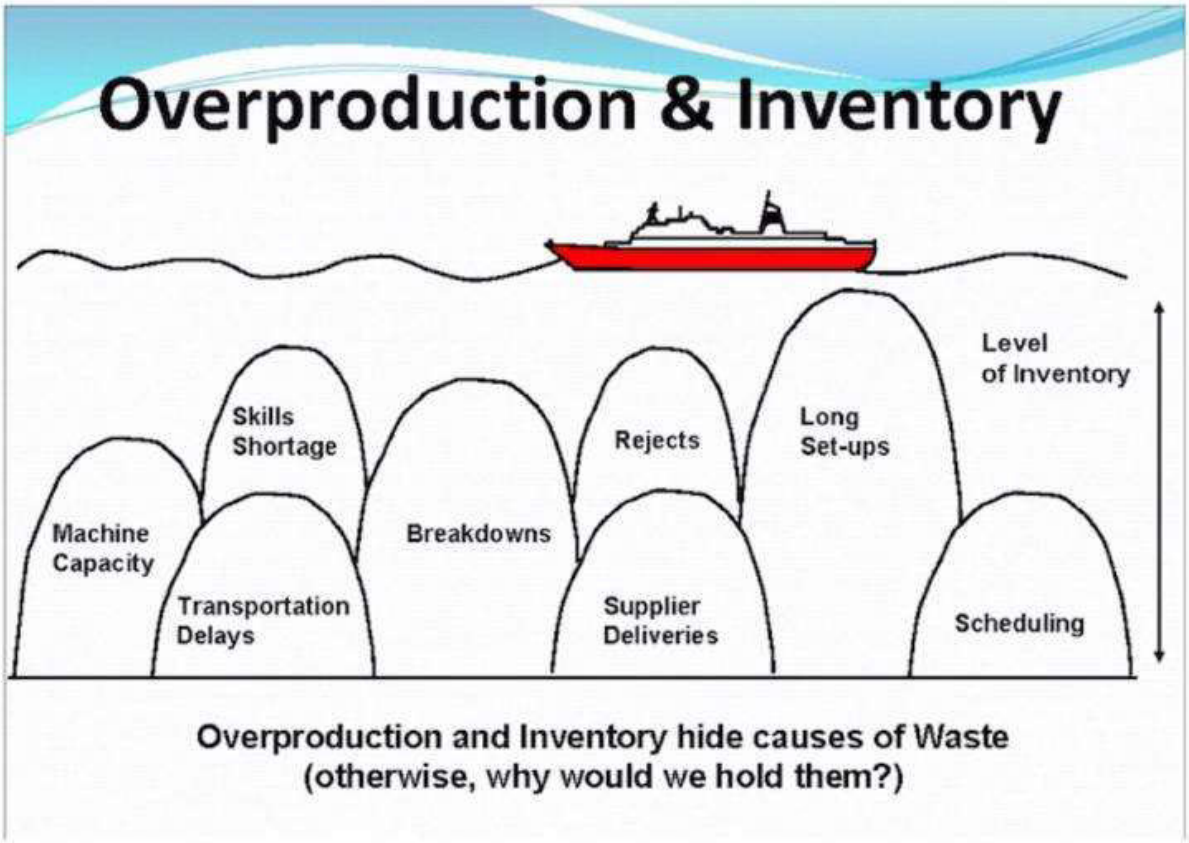
The Waste of Transport



Transportation waste, unnecessary movement or excess motion of products from one place to another adds no value, uses up capital and space. Lean manufacturing reduces the amount of handling required to support any given process and minimises the distances between points such as the loading bay, lineside or workstation so that less time and space is utilised. Adaptable carts

and trolleys can be used for handling specific products that can be modified if the items change. The 'muda' of transportation also applies to the workforce. Your team should be stationed at appropriate points to complete their job, that means no excess walking or waiting for parts; a great solutions for this is to implement shadow tool boards or ergonomic workstations that can be adapted to individual work requirements.

The Waste of Inventory



Align production to demand so that products leave the factory (and are invoiced) as soon as they are ready. Deliveries of raw materials are arranged to coincide with when they are needed at the lineside. At the most extreme this means taking

deliveries of supplies just-in-time straight to the lineside to minimise handling costs and eliminate storage needs.

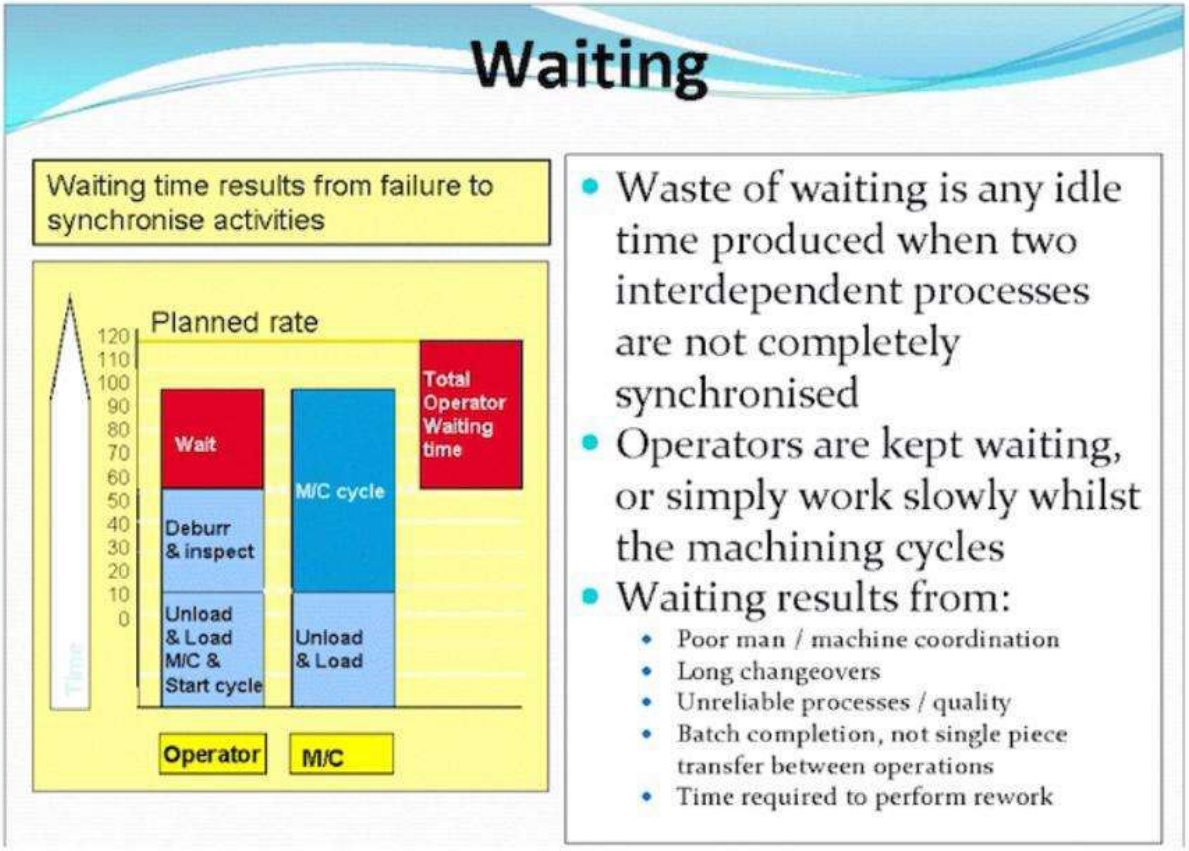
Shortening production lead times and reducing handling and storage tasks releases capital and cash. Reduce waste by using adaptable carts and trolleys designed to carry precise numbers of specific items to the lineside and modular parts supermarkets positioned at the lineside, replenished frequently when stocks fall below predetermined levels. This prevents excess inventory. In practice, many companies operate small buffer warehouses that feed the lineside, allowing them to combine the economy of scale benefits of batch deliveries with the super-efficiency of just-in-time lineside replenishment.

The Waste of Motion

Eliminate unnecessary movement in the working area to reduce the time taken to complete a task.

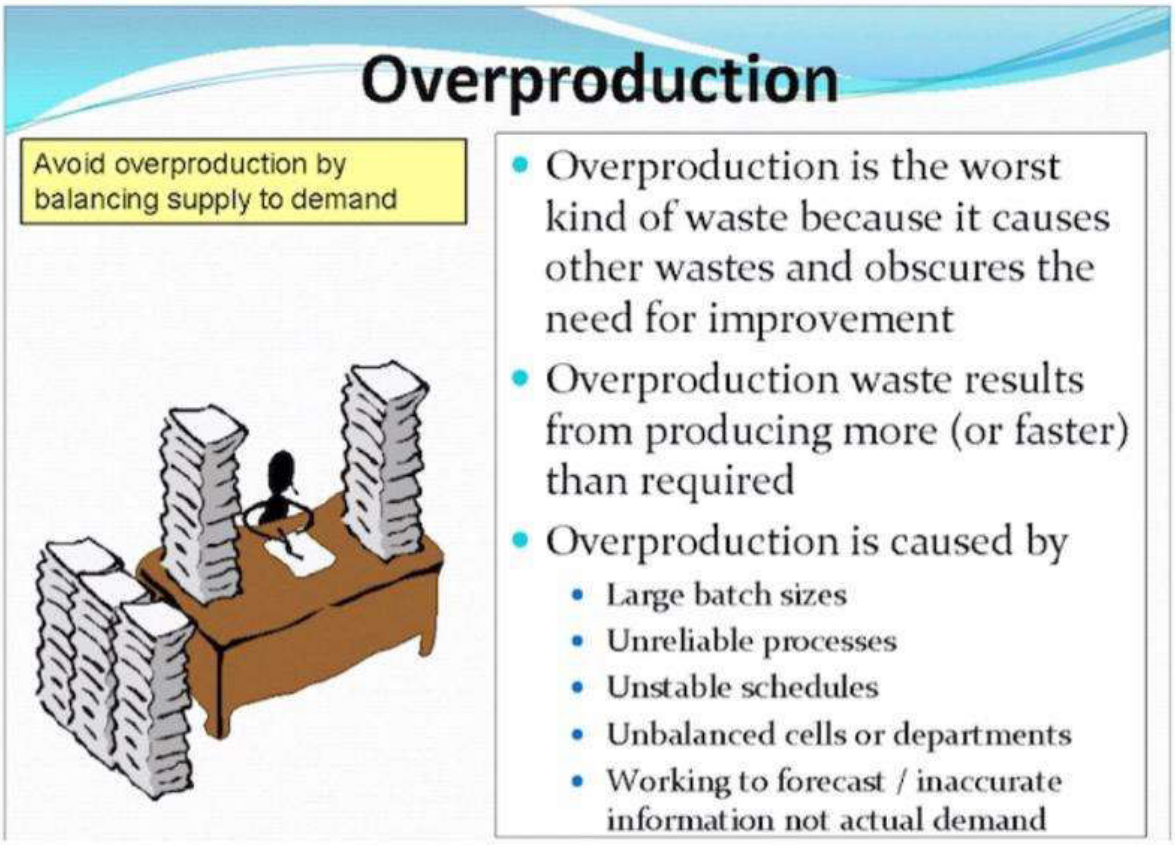
Workstations and storage areas should be designed ergonomically so that items are close to hand whenever they are needed and so avoid time-consuming steps and movements to fetch or reach for them. Production staff have fewer distractions and are then less likely to make mistakes which helps improve quality and productivity.

The Waste of Waiting



The waste of waiting. Production staff waste time spent waiting for replenishment if they run out of components. Lean manufacturing aims to ensure a steady flow of items to the line side, not too many and certainly not too few, to allow production to continue without interruptions. Installing lineside parts supermarkets which are replenished regularly helps avoid the problem. Larger items can be brought to the lineside or workstation when they are needed using adaptable kitting trolleys.

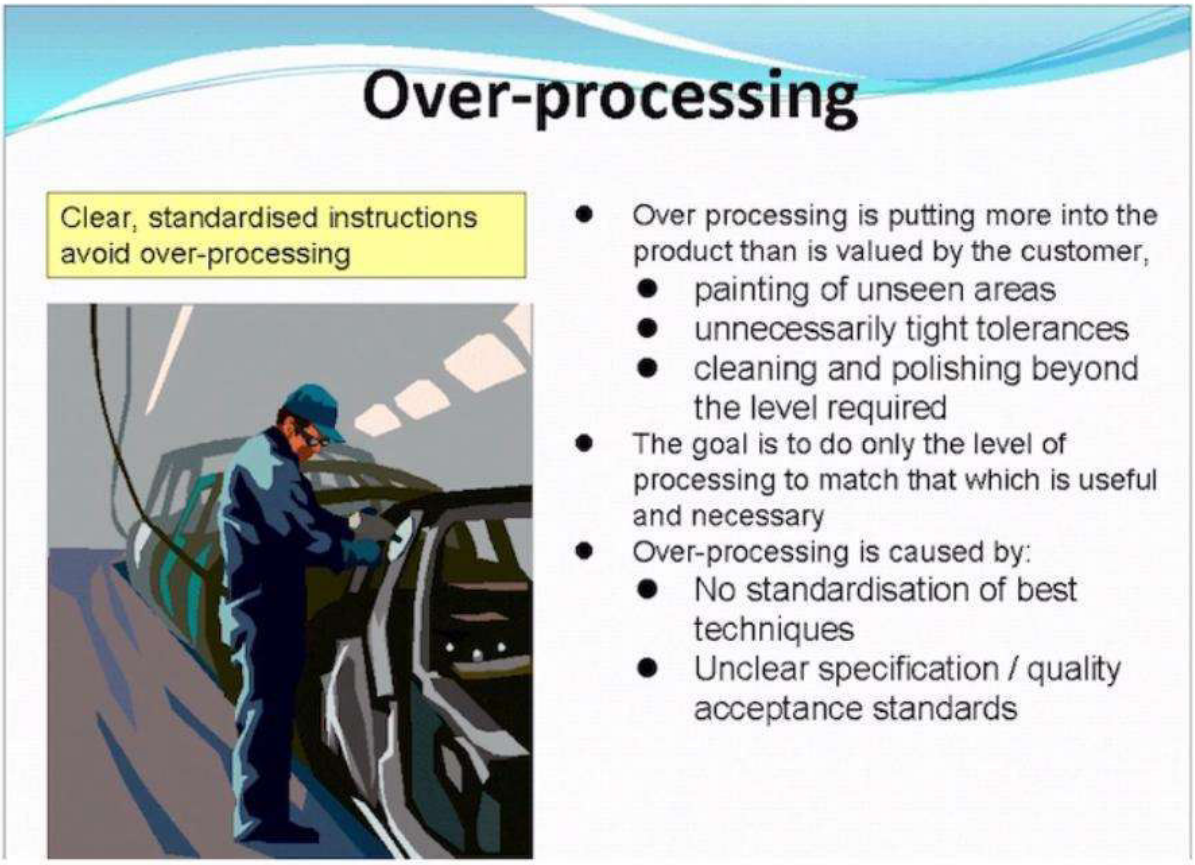
The waste of Overproduction



Overproduction occurs when manufacturing schedules are misaligned with demand.

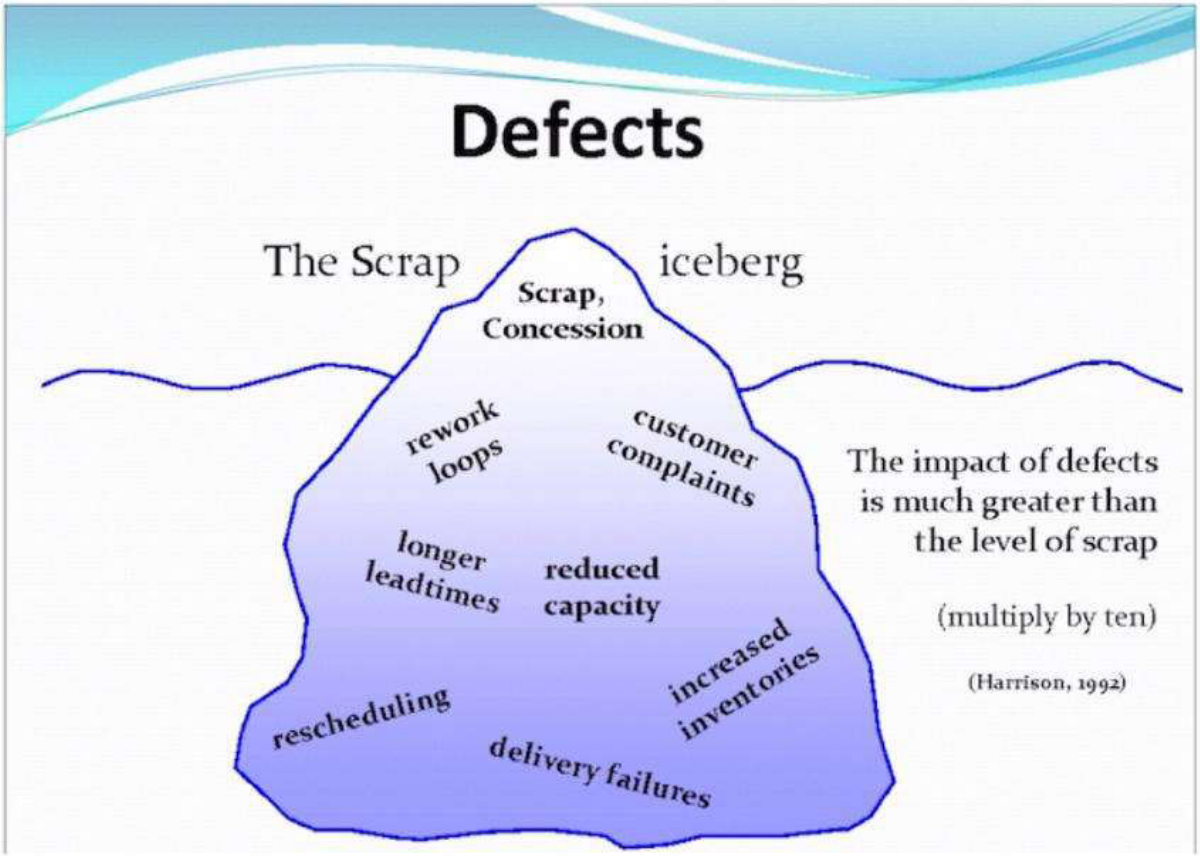
Introducing customer-focused "pull" scheduling through use of just-in-time or Kanban principles helps ensure that products are produced to the customer's specification when they are needed. Adaptable parts supermarkets and the use of carts, trolleys and trains to supply the production line or cell promote flexibility and enable production to be modified very quickly to match changing customer demand.

The Waste of Over-processing



Any task that can be eliminated without affecting the production of an item is wasteful. For example, using small front-picked containers reduces the length of the production line, optimises pick paths, reduces flow costs and saves time. Making an installation smaller generally makes it less expensive to build in the first place.

The Waste of Defects



Defects cost time and money. Returned items must be fixed and this affects customer perceptions and service. Disposing of rejects adds more cost. The easiest solution is to avoid making bad products. Adaptable ergonomic workstations matched to the specific process can be designed and built where components, assemblies and tools are in the correct position and easy to reach. This makes the working area much more efficient and staff are more productive and less stressed or fatigued which means they are less likely to make mistakes and damage items. Reduce defects with our lean solutio

MODULE 5

Quality Management

Quality management is the act of overseeing all activities and tasks that must be accomplished to maintain a desired level of excellence. This includes the determination of a quality policy, creating and implementing quality planning and assurance, and quality control and quality improvement.In general, quality management focuses on long-term goals through the implementation of short-term initiatives.

Principles of Quality Management

1. **Customer Focus:** This standard is associated with customer needs and customer service. Business should understand their customers and try to find ways to fulfil their requirements. Where possible, they should aim to surpass customer expectations. In this way, company can increase customer loyalty, increase revenue due to the ability to find new customer opportunities and increase effectiveness of processes related to customer satisfaction.

2. **Leadership:** This standard is linked with the direction of the organisation. Company's business should have clear objectives and workers should be actively involved to accomplish these goals. It will assist the company to enhance motivation of employee engagement. Numerous researches have shown that if employees are involved in

making a business vision they are likely to be more prolific.

3. **Involvement of people:** This principle identifies that company staff has great significance and that their abilities should be used for business success. This will enable the company to enhance employee enthusiasm and increase innovation.

4. **Process Approach:** The process approach relates to efficiency and the understanding that appropriate processes will speed up activities.

5. **System approach to management:** ISO define that identifying, understanding and managing interrelated processes as a system, contributes to the organisation's effectiveness and efficiency in achieving its objectives. This means that manifold processes are managed together as a system which should lead to greater efficiency. This allows a business to focus their efforts on the processes for success as well as supporting complementary processes for improved efficiency.

6. **Continual improvement:** Continual improvement should be an active business objective. It will increase ability to hold new opportunities, organisational flexibility and improved performance.

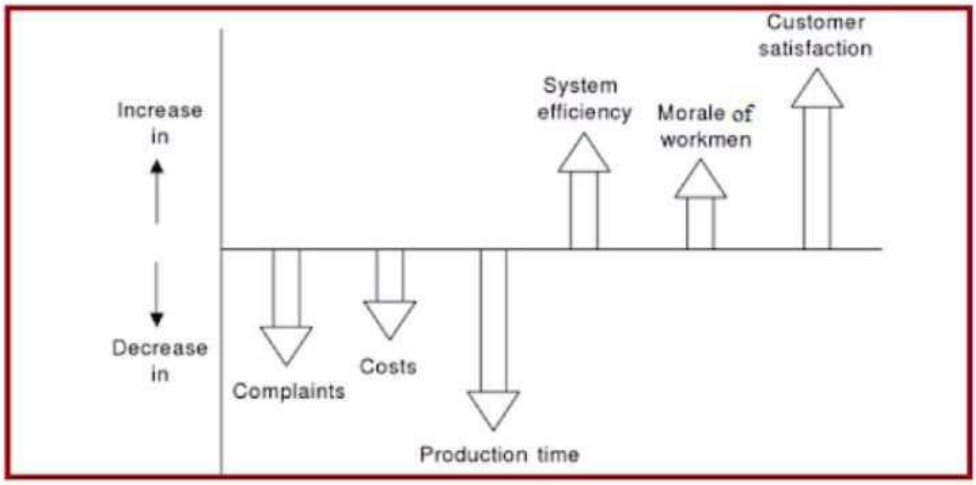
7. **Realistic approach to decision making:** A logical approach, based on data and analysis, is good business sense. Informed decisions lead to improved understanding of the marketplace as data is collated and analysed, and the ability to defend past decisions.

8. **Mutually beneficial supplier relations:** This standard relates to supply chains and acknowledges that the relationship between an organisation

and its suppliers is interdependent. A strong relationship between the two will augment productivity and encourage seamless working practices.

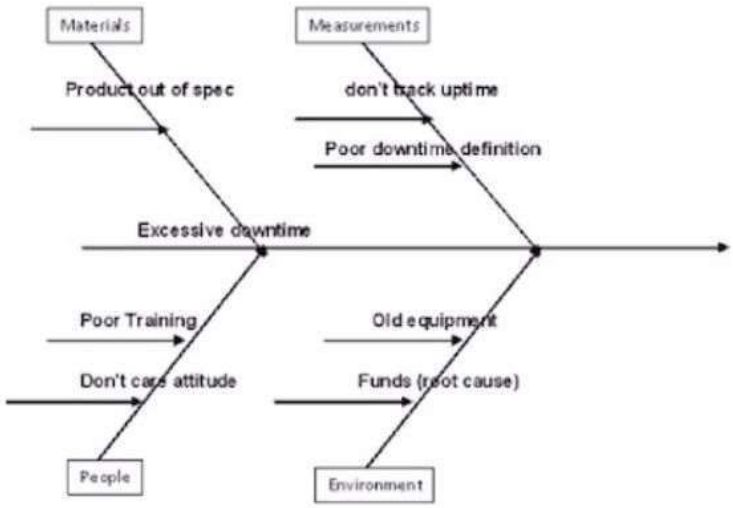
Benefits of Quality Management

Quality management has numerous advantages. At international level, many industries, service organizations, and educational institutes have implemented quality system. These organizations get many advantages such as reduction in complaints from customers both internal and external, decrease in cost of the product, reduction in cost of production time, increased system efficiency, increased morale of workman, increased customer satisfaction.



Quality Management Tools And Techniques

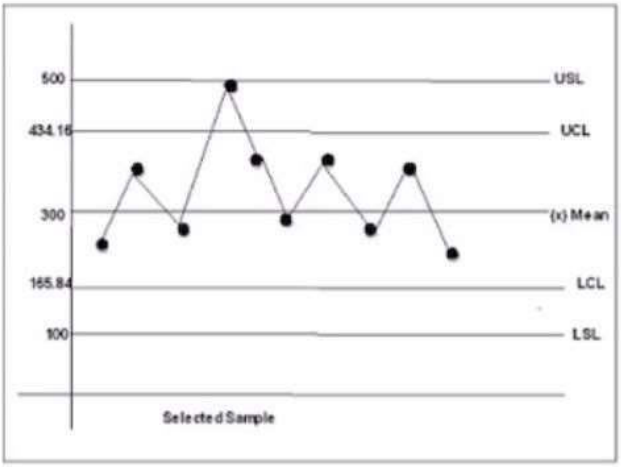
Cause and effect diagram



Cause and Effect Diagram

Cause and effect diagram is very helpful to find the root cause of the defect. Cause-and-effect diagrams show the relationship between the results of problems and the root cause of these problems. This diagram shows all the primary and secondary causes of a problem and the effect of all the proposed solutions. This Ishikawa diagram is also called fishbone diagram due to its fish-like shape. In the above diagram: poor training, old equipment, funds are the causes and "Excessive downtime" is the effect

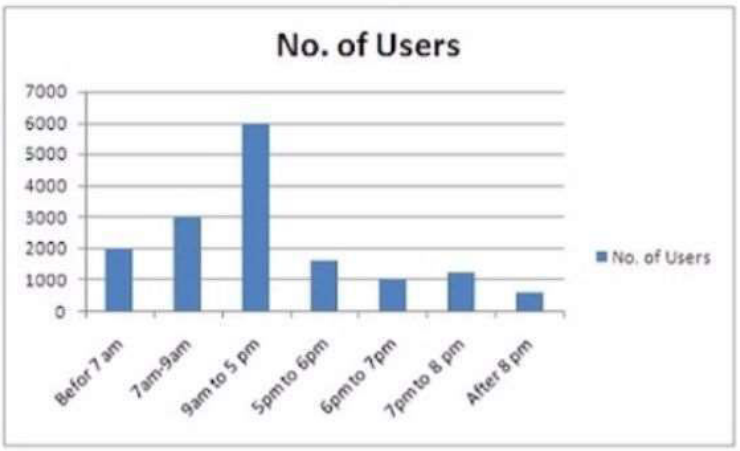
Control Charts



Control charts measure the results of processes over time and display the results in the form of a graph. By using control charts one can determine whether process variances are in control or out of control. A control chart is works on sample variance measurements, from the samples chosen and measured, the mean and standard deviation are determined.

Let's assume from a sample you have determined the measurement that mean is 300 and the standard deviation equals 44.72. Three standard deviations on either side of the mean become your upper and lower control points on this chart. In this case 3 standard deviations is equal to 300 +- (134.16). Therefore, if all control points fall within plus or minus three standard deviations on either side of the mean, the process is in control. If points fall outside the acceptable limits, the process is not in control and corrective action is needed. UCL and LCL are Upper control limit and lower control limit respectively. USL and LSL are upper specification limit and lower specification limit.

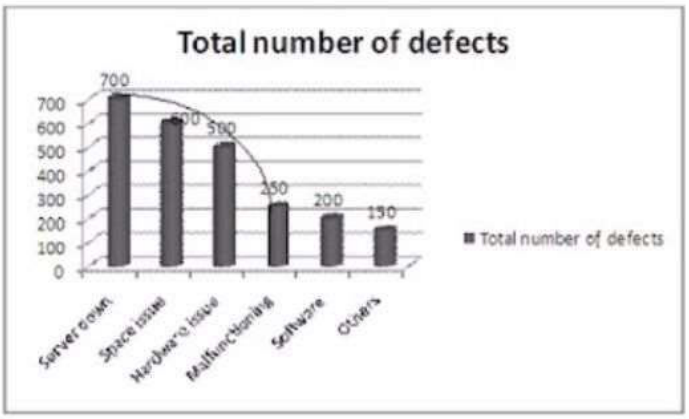
Histogram



Histograms are a type of bar charts that depict the distribution of variables over time. This represents the distribution by mean. This graph may take different shapes based on the condition of the distribution. Histogram can be used to measure something against time i.e. the graph is plotted with a variable on x-axis and time on the y-axis.

Consider the following example: The following histogram shows number of hits on the company's website in different time of the day. The x-axis shows the number of users or customers active on the website and the y-axis shows the time of the day.

Pareto chart



Pareto observed that 80 percent of issues occur due to 20% reasons. Over the years, others have shown that the 80/20 rule applies across many disciplines and areas. So it was a good idea to identify and focus on that category of defects which covers the maximum portion. It is a special form of vertical bar chart and used to identify the first few major sources responsible for the problem. In the figure below the total no. of defects are plotted against the reasons for those defects. The problems are rank-ordered according to their frequency and percentage of defects. By doing this ordering it is easier for you to identify the primary areas for corrective action.

Flowchart

Flowcharts are logical steps in a logical order so as to accomplish an objective. Flow charts are drawn with the use of geometrical objects like rectangular, rhombus, parallelogram, activities, decision points to in a process. Flowcharting can help identify where quality problems might occur on the project and how problems happen. There are different software tools in the market today for drawing flow charts, such as MS Visio.

The quality policy is a guideline created by the top management that describes what quality policies should be adopted by the project team, in line with other companies. These tools and techniques are very helpful for a project manager to understand it and incorporate it and deliver a quality product.

CHECK SHEET

Also called: defect concentration diagram

A check sheet is a structured, prepared form for collecting and analyzing data. This is a generic data collection and analysis tool that can be adapted for a wide variety of purposes and is considered one of the seven basic quality tools.WHEN TO USE A CHECK SHEET :

- When data can be observed and collected repeatedly by the same person or at the same location
- When collecting data on the frequency or patterns of events, problems, defects, defect location, defect causes, or similar issues
- When collecting data from a production process

CHECK SHEET EXAMPLE

Telephone Interruptions

Reason	Day					
	Mon	Tues	Wed	Thurs	Fri	Total
Wrong number	𝍸	||	|	𝍸	𝍸||	20
Info request	||	||	||	||	||	10
Boss	𝍸	||	𝍸||	|	||||	19
Total	12	6	10	8	13	49

SCATTER DIAGRAM

Also called: scatter plot, X-Y graph

The scatter diagram graphs pairs of numerical data, with one variable on each axis, to look for a relationship between them. If the variables are correlated, the points will fall along a line or curve. The better the correlation, the tighter the points will hug the line. This cause analysis tool is considered one of the seven basic quality tools.WHEN TO USE A SCATTER DIAGRAM

- When you have paired numerical data
- When your dependent variable may have multiple values for each value of your independent variable
- When trying to determine whether the two variables are related, such as:
    - When trying to identify potential root causes of problems
    - After brainstorming causes and effects using a fishbone diagram to determine objectively whether a particular cause and effect are related
    - When determining whether two effects that appear to be related both occur with the same cause
    - When testing for autocorrelation before constructing a control chart

SCATTER DIAGRAM PROCEDURE

Collect pairs of data where a relationship is suspected.

Draw a graph with the independent variable on the horizontal axis and the dependent variable on the vertical axis. For each pair of data, put a dot or a symbol where the x-axis value intersects the y-axis value. (If two dots fall together, put them side by side, touching, so that you can see both.)

Look at the pattern of points to see if a relationship is obvious. If the data clearly form a line or a curve, you may stop because variables are correlated. You may wish to use regression or correlation analysis now. Otherwise, complete steps 4 through 7.

Divide points on the graph into four quadrants. If there are X points on the graph:

Count X/2 points from top to bottom and draw a horizontal line.

Count X/2 points from left to right and draw a vertical line.

If number of points is odd, draw the line through the middle point.

Count the points in each quadrant. Do not count points on a line.

Add the diagonally opposite quadrants. Find the smaller sum and the total of points in all quadrants.

A = points in upper left + points in lower right

B = points in upper right + points in lower left

Q = the smaller of A and B

N = A + B

Look up the limit for *N* on the trend test table.

If Q is less than the limit, the two variables are related.

If Q is greater than or equal to the limit, the pattern could have occurred from random chance.

Table 5.18 Trend test table.

N	Limit	*N*	Limit
1–8	0	51–53	18
9–11	1	54–55	19
12–14	2	56–57	20
15–16	3	58–60	21
17–19	4	61–62	22
20–22	5	63–64	23
23–24	6	65–66	24
25–27	7	67–69	25
28–29	8	70–71	26
30–32	9	72–73	27
33–34	10	74–76	28
35–36	11	77–78	29
37–39	12	79–80	30
40–41	13	81–82	31
42–43	14	83–85	32
44–46	15	86–87	33
47–48	16	88–89	34
49–50	17	90	35

SCATTER DIAGRAM EXAMPLE

The ZZ-400 manufacturing team suspects a relationship between product purity (percent purity) and the amount of iron (measured in parts per million or ppm). Purity and iron are plotted against each other as a scatter diagram, as shown in the figure below.

There are 24 data points. Median lines are drawn so that 12 points fall on each side for both percent purity and ppm iron.

To test for a relationship, they calculate:

A = points in upper left + points in lower right = 9 + 9 = 18

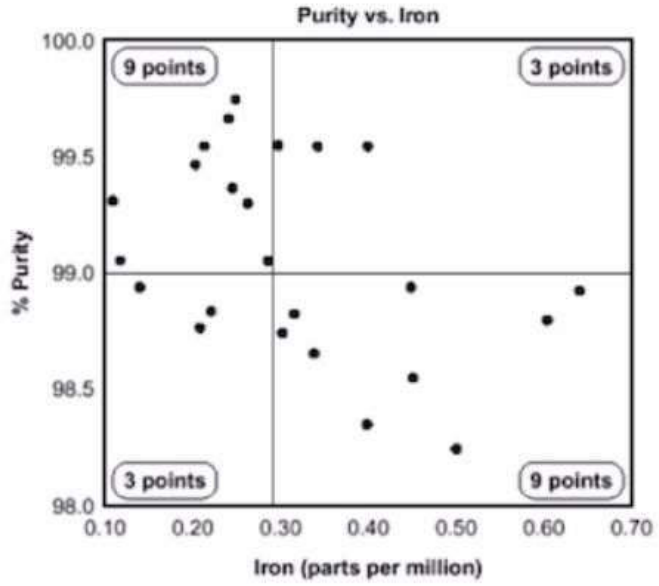
B = points in upper right + points in lower left = 3 + 3 = 6

Q = the smaller of A and B = the smaller of 18 and 6 = 6

N = A + B = 18 + 6 = 24

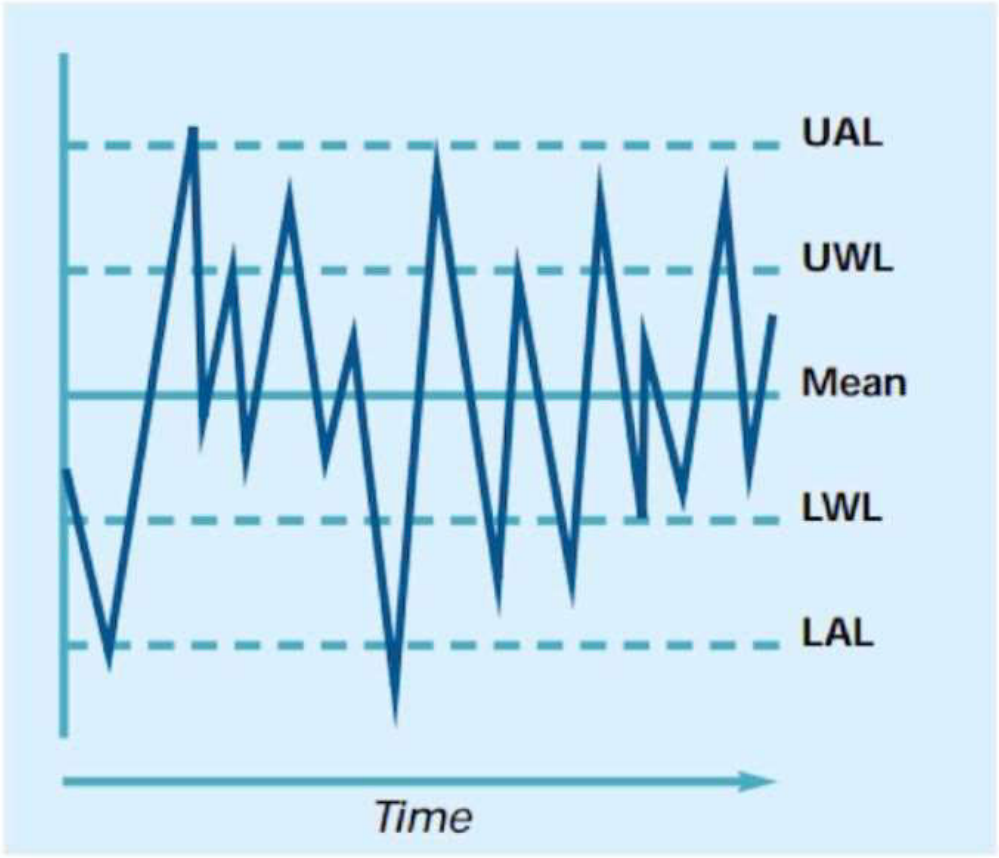
Then they look up the limit for N on the trend test table. For N = 24, the limit is 6.

Q is equal to the limit. Therefore, the pattern could have occurred from random chance, and no relationship is demonstrated.



Scatter Diagram Example

Statistical Process Control (SPC)



Statistical Process Control (SPC) is a toolkit for managing processes. It is also a strategy for reducing the variability in products, deliveries, materials, equipment, attitudes and processes, which are the cause of most quality problems. SPC will reveal whether a process is "in control" – stable and exhibiting only random variation, or "out of control" and needing attention. It also automatically warns when performance deteriorates, and can assist with long-term defect reduction, identification of special or assignable causes, reduction or elimination of causes of variation and achievement of a level of performance as close to target as possible.

In SPC, numbers and information form the basis for decisions and actions, and a thorough data recording system is essential. In addition to the tools necessary for recording the data, there also exists a set of tools to analyse and interpret the data, some of which are covered in the following pages. An understanding of the tools and how to use them requires no prior knowledge of statistics. One of the key tools of SPC is a Control Chart. It is used to monitor processes that are in control, using means and ranges. It represents data, e.g, sales, volume, customer complaints, in chronological order, showing how the values change with time. In a control chart each point is given individual significance and is joined to its neighbours. Above and below the mean, Upper and Lower Warning and Action lines (UWL, LWL, UAL, LAL) are drawn. These act as signals or decision rules, and give operators information about the process and its state of control. The charts are useful as a historical record of the process as it happens, and as an aid to detecting and predicting change.

TOTAL QUALITY MANAGEMENT (TQM) MODEL

Definition of TQM

Total Quality Management is defined as a customer-oriented process and aims for continuous improvement of business operations. It ensures that all allied works (particularly work of employees) are toward the common goals of improving product quality or service quality, as well as enhancing the production process or process of rendering of services. However, the emphasis is put on fact-based decision making, with the use of performance metrics to monitor progress.

The key principles of Total Quality Management

Commitment from the management:

- Plan (drive, direct)
- Do (deploy, support, and participate)
- Check (review)
- Act (recognize, communicate, revise)

Employee Empowerment

- Training
- Excellence team
- Measurement and recognition
- Suggestion scheme

Continuous Improvement

- Systematic measurement
- Excellence teams
- Cross-functional process management
- Attain, maintain, improve standards

Customer Focus

- Partnership with Suppliers
- Service relationship with internal customers
- Customer-driven standards
- Never compromise quality

Process Oriented

- Thinking about the process
- Handling of the process
- Processes which are result oriented

Decision Making Based on Facts Only and Not on Opinions

- Integrated, strategic and systematic approach to ensure the entire organisation is aligned
- Communication must be open and at all levels of the organisation.

Benefits of Total Quality Management

The benefits arising from the implementation of a Total Quality Management in an organization are:

- This will increase the awareness of quality culture within the organization.

- A special emphasis on teamwork will be achieved.
- TQM will lead to a commitment towards continuous improvement.

Essential requirements for successful implementation of TQM

- **Commitment:** Quality improvement (in all aspects) must be everyones' job in the organization. An apparent commitment from the top management, breaking down the barriers for continuous quality improvement and steps required to provide an environment for changing attitudes must be provided. Training and support for this should be extended.
- **Culture:** There should be proper training to effect the changes in attitude and culture.
- **Continuous Improvement:** Recognize improvement as a continuous process, and not merely a one-off program.
- **Customer Focus:** Perfection in service with zero defects and full satisfaction to the end-user whether it's internal or external.
- **Control:** Ensure monitoring and control checks for any deviation from the intended course of implementation.

1. Plan
2. Do
3. Check
4. Act

This is also referred to as the PDCA cycle.

1. **Planning Phase:** This phase is the most crucial phase of total quality management. Under this phase, employees have to come up with their

respective queries and problems which need to be addressed. The employees apprise the management of different challenges which they are facing in their day to day operations and also analyze the root cause of the problem. They need to do the required research and collect significant data which would help them find solutions to all the problems.

2. **Doing Phase:** In this phase, a solution for the identified problems in the planning phase is developed by the employees. Strategies are devised and implemented to crack down the challenges faced by employees. The efficiency and effectiveness of solutions and strategies are also evaluated in this stage.

3. **Checking Phase:** Under this phase, a comparison analysis of before and after is done in order to assess the effectiveness of the processes and measure the results.

4. **Acting Phase:** This is the last phase of the cycle, in this phase employees document their results and prepare themselves to address other problems.

Beliefs about Total Quality Management

Following are the universal Total Quality Management beliefs:

- Satisfaction of the customer/owner is the measure of quality.
- Everyone is an owner.
- Continuous Quality improvement must be there.
- Analysis of the processes is the key to quality improvement.
- Constant TQM is not possible without consistent, active and enabling leadership by managers at all levels.

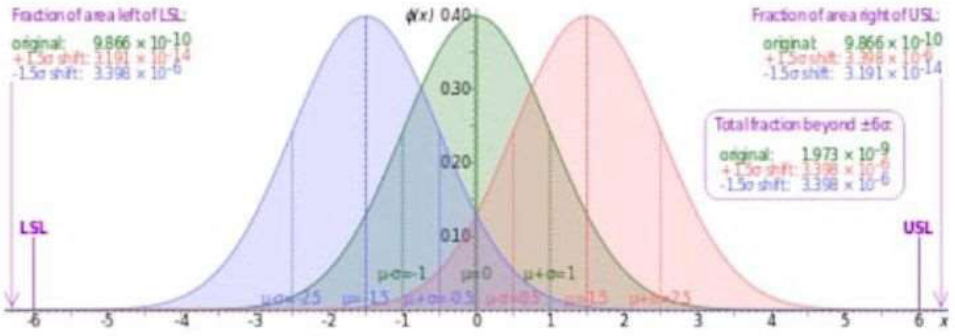
- It is important to incessantly improve the quality of the products and services which we are supposed to provide to our customers/owners.

SIX SIGMA

Six Sigma is a set of management tools and techniques designed to improve business by reducing the likelihood of error. It is a data-driven approach that uses a statistical methodology for eliminating defects.

The etymology is based on the Greek symbol "sigma" or "σ," a statistical term for measuring process deviation from the process mean or target. "Six Sigma" comes from the bell curve used in statistics, where one Sigma symbolizes a single standard deviation from the mean. If the process has six Sigmas, three above and three below the mean, the defect rate is classified as "extremely low."

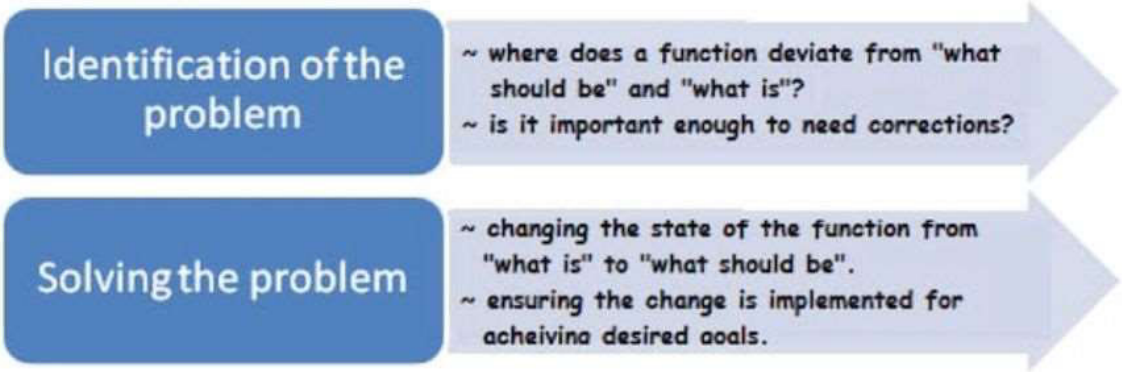
The graph of the normal distribution below underscores the statistical assumptions of the Six Sigma model. The higher the standard deviation, the higher is the spread of values encountered. So, processes, where the mean is minimum 6σ away from the closest specification limit, are aimed at Six Sigma.



The 5 Key Principles of Six Sigma

The concept of Six Sigma has a simple goal – delivering near-perfect goods and services for business transformation for optimal customer satisfaction (CX).

Goals are achieved through a two-pronged approach:



Six Sigma has its foundations in five key principles:

1. **Focus on the Customer**

   This is based on the popular belief that the "customer is the king." The primary goal is to bring maximum benefit to the customer. For this, a business needs to understand its customers, their needs, and what drives sales or loyalty. This requires establishing the standard of quality as defined by what the customer or market demands.

2. **Measure the Value Stream and Find Your Problem**

   Map the steps in a given process to determine areas of waste. Gather data to discover the specific problem area that is to be addressed or transformed. Have clearly defined goals for data collection, including defining the data to be collected, the reason for the data gathering, insights expected, ensuring the accuracy of measurements, and establishing a standardized data collection system. Ascertain if the data is helping to achieve the goals, whether or not the data needs to be refined, or additional information collected. Identify the problem. Ask questions and find the root cause.

3. **Get Rid of the Junk**

   Once the problem is identified, make changes to the process to eliminate variation, thus removing defects. Remove the activities in the process that do not add to the customer value. If the value stream doesn't reveal where the problem lies, tools are used to help discover the outliers and problem areas. Streamline functions to achieve quality control and efficiency. In the end, by taking out the above-mentioned

junk, bottlenecks in the process are removed.

4. **Keep the Ball Rolling**

   Involve all stakeholders. Adopt a structured process where your team contributes and collaborates their varied expertise for problem-solving.

   Six Sigma processes can have a great impact on an organization, so the team has to be proficient in the principles and methodologies used. Hence, specialized training and knowledge are required to reduce the risk of project or re-design failures and ensure that the process performs optimally.

5. **Ensure a Flexible and Responsive Ecosystem**

   The essence of Six Sigma is business transformation and change. When a faulty or inefficient process is removed, it calls for a change in the work practice and employee approach. A robust culture of flexibility and responsiveness to changes in procedures can ensure streamlined project implementation. The people and departments involved should be able to adapt to change with ease, so to facilitate this, processes should be designed for quick and seamless adoption. Ultimately, the company that has an eye fixed on the data examines the bottom line periodically and adjusts its processes where necessary, can gain a competitive edge.

The Six Sigma Methodology

The two main Six Sigma methodologies are **DMAIC** and **DMADV.** Each has its own set of recommended procedures to be implemented for business transformation.

DMAIC is a data-driven method used to improve existing products or services for better customer satisfaction. It is the acronym for the five phases: D – Define, M – Measure, A – Analyse, I – Improve, C – Control. DMAIC is applied in the manufacturing of a product or delivery of a service.

DMADV is a part of the Design for Six Sigma (DFSS) process used to design or re-design different processes of product manufacturing or service delivery. The five phases of DMADV are: D – Define, M – Measure, A – Analyse, D – Design, V – Validate. DMADV is employed when existing processes do not meet customer conditions, even after optimization, or when it is required to develop new methods. It is executed by Six Sigma Green Belts and Six Sigma Black Belts and under the supervision of Six Sigma Master Black Belts. We'll get to the belts later.

The two methodologies are used in different business settings, and professionals seeking to master these methods and application scenarios would do well to take an online certificate program taught by industry experts.

The Juran Trilogy

The Juran Trilogy was developed by Dr. Joseph Juran, and it's something I learned about recently in my Total Quality Management

and Six Sigma course. The Juran Trilogy is an improvement cycle that is meant to reduce the cost of poor quality by planning quality into the product/process.

The Juran Trilogy

1. **Quality Planning** In the planning stage, it is critical to define who your customers are and find out their needs (the "voice of the customer"). After you know what your customers need, you're able to define the requirements for your product/process/service/system, etc., and develop it. Additionally, any plans that might need to be transferred to operators or other key stakeholders should be done during the planning phase. Planning activities should be done with a multidisciplinary team, with all key stakeholders represented.

2. **Quality Control** During the control phase, determine what you need to measure (what data do you need to know if your process is working?), and set a goal for your performance. Get feedback by measuring actual performance, and act on the gap between your performance and your goal. In Statistical Process Control (SPC), there are several tools that could be used in the "control" phase of the Juran Trilogy: Pareto Analysis, flow diagrams, fishbone diagram, and control charts, to name a few.

3. **Quality Improvement** There are four different "strategies" to

improvement that could be applied during this phase:

- Repair: Reactive; fix what's broken.
- Refinement: Proactive; continually improve a process that isn't broken (like the continual pursuit of perfection in Lean!)
- Renovation: Improvement through innovation or technological advancement
- Reinvention: Most demanding approach; start over with a clean slate.

Deming's 14-Point

The 14 Points

- **Create a constant purpose toward improvement.**
  - Plan for quality in the long term.
  - Resist reacting with short-term solutions.
  - Don't just do the same things better – find better things to do.
  - Predict and prepare for future challenges, and always have the goal of getting better.

- **Adopt the new philosophy.**
  - Embrace quality throughout the organization.
  - Put your customers' needs first, rather than react to competitive pressure – and design products and services to meet those needs.
  - Be prepared for a major change in the way business is done. It's about leading, not simply managing.
  - Create your quality vision, and implement it.

- **Stop depending on inspections.**
  - Inspections are costly and unreliable – and they don't improve quality, they merely find a lack of quality.
  - Build quality into the process from start to finish.
  - Don't just find what you did wrong – eliminate the "wrongs" altogether.
  - Use statistical control methods – not physical inspections alone – to prove that the process is working.

- **Use a single supplier for any one item.**
  - Quality relies on consistency – the less variation you have in the input, the less variation you'll have in the output.
  - Look at suppliers as your partners in quality. Encourage them to spend time improving their own quality – they shouldn't compete for your business based on price alone.
  - Analyze the total cost to you, not just the initial cost of the product.
  - Use quality statistics to ensure that suppliers meet your quality standards.

- **Improve constantly and forever.**
  - Continuously improve your systems and processes. Deming promoted the Plan-Do-Check-Act approach to process analysis and improvement.
  - Emphasize training and education so everyone can do their jobs better.
  - Use kaizen as a model to reduce waste and to improve productivity, effectiveness, and safety.

- **Use training on the job.**
  - Train for consistency to help reduce variation.
  - Build a foundation of common knowledge.
  - Allow workers to understand their roles in the "big picture."
  - Encourage staff to learn from one another, and provide a culture and environment for effective teamwork.

❖ **Implement leadership.**

- ➢ Expect your supervisors and managers to understand their workers and the processes they use.
- ➢ Don't simply supervise – provide support and resources so that each staff member can do his or her best. Be a coach instead of a policeman.
- ➢ Figure out what each person actually needs to do his or her best.
- ➢ Emphasize the importance of participative management and transformational leadership.
- ➢ Find ways to reach full potential, and don't just focus on meeting targets and quotas.

❖ **Eliminate fear.**

- ➢ Allow people to perform at their best by ensuring that they're not afraid to express ideas or concerns.
- ➢ Let everyone know that the goal is to achieve high quality by doing more things right – and that you're not interested in blaming people when mistakes happen.
- ➢ Make workers feel valued, and encourage them to look for better ways to do things.
- ➢ Ensure that your leaders are approachable and that they work with teams to act in the company's best interests.
- ➢ Use open and honest communication to remove fear from the organization.

- **Break down barriers between departments.**
  - Build the "internal customer" concept – recognize that each department or function serves other departments that use their output.
  - Build a shared vision.
  - Use cross-functional teamwork to build understanding and reduce adversarial relationships.
  - Focus on collaboration and consensus instead of compromise.

- **Get rid of unclear slogans.**
  - Let people know exactly what you want – don't make them guess. "Excellence in service" is short and memorable, but what does it mean? How is it achieved? The message is clearer in a slogan like "You can do better if you try."
  - Don't let words and nice-sounding phrases replace effective leadership. Outline your expectations, and then praise people face-to-face for doing good work.

- **Eliminate management by objectives.**
  - Look at how the process is carried out, not just numerical targets. Deming said that production targets encourage high output and low quality.
  - Provide support and resources so that production levels and quality are high and achievable.
  - Measure the process rather than the people behind the process.

- **Remove barriers to pride of workmanship.**

- Allow everyone to take pride in their work without being rated or compared.
- Treat workers the same, and don't make them compete with other workers for monetary or other rewards. Over time, the quality system will naturally raise the level of everyone's work to an equally high level.

- **Implement education and self-improvement.**
  - Improve the current skills of workers.
  - Encourage people to learn new skills to prepare for future changes and challenges.
  - Build skills to make your workforce more adaptable to change, and better able to find and achieve improvements.

- **Make "transformation" everyone's job.**
  - Improve your overall organization by having each person take a step toward quality.
  - Analyze each small step, and understand how it fits into the larger picture.
  - Use effective change management principles to introduce the new philosophy and ideas in Deming's 14 points.

PDCA

PDCA, sometimes called PDSA, the "Deming Wheel," or "Deming Cycle," was developed by renowned management consultant Dr William Edwards

Deming in the 1950s. Deming himself called it the "Shewhart Cycle," as his model was based on an idea from his mentor, Walter Shewhart.

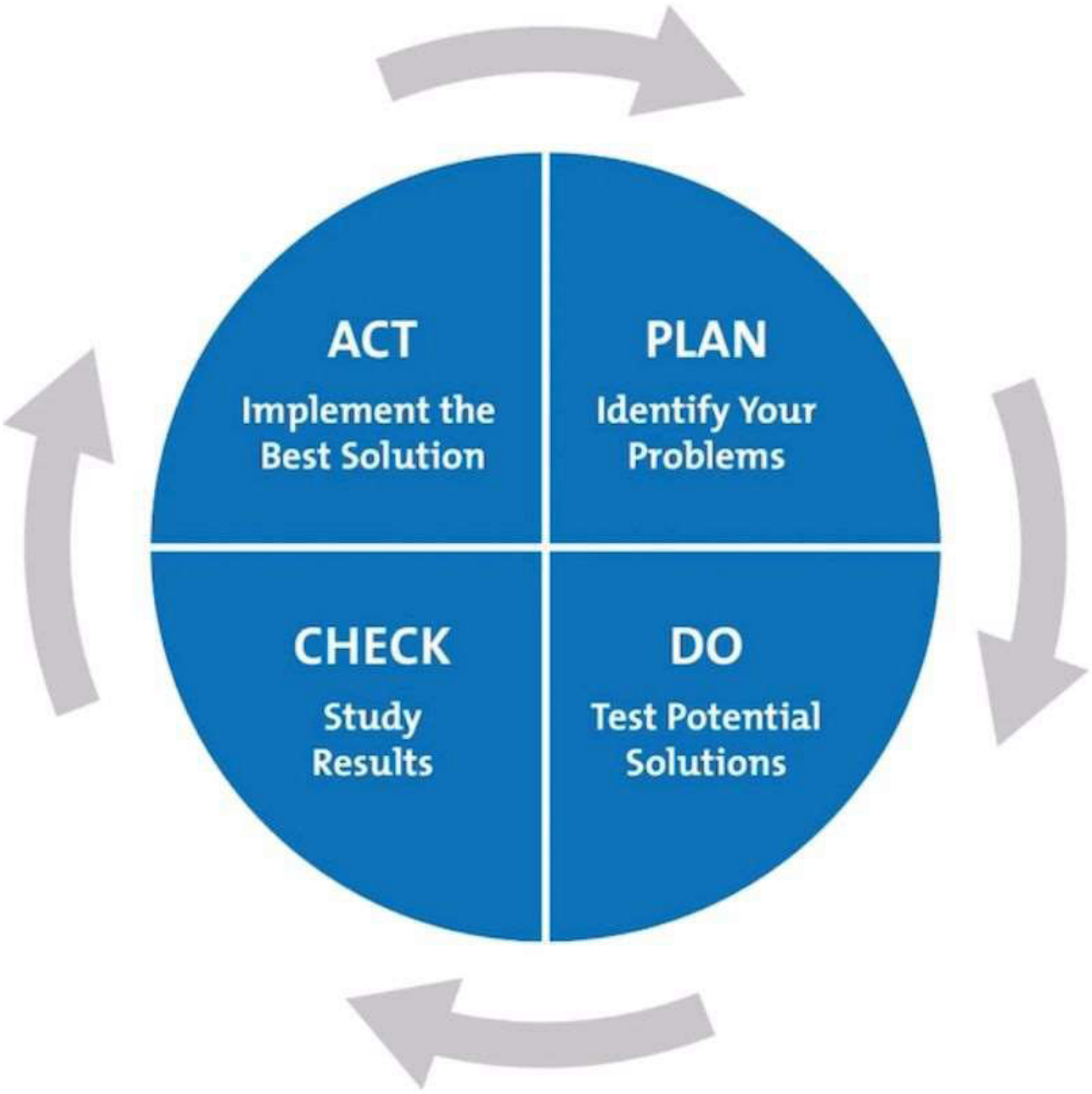
Deming wanted to create a way of identifying what caused products to fail to meet customers' expectations. His solution helps businesses to develop hypotheses about what needs to change, and then test these in a continuous feedback loop.

PDCA / PDSA is an iterative, four-stage approach for continually improving processes, products or services, and for resolving problems. It involves systematically testing possible solutions, assessing the results, and implementing the ones that are shown to work.

The four phases are:

- **Plan:** identify and analyze the problem or opportunity, develop hypotheses about what the issues may be, and decide which one to test.
- **Do:** test the potential solution, ideally on a small scale, and measure the results.
- **Check/Study:** study the result, measure effectiveness, and decide whether the hypothesis is supported or not.
- **Act:** if the solution was successful, implement it.

These stages are illustrated in Figure 1, below


ACT
Implement the Best Solution
PLAN
Identify Your Problems
CHECK
Study Results
DO
Test Potential Solutions

The PDCA or PDSA Cycle

The PDCA cycle helps you to solve problems and implement solutions in a rigorous, methodical way. Follow these four steps to ensure that you get the highest quality results.

Plan

First, you need to identify and understand your problem, or the opportunity that you want to take advantage of. Using the first six steps of The Simplex Process can help you to do this, by guiding you through a process of exploring information, defining your problem, generating and screening ideas, and developing an implementation plan.

At the final part of this stage, state quantitatively what your expectations are, if the idea is successful and your problem is resolved. You'll return to this in the Check stage

Do

Once you've identified a potential solution, test it with a small-scale pilot project. This will allow you to assess whether your proposed changes achieve the desired outcome, with minimal disruption to the rest of your operation if they don't. For example, you could organize a trial within a department, in a limited geographical area, or with a particular demographic.

As you run the pilot project, gather data to show whether the change has worked or not. You'll use this in the next stage.

Check

At this stage, you analyze your pilot project's results against the expectations that you defined in Step 1 to assess whether the idea has worked or not. If it hasn't worked, you return to Step 1. If it has worked, you go on to Step 4.

You may decide to try out more changes, and repeat the Do and Check phases – don't settle for a less-than-satisfactory solution. Move on to the final phase (Act) only when you're genuinely happy with the trial's outcome.

Act

This is where you implement your solution. But remember that PDCA / PDSA is a loop, not a process with a beginning and an end. This means that your improved process or product becomes the new baseline, and you continue to look for ways to make it even better for your organization or customers.

The Pros and Cons of PDCA / PDSA

The model is a simple, yet powerful way to resolve new and recurring issues in any industry, department or process. Its iterative approach allows you and your team to test solutions and assess results in a waste-reducing cycle.

It instills a commitment to continuous improvement, however small, and can improve efficiency and productivity in a controlled way, without the risks of making large scale, untested changes to your processes.

However, going through the PDCA / PDSA cycle can be much slower than a straightforward, "gung ho" implementation. So, it might not be the appropriate approach for dealing with an urgent problem or emergency.

It also requires significant "buy-in" from team members, and offers fewer opportunities for radical innovation, if that's what your organization needs.

Quality Circle

Definition: The Quality Circle refers to the group of individuals who meet on a regular basis to discuss the work-related problems. Generally, the quality circles are small group gatherings, led by the supervisor or the manager who presents the solutions to the management.

The purpose behind the formation of a quality circle is to motivate employees to share the problems affecting their work area and help in improving the performance of the organization as a whole. Generally, the quality circles focus on issues such as occupational health and safety, improvement in the working environment and manufacturing processes, etc.

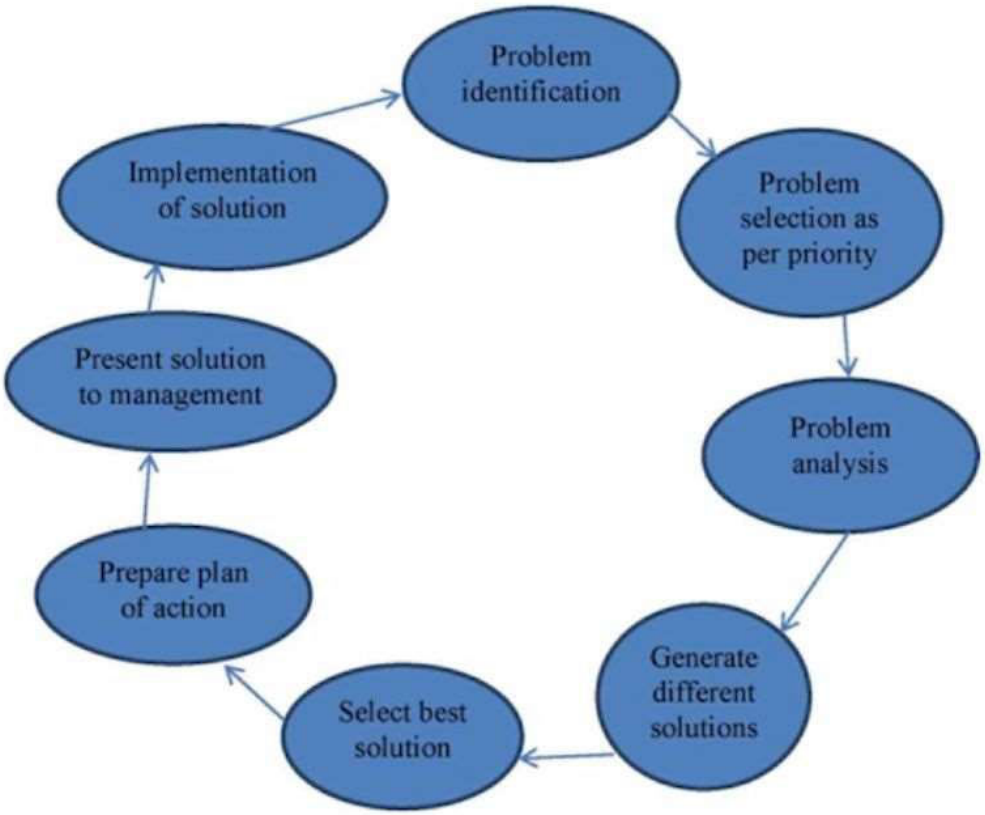
The quality circles are formed to fulfill any of the following objectives:

- To contribute towards the development of an organization.
- To create a healthy work environment such that employees find the place worthwhile to work
- To explore the hidden potential of the individuals and drawing out the

infinite possibilities.

- To improve the product quality and the productivity of the organization.
- To improve the team skills, capabilities, confidence and creativity through education, training, and participation of volunteers in the circles.

Often, six to twelve personnel from the same work area come together to form these circles. These members receive proper training in problem solving, group process and statistical processes.



Quality Circle

Quality improvement and cost reduction

The importance of Quality can never be over emphasized. Quality is the most important competitive priority for every Organization, achieving better quality is imperative to stay in the race today. Cost and Quality were considered to be at two different ends of the same continuum i.e. to improve quality meant increasing cost, but over time this view has changed drastically. Improved Quality, achieved through continuous improvement of process has been able to reduce the total Cost function in the long run. Doing things right the first time, managing operations by facts and applying statistical process controls has led to better Quality for Organizations and have reduced costs such as rework, rejection, reverse logistics, labor costs, materials cost and many other costs that contribute to the overall cost function. Practices like Kaizen, Poka Yoke, TQM, Lean Management, JIT management etc. have contributed towards the Quality revolution and have become a part of day-to-day operations for firms world-wide. Information Technology plays a vital role in monitoring and maintaining Quality, doing things right the first time is possible only when the facility has the capability of analyzing quality in real time as the process is performed.

THE 7QUALITY TOOLS

The "7 Basic Tools of Quality" (or 7 QC Tools) is a set of relatively simple data analysis tools used to support continuous improvement efforts, specifically as they relate to quality.

These tools are fairly straightforward in that they don't require sophisticated statistics to use though control charts do border on being too complex for the typical user to develop.

The 7 Basic Tools of Quality are:

- Cause and Effect Diagram (or Ishikawa Diagram or Fishbone Diagram)
- Control Chart
- Pareto Chart
- Scatter Diagram
- Histogram
- Check Sheet
- Flow Chart

Let's look at the 7 Basic Tools of Quality in more detail.

- **Cause and Effect Diagram (Ishikawa Diagram / Fishbone Diagram):** The cause and effect diagram gives a graphical arrangement to the potential causes of a problem (effect). This arrangement helps both with brainstorming and with understanding areas of opportunity.

- **Control Chart:** Control charts are fairly sophisticated run charts that add in limits of statistical variation. This helps teams separate normal, random fluctuations built into a system from special causes that spike the output.

- **Pareto Chart:** A Pareto Chart takes advantage of the 80/20 rule to visually show the categories with the largest impact on a problem.

- **Scatter Diagram:** A scatter diagram shows the relationship between two

factors. The visual nature of the chart makes patterns jump out.

- **Histogram:** A histogram is a type of bar chart that shows data in equal 'buckets.' This let the user see the distribution of data.

- **Check Sheet:** Check sheets provide a way to collect and tally data. The individual collecting data simply makes a mark in the appropriate box as a data event is tallied. Check sheets are commonly set up as a grid, allowing for two factors to be recorded at once. For example, the type of defect might be across the top and the workstation the problem was identified in might be on the vertical column. Check sheets are also commonly organized by time or date.

- **Flow Chart:** A flow chart is a visual representation of the path an entity takes through a process. This 'entity' could be a person, product or information.

THE 7 NEW QUALITY TOOLS

In 1976, the Union of Japanese Scientists and Engineers (JUSE) saw the need for tools to promote innovation, communicate information and successfully plan major projects. A team researched and developed the seven new quality control tools, to be used with the 7 basic quality tools. Often called the seven management and planning (MP) tools, or simply the seven management tools.

The seven new tools, listed in an order that moves from abstract analysis to detailed planning, are:

1. Affinity Diagram
2. Relations Diagram
3. Tree Diagram
4. Matrix Diagram
5. Arrows Diagram
6. Process Decision Program Chart
7. Prioritization Matrix- Matrix Data Analysis

New Seven Q.C. Tools

Developed to organize verbal data diagrammatically. Basic 7 tools effective for data analysis, process control, and quality improvement (numerical data) Used together increases TQM effectiveness

Tool 1 – The Affinity Diagram

Gathers large amounts of verbal data (ideas, opinions, issues); then Organizes the data into groups based on natural relationship; and Makes it feasible for further analysis and to find a solution to the problem

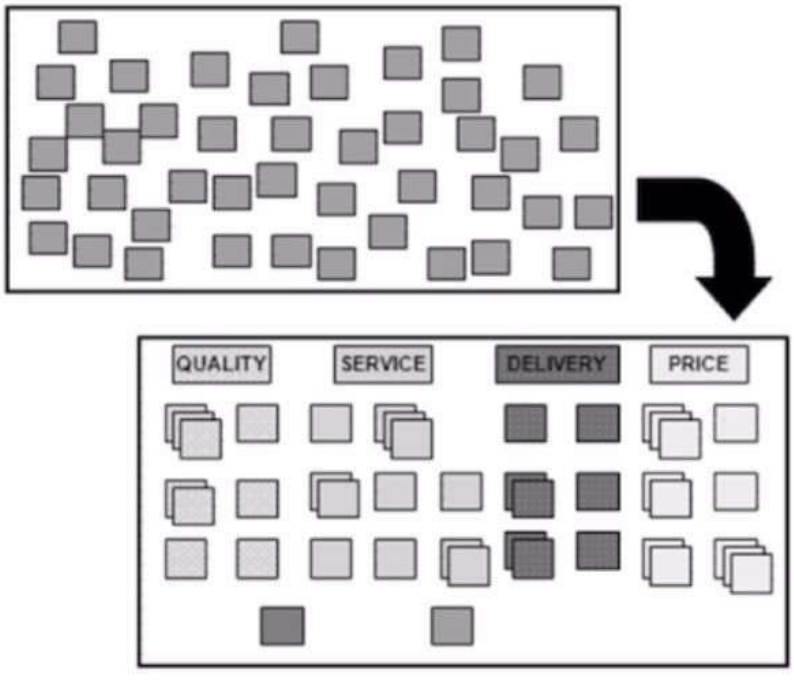
To allow a team to creatively generate a large number of ideas/issues and then organize and summarize natural groupings among them to understand the essence of a problem and propose solutions.

How to construct an Affinity Diagram

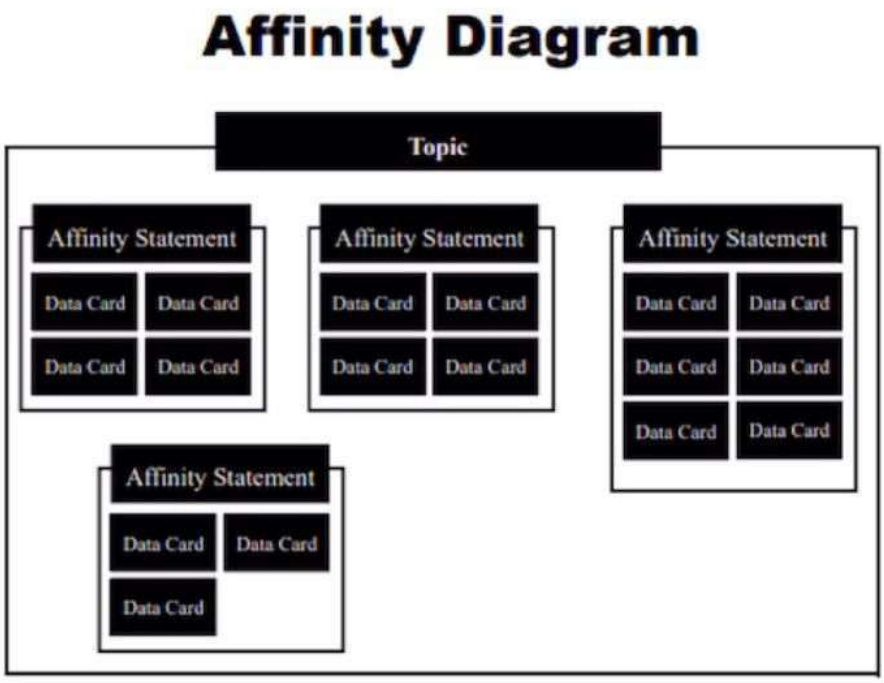
- Select the topic to be analyzed
- Use brainstorming to collect verbal data and ideas
- Write each item on separate data card
- Spread out all cards on table or stick them on a board
- Move data cards into groups of similar themes (natural affinity for each other)
- Combine statements on data cards to new Affinity statement Make new card with Affinity statement
- Continue to combine until less than 5 groups
- Draw the final Affinity Diagram for the problem discussed

Affinity Diagram

Verbal data generated by brainstorming and written on cards



Organized cards through natural relations = **Affinity diagram**

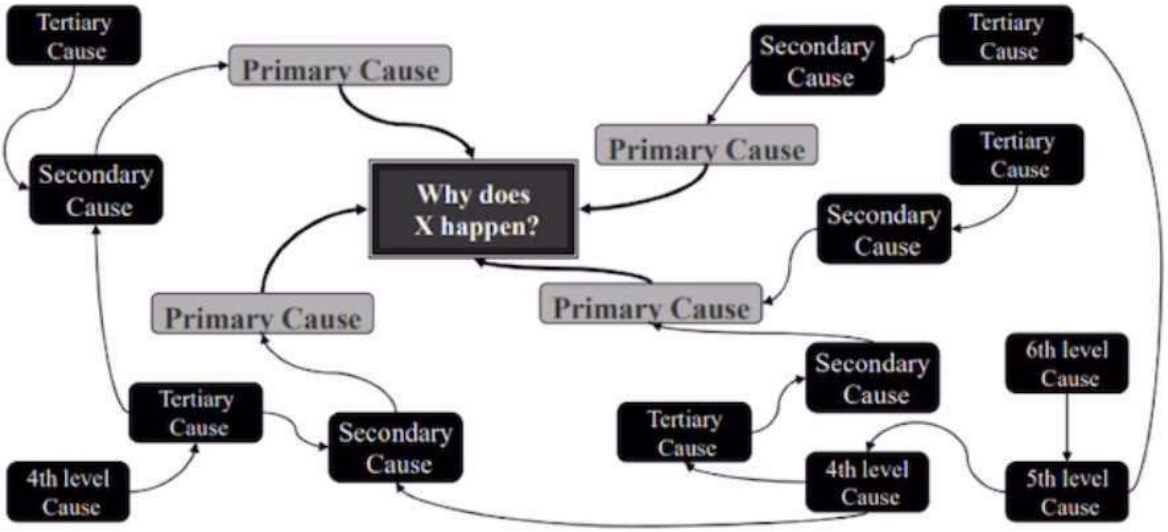


Tool N. 2 : Relations Diagrams

For Finding Solutions Strategies by Clarifying Relationships with Complex Interrelated Causes. To allow a team to systematically identify, analyze, and classify the cause and effect relationships that exist among all critical issues.

- Useful at planning stage for obtaining perspective on overall situation.
- Facilitates consensus among team
- Assists to develop and change people's thinking
- Enables priorities to be identified accurately

Relations Diagram Makes the problem recognizable by clarifying the relationships among causes



Constructing a Relations Diagram

- Express the problem in form of "Why isn't something happening?"
- Each member lists 5 causes affecting problem Discuss info collected until everyone understands it thoroughly
- Write each item on a card
- Move cards into similar groups
- Asking why, explore the cause-effect relationships, and divide the cards into primary, secondary and tertiary causes
- Connect all cards by these relationships
- Further discuss until all possible causes have been identified
- Review whole diagram looking for relationships among causes
- Connect all related groups
- Next, complete the diagram

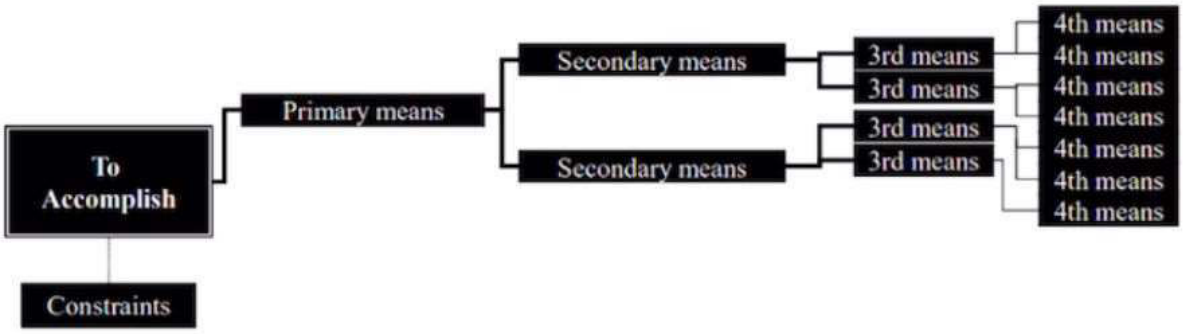
Tool N. 3: Tree Diagram

For Systematically Pursuing the Best Strategies for Attaining an Objective

- Develops a succession of strategies for achieving objectives
- Reveals methods to achieve the results.
- Also known as Systematic diagrams or Dendrograms

Advantages of Tree Diagrams

1. Systematic and logical approach is less likely that items are omitted
2. Facilitates agreement among team
3. Are extremely convincing with strategies



Constructing a Tree Diagram

- Write Relations Diagram topic (Objective card)
- Identify constraints on how objective can be achieved
- Discuss means of achieving objective (primary means, first level strategy)
- Take each primary mean, write objective for achieving it (secondary means)

Production personnel take a corrective action on a customer complaint for product A. A similar, but preventative action is taken for product B in anticipation of the same problem, even though no problem has occurred.

- **External audit:** (Also 3rd party audit) An audit of the QS-9000 quality system elements by personnel which are not members of your company, such as UL or ABS.

- **Certification Audit:** (Also registration audit) The formal audit by personnel empowered to issue QS-9000 certification. These personnel are called Registars. Examples are Underwriters's Laboratories (UL) and the American Bureau of Shipping (ABS). Upon passing this audit, your company is issued a certificate and is registered with the appropriate registration bodies.

QS-9000 Differ From ISO-9000

QS-9000 is sometimes seen as being identical to ISO 9000, but this is not true. Even though each element of ISO 9000 is an element of QS-9000, QS-9000 adds clauses to the majority of the ISO 9000 elements. For example, QS-9000 adds requirements for a business plan, tracking customer satisfaction and bench marking to element 4.1 of ISO 9000, Management Responsibility. QS-9000 also uses sector-specific requirements. The following requirements are not based on ISO 9000:

- production part approval process

- Continue to expand to the fourth level
- Review each system of means in both directions (from objective to means and means to objective)
- Add more cards if needed
- Connect all levels
- Next, complete the diagram

Tool 4 - Matrix Diagrams

For Clarifying Problems by "Thinking Multidimensionally"To allow a team or individual to systematically identify, analyze, and rate the presence and strength of relationships between two or more sets of information.

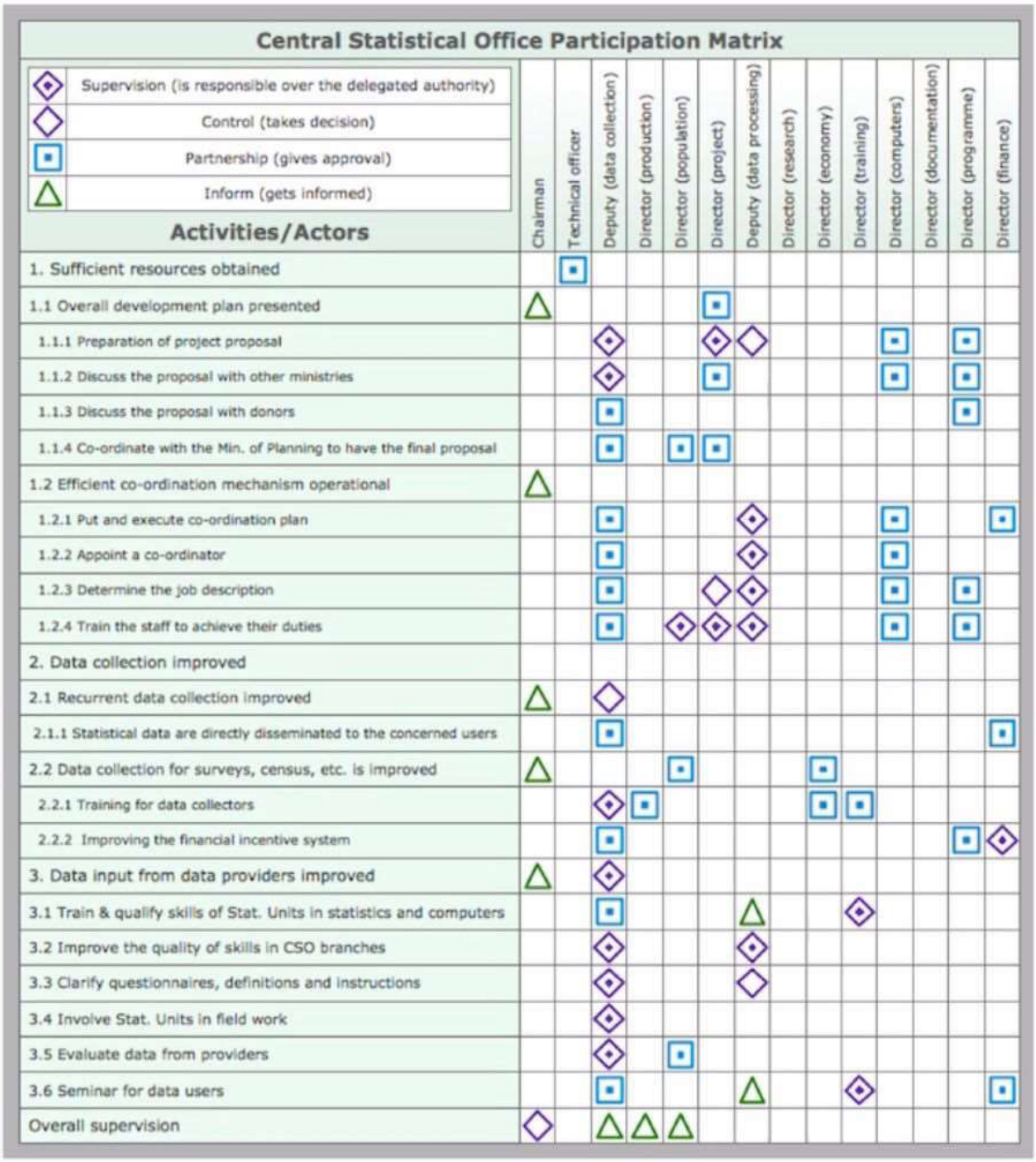
Matrix Diagrams

- **Consists of a two-dimensional array to determine location and nature of problem**
- **Discovers key ideas by relationships represented by the cells in matrix.**
- **Enable data on ideas based on extensive experience**
- **Clarifies relationships among different elements**
- **Makes overall structure of problem immediately obvious**
- **Combined from two to four types of diagrams, location of problem is clearer.**

- the requirements for gaining approval from the customer to run a new or altered part or process
- continuous improvement
- automotive suppliers are required to have systems in place to ensure that organized, measurable improvement activities take place for a variety for business aspects
- manufacturing capabilities
- requirements for planning and effectiveness for equipment, facilities and processes
- requirements for mistake proofing, and tooling management.

Constructing a Matrix Diagram

- Write final-level means from Tree diagram forming vertical axis
- Write in Evaluation categories (efficacy, practicability, and rank) on horizontal axis.
- Examine final-level means to identify whom will implement them
- Write names along horizontal axis
- Label group of columns as "Responsibilities"
- Label right-hand end of horizontal axis as "Remarks"
- Examine each cell and insert the appropriate symbol:
- Efficacy: O=good, Δ=satisfactory, X=none
- Practicability: O=good, Δ=satisfactory, X=non
- Determine score for each combination of symbols, record in rank column.
- Examine cells under Responsibility Columns, insert double-circle for Principal and singlecircle for Subsidiary
- Fill out remarks column and record meanings of symbol
- Next, complete the diagram



Central Statistical Office Participation Matrix

◈ Supervision (is responsible over the delegated authority)
◇ Control (takes decision)
▣ Partnership (gives approval)
△ Inform (gets informed)

Activities/Actors	Chairman	Technical officer	Deputy (data collection)	Director (production)	Director (population)	Director (project)	Deputy (data processing)	Director (research)	Director (economy)	Director (training)	Director (computers)	Director (documentation)	Director (programme)	Director (finance)
1. Sufficient resources obtained		▣												
1.1 Overall development plan presented	△					▣								
1.1.1 Preparation of project proposal			◈			◈	◇				▣		▣	
1.1.2 Discuss the proposal with other ministries			◈			▣					▣		▣	
1.1.3 Discuss the proposal with donors			▣										▣	
1.1.4 Co-ordinate with the Min. of Planning to have the final proposal			▣		▣	▣								
1.2 Efficient co-ordination mechanism operational	△													
1.2.1 Put and execute co-ordination plan			▣				◈				▣			▣
1.2.2 Appoint a co-ordinator			▣				◈				▣			
1.2.3 Determine the job description			▣			◇	◈				▣		▣	
1.2.4 Train the staff to achieve their duties			▣		◈	◈	◈				▣		▣	
2. Data collection improved														
2.1 Recurrent data collection improved	△		◇											
2.1.1 Statistical data are directly disseminated to the concerned users			▣											▣
2.2 Data collection for surveys, census, etc. is improved	△				▣				▣					
2.2.1 Training for data collectors			◈	▣					▣	▣				
2.2.2 Improving the financial incentive system			▣										▣	◈
3. Data input from data providers improved	△		◈											
3.1 Train & qualify skills of Stat. Units in statistics and computers			▣				△			◈				
3.2 Improve the quality of skills in CSO branches			◈				◈							
3.3 Clarify questionnaires, definitions and instructions			◈				◇							
3.4 Involve Stat. Units in field work			◈											
3.5 Evaluate data from providers			◈		▣									
3.6 Seminar for data users			▣				△			◈				▣
Overall supervision	◇		△	△	△									

Tool 5 - Arrows Diagram

For Working Out Optimal Schedules and Controlling Them Effectively

- Shows relationships among tasks needed to implement a plan
- Network technique using nodes for events and arrows for activities
- Allows overall task to viewed and potential snags to be identified before work starts
- Leads to discovery of possible improvements
- Makes it easy to monitor progress of work
- Deals promptly with changes to plan
- Improves communication among team

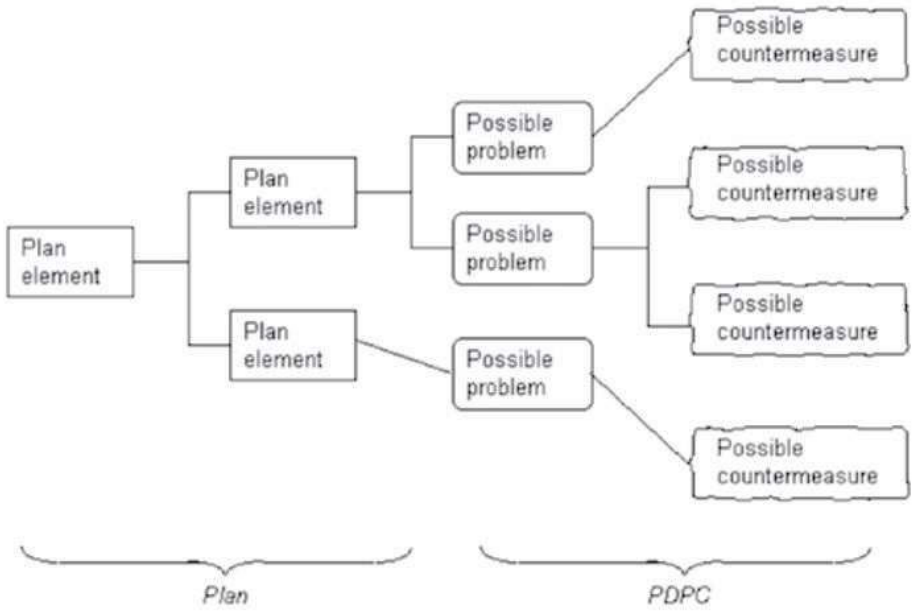
Constructing an Arrow Diagram

- From strategies on Tree diagram, select one (Objective of Arrow Diagram)
- Identify constraints to Objective
- List all activities necessary to achieving Objective
- Write all essential activities on separate cards
- Organize cards in sequential order of activities
- Remove any duplicate activities
- Review order of activities, find sequence with greatest amount of activities
- Arrange parallel activities
- Examine path, number nodes in sequence from left to right
- Record names and other necessary information
- Next, complete the diagram

Tool 6 - Process Decisions

Program Charts (PDPC)

- PDPCs are used for planning the activities needed to solve problem when information is incomplete or the situation is fluid and hard to forecast.
- Examples include planning an R & D project, mapping out countermeasure against long-term chronic problems, and planning a sales campaign.
- A PDPC consists of a series of steps linked in sequence. Its goal is to depict the events and contingencies likely to occur when progressing from a starting point to one or more final outcomes



Tool 7 - Prioritization Matrix (Matrix Data Analysis)

- Technique quantifies and arranges data presented in Matrix
- Based solely on numerical data.
- Finds indicators that differentiate and attempt to clarify large amount of information.

Prioritization Matrix is used by teams to narrow down options through a systematic approach of comparing choices by selecting, weighting, and applying criteria.

Constructing a Prioritization Matrix

- Determine your goal, your alternatives, and criteria for decision
- Place selection in order of importance
- Apply percentage weight to each option
- Sum individual ratings to establish overall ranking (Divide by number of options for average ranking)
- Rank order each option with respect to criterion (Average the rankings and apply a completed ranking)
- Multiply weight by associated rank in Matrix (in example, 4 is best, 1 is worst)
- Result is Importance Score
- Add up Importance Scores for each option
- Rank order the alternatives according to importance

Practical Application of New Seven Q.C. Tools

"Abilities Required for Applying New Seven QC Tools"

A	Interpret data clearly	N	Understand seriousness of problem
B	Select appropriate tool	0	Think flexibly from various standpoints
C	Think systematically	P	Obtain appropriate verbal data
D	Give opinions	Q	Expose core of problem
E	Know what the problem is	R	Communicate well
F	Extract necessary information	S	Accurately understand real problem
G	Collect reliable verbal data	T	Have excellent intuition
H	Think multidimensionally	U	See to heart of problem
1	Obtain facts	V	Select appropriate type of verbal data
J	Interpret analytical results	W	Think in terms of word-based diagram
K	Generate ideas	X	Express genuine thoughts
L	Know that distorted data is useless	Y	Hear and respect other's opinions
M	Grasp overall pictured	Z	Generate highly accurate verbal data

ISO 9000

ISO stands for International organization for standardization. It is an international body consisting of representatives from more than 90 countries. The national standard bodies of these countries are the members of this organization. These are non-governmental organizations and can provide common standards of goods and services on international trades.

ISO9000 series has 5 numbers of international standards on quality management which are listed below with different objectives.

ISO 9000: Provides guide lines on selection and use of quality management and quality assurance standards.

ISO 9001: This is applicable for industries doing their own design and development, production, installation and servicing. It has 20 elements.

ISO 9002: It has 18 elements. It is same as ISO 9001 without the 1st two tasks i.e. design and development.

ISO 9003: It has 12 elements covering final inspection and testing for laboratories and warehouses.

ISO 9004: This provides guidelines to interpret the quality management and quality assurance. It also has suggestions which are not mandatory.

Benefits of ISO 9000 Series

1. This gives competitive advantage in the global market.
2. Consistency in quality, as ISO helps in detecting non-conforming early

which makes it possible to rectify.

3. Documentation of quality procedure adds clarity to quality system.
4. It ensures adequate and regular quality training for all members of the organization.
5. It helps in customers to have cost effective purchase procedure.
6. The customers during purchase from firm holding ISO certificate need not spend much on inspection and testing. This will reduce quality cost and lead time.
7. This will aid to improved morale and involvement of workers.
8. The level of job satisfaction will be more.
9. This will help in increasing productivity.

Steps in ISO 9000 Registration

Selection of appropriate standard from ISO 9001/9002/9003 using guidelines given in ISO 9000.

Preparation of quality manual to cover all the elements in the selected model.

Preparation of procedure and shop floor instruction which are used at the time of implementing the system. Also document these items.

Self-auditing to check compliance of the selected module.

Selection of a registrar (an independent body with knowledge and experience to evaluate any one of the three quality systems i.e. ISO 9001/ 9002/ 9003) and the application is to be submitted to obtain certificate for the selected quality system/ model.

Sl.No.	System requirement	ISO 9001	ISO 9002
1	Management responsibility	✓	✓
2	Quality system	✓	✓
3	Product identification & traceability	✓	✓
4	Inspection status	✓	✓
5	Inspection & Testing	✓	✓
6	Inspection, measuring & test equipment	✓	✓
7	Control of non-conforming products	✓	✓
8	Handling, storage, packaging & delivery	✓	✓

9	Document control	✓	✓
10	Quality record	✓	✓
11	Training	✓	✓
12	Statistical technique	✓	✓
13	Internal auditing	✓	✓
14	Contract review	✓	✓
15	Purchasing	✓	✓
16	Process control	✓	✓
17	Purchaser's supplied product	✓	✓
18	Corrective action	✓	✗

19	Design control	✓	✗
20	Servicing	✓	

Present ✓

Not Present ✗

QS-9000

QS 9000 is the name given to the Quality System Requirements of the automotive industry which were developed by Chrysler, Ford, General Motors and major truck manufacturers and issued in late 1994. QS-9000 replaces such quality system requirements as Ford Q-101, Chrysler's Supplier Quality Assurance Manual, GM's NAO Targets for Excellence and the Truck Manufacturer's quality system manuals. The influence of QS-9000 is being seen throughout the automotive industry as it has virtually eliminated varying demands and waste associated with redundant systems. Proof of conformance to QS-9000 is certification/registration by an accredited third party such as Underwriter's Laboratories (UL) or the American Bureau of Shipping (ABS). Companies that become registered under QS-9000 will be considered to have higher standards and better quality products. This paper will describe the steps a company needs to take to achieve this goal.

QS-9000 will help companies to stay ahead of their competition. It will do

this by filling gaps in the business and quality systems that can cause problems. QS-9000 eliminates redundant and unnecessary work practices. QS-9000 tells current and potential customers that the product has consistent quality and is manufactured under controlled conditions. This system is globally accepted as proof of quality in the automotive industry and is also a major customer requirement.

QS-9000 Quality Statement

The QS-9000 Quality Statement tells of your company's objectives for quality and commitment to quality, and is relevant to company goals and customer needs and expectations. The Quality Statement will be given to all associates in the form of a laminated card that they must keep with them at all times. The Quality Statement should be posted in all areas of the facility. Though it is not necessary for each associate to memorize the quality policy statement, they should be able to read it from the card or wall and tell what it means to them. All management personnel must know the quality policy statement.

QS-9000 Definitions

- **Internal Auditor:** An employee of the company who has been trained to perform audits of certain elements of the quality system. An internal auditor must be independent of the elements he is auditing (can not audit himself).

- **Quality Policy Statement:** A documented statement defined by management which tells of the company's commitment to quality and the

customer. The quality policy statement is intended to strengthen the daily focus on quality and must be known by all plant and office personnel.

- **Work Instructions:** Written methods and visual aids which detail how a particular job is performed. Work instructions are supposed to be available at the work area and followed consistently by all shifts.

- **Internal audit:** Questions about QS-9000 asked by audit teams which are made up by the company's own employees.

- **Audit Finding/Nonconformance (Also Noncompliance):** If during an audit, something is not documented, or something is not being followed, the auditor reports this as a nonconformance and corrective action must be taken.

- **Corrective Action:** Once an audit finding or occurrence had been reported to personnel responsible for that area, those personnel must agree on a cure for the nonconformance and a date in which the plan will be completed. This is usually handled through a Corrective Action Report (CAR) form.

- **Preventative Action:** An action taken to prevent the occurrence of a nonconformance or quality problem that has not yet occurred. Example:

MODULE 6

Productivity

Productivity is a relationship between the output (product/service) and input (resources consumed in providing them) of a business system. The ratio of aggregate output to the aggregate input is called productivity.

Productivity = output/Input

For survival of any organization, this productivity ratio must be at least 1.If it is more than 1, the organization is in a comfortable position. The ratio of output produced to the input resources utilized in the production.

Importance

Benefits derived from higher productivity are as follows:

- It helps to cut down cost per unit and thereby improve the profits.
- Gains from productivity can be transferred to the consumers in form of lower priced Products or better quality products.
- These gains can also be shared with workers or employees by paying them at higher rate.
- A more productive entrepreneur can have better chances to exploit expert opportunities.
- It would generate more employment opportunity.
- Overall productivity reflects the efficiency of production system.
- More output is produced with same or less input.
- The same output is produced with lesser input.
- More output is produced with more input.

- The proportional increase in output being more than the proportional increase in input.

Material Productivity

Material productivity is defined as the amount of output produced in term of per unit input of materials. Materials, in this case, are defined as natural resources. It can be broadly differentiated from total productivity.

The capacity to make the equivalent or more yield utilizing less material assets is known as material productivity. Procedure inconstancy is at the base of materials overconsumption. It begins process wasteful aspects that bring about faulty production, procurement errors, faulty billing practises etc. In other words, it is a blatant wastage of resources.

Each business needs to see if its utilization of materials is changed in accordance with the base adequate levels, or, on a flip side, overconsumption is available. Numerous organizations set the base minimum level dependent on historical data or forecasted data of consumption. However, setting the minimum level should always be based on optimum consumption. R&G can help an organisation by baselining what that minimum level is, along these lines setting the measures. When this count is comprehended and shared by all the essential partners, the time has come to evaluate the deviations between real utilization and guidelines, and to make a framework for persistently lessening or removing the sources of those deviations, subsequently expanding material efficiency.

Material productivity

- **Material productivity= $\frac{\text{Total output}}{\text{Material input}}$ or**
- **M.P= $\frac{\text{Number of units produced}}{\text{Total material cost}}$**
- Material productivity plays important role in cost of production.
- Material productivity depends upon how material is effectively utilized in its conversion into finished product.
- Material productivity can be increased by using skilled workers, adequate machine tools, good design of product etc.

Productivity and its various types are extremely relevant in any big or small workplace. It helps to keep a proper check on resources and also works as an alarm for necessary changes that have to be made to make the best use of all kinds of availability.

MATERIAL MANAGEMENT

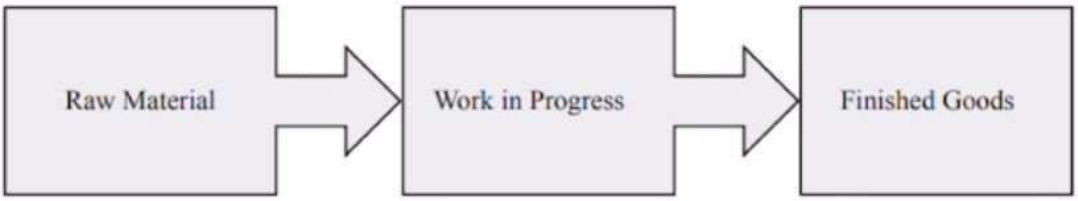
Every organisation depends on materials and services from other organisations to varying extents. These materials and services are obtained through exchange of money. Various materials are used as inputs such as raw materials, consumables and spares. These are required to be purchased and made available to the shops/users as and when needed to ensure uninterrupted production. Efficient management of input materials is of paramount importance in a business organisation for maximising materials productivity, which ultimately adds to the profitability of the organisation. Material cost is probably the most

important element of cost. In the case of certain industries like cement, sugar, chemicals, iron and steel, etc., the materials cost forms a very significant portion of the overall cost of production.

The term material refers to all commodities which are consumed in the production process. The materials which can be consumed in the production process can be basically classified as:

- Direct Materials
- Indirect Materials

Material is generally called raw material. Inventory is a name collectively given to raw material; work in process and finished goods. Even though Material and Inventory are used as synonyms, material usually means raw material and inventory means raw material along with work in process plus finished goods



Raw Material is first subjected to a manufacturing process before it becomes finished goods. Raw material is also present with work in process and finished goods. It is a continuous process.

Inventory classification Inventory includes idle resources that have future economic value. It indicates that it may be available in different forms depending

upon the production cycle stage it is in. Classification of inventory is done on this basis and thus, the different classifications of inventory are as follows:

- **Raw materials:** Raw materials are input goods intended for combination and/or conversion through the manufacturing process into semi-finished or finished goods. They change their form and become part of the finished product.

- **Components and parts:** Just as raw materials are converted to finished goods in a manufacturing operation, components and parts are assembled into finished goods in an assembly operation.

- **Maintenance, repair and operating inventories (MRO):** These include parts, supplies and materials used in or consumed by routine maintenance and repair of operating equipment, or in support of operations.

- **Work-in-process goods:** These include goods in the process of manufacturing and only partially completed. They are usually measured for accounting purposes in between significant conversion phases. In-process inventories provide the flexibility necessary to deal with variations in demand between different phases of manufacturing.

- **Finished goods:** These represent the completed conversion of raw materials into the final product. They are goods ready for sale and shipment

- **Resale goods:** These are goods acquired for resale. Such goods may be purchased by a wholesaler for resale to distributors, or by distributors for resale to consumers, etc.

- **Capital goods:** These are items (such as, equipment) that are not used or consumed during a single operating period, but have extended useful lives and must be utilised over multiple operating periods. Tax laws require that such an item be capitalised, and a predetermined percentage of its cost be recognised as an expense, each operating period, over a predetermined time frame, according to equipment classes.

- **Construction materials:** These are raw materials and components for construction projects such as a building, bridge, etc.

- **Hard goods/soft goods:** What one identifies as hard goods and soft goods will vary depending on the industry involved. For example, in data processing, hard goods include apparatus such as, computers and terminals, while soft goods include software, data storage media and the like.

- **Fuel and lubricants:** Fuel and lubricants are used for the oiling purpose for the equipment used in the process which again varies with the type of industry.

- **Stationery goods:** It includes writing material like, paper, pen, ink, etc., which are used by the people involved in the process.

- **Primary packing material:** Packing material like, plastic, paper, etc. are used to pack the finished goods for sale.

Meaning of Material Management

Materials management can be defined as "an integrated management approach to planning, acquiring, processing and distributing production materials from the raw material state to the finished product state". Materials management is a key business function that is responsible for the coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner, so as to provide pre-determined service to the customer at a minimum cost. Materials management has such sub-fields as:

- inventory management
- value analysis
- Receiving
- stores and management of the obsolete
- slow moving and non moving materials

Materials management is the branch of logistics that deals with tangible components of a supply chain. It covers the acquisition of spare parts and replacements, quality control of purchasing and ordering such parts, and the standards involved in ordering, shipping, and warehousing the said parts. The physical arrangement of materials/spare parts is called materials management. Planning and control of the functions supporting the complete cycle (flow) of materials, and the associated flow of information is called materials management. Materials management is concerned with the control of materials in such a manner which ensures maximum return on working capital. Materials management is concerned with the location and purchase of materials needed, their storage and movement. It also arranges to keep an account of them. It is also responsible for planning their movement through manufacturing processes, store rooms and distribution channels. Materials management provides an

integrated systems approach to the coordination of the materials activities and the control of total material costs. The materials management function ranges from receiving the material requisitions from the user department to placement of purchase orders and then, on the other hand, receiving the materials from vendors and making it available to the users departments.

Objectives of Material Management

The fundamental objectives of the materials management function are acquisition of materials and services:

- of the right quality
- in the right quantity
- at the right time
- from the right source

The key **objectives** of material management are as follows:

- Buying at the lowest price, consistent with the desired quality and service
- Maintaining a high inventory turnover, by reducing excess storage, carrying costs and inventory losses occurring due to deteriorations, obsolescence and pilferage
- Maintaining continuity of supply, preventing interruption of the flow of materials and services to users
- Maintaining the specified material quality level and a consistency of quality. This permits efficient and effective operation
- Developing reliable alternate sources of supply to promote a competitive atmosphere in performance and pricing
- Minimising the overall cost of acquisition by improving the efficiency of operations and procedures

- Hiring, developing, motivating and training personnel and providing a reservoir of talent
- Developing and maintaining good supplier relationships in order to create a supplier attitude and desire furnish the organisation with new ideas, products, and better prices and service
- Achieving a high degree of cooperation and coordination with user departments
- Maintaining good records and controls that provides an audit trail and ensures efficiency and honesty
- Participating in 'Make or Buy' decisions

Scope of Material Management

The scope of material management includes the following aspects:

- Material planning
- Cataloguing or coding the materials
- Standardisation
- Scheduling
- Procurement
- Inspection
- Quality control
- Packaging
- Storage
- Inventory control
- Distribution
- Disposal

PURCHASING MANAGEMENT

Purchasing is an important function of materials management. In any industry purchase means buying of equipment, materials, tools, parts etc. required for industry. The importance of the purchase function varies with nature and size of industry. In small industries, this function is performed by the works manager and in large manufacturing concerns; this function is done by a separate department. The moment a buyer places an order he commits a substantial portion of the finance of the corporation which affects the working capital and cash flow position. He is a highly responsible person who meets various salesmen and thus can be considered to have been contributing to the public relations efforts of the company. Thus, the buyer can make or mar the company's image by his excellent or poor relations with the vendors

DEFINITION : The purchasing can be defined as the process of buying and procuring the materials, parts, components, equipment, spare parts, tools and supporting items required by industries or any organization to deliver its products as per customer requirements at the competitive rates and of good quality.

OBJECTIVES OF PURCHASING

The basic objective of the purchasing function is to ensure continuity of supply of raw materials, subcontracted items and spare parts and to reduce the ultimate cost of the finished goods. In other words, the objective is not only to procure the raw materials at the lowest price but to reduce the cost of the final product. The objectives of the purchasing department can be outlined as under:

- **To avail the materials, suppliers and equipments at the minimum possible costs:** These are the inputs in the manufacturing operations. The minimization of the input cost increases the productivity and resultantly the profitability of the operations.

- To ensure the continuous flow of production through continuous supply of raw materials, components, tools etc. with repair and maintenance service.

- **To increase the asset turnover:** The investment in the inventories should be kept minimum in relation to the volume of sales. This will increase the turnover of the assets and thus the profitability of the company.

- **To develop an alternative source of supply:** Exploration of alternative sources of supply of materials increases the bargaining ability of the buyer, minimisation of cost of materials and increases the ability to meet the emergencies.

- **To establish and maintain the good relations with the suppliers:** Maintenance of good relations with the supplier helps in evolving a favourable image in the business circles. Such relations are beneficial to the buyer in terms of changing the reasonable price, preferential allocation of material in case of material shortages, etc.

- **To achieve maximum integration with other department of the company:** The purchase function is related with production department for specifications and flow of material, engineering department for the purchase of tools, equipments and machines, marketing department for the forecasts of sales and its impact on procurement of materials, financial department for the purpose of maintaining levels of materials and estimating the working capital required, personnel department for the purpose of manning and developing the personnel of purchase department and maintaining good vendor relationship.

- **To train and develop the personnel:** The Purchasing department is manned with varied types of personnel. The company should try to build the imaginative employee force through training and development.

- **Efficient record keeping and management reporting:** Paper processing is inherent in the purchase function. Such paper processing should be standardised so that record keeping can be facilitated. Periodic reporting to the management

Functions of Purchase Department

The job of a materials manager is to provide, to the user departments, the right material at the right time in the right quantity of right quality at the right price from the right source. To meet these objectives, the activities undertaken include selection of sources of supply, finalisation of terms of purchase, placement of

purchase orders, follow up, maintenance of relations with vendors, approval of payments to vendors, evaluating, rating and developing vendors.

The functions of purchase department are to:

- support company operations with an uninterrupted flow of materials and services
- buy competitively and wisely
- help keep a minimum inventory
- develop reliable alternate sources of supply
- develop good vendor relationship and a good continuing supplier relationship
- achieve maximum integration with the other departments of the firm
- train and develop highly competent personnel who are motivated to make the firm as well as their department succeed
- develop policies and procedures which permit accomplishment of the preceding objectives at the lowest reasonable operating cost

Before deciding the quantity to be purchased, the following factors should be taken into consideration:

- Quantity already ordered
- **Quantity reserved:** It may happen that a particular quantity, though in hand, might have been reserved for a particular job which is not available for other purposes. In such cases, this quantity is treated as if it is not in stock.

Funds availability: Amounts which are kept aside for drawing up purchase budget should be considered are used. For any organisation, purchasing function assumes importance for the reason that it fulfils, to a great extent, the input needs of the organisation. An organisation needs input of right quality at right price from the right source in right quantity at the right time. Called 5 R's (right things to do), these determine the broad parameters within which the purchasing functions in any organisation. Depending upon the size and nature of operation, the quantum of purchase of product and services vary. Purchase Department carries out all the tasks associated with the development of policies, procedures, controls and the mechanics for coordinating purchasing operations with those of other departments.

The following are the **important activities** of a purchase department:

- **Buying activity:** It addresses to a wide gamut of activities such as, reviewing requisitions, analysing specifications, investigating vendors, interviewing sales people studying costs and prices and negotiating.

- **Expediting:** This is basically the order follow up activity involving various types of vendor relationship work. It involves reviewing order status, providing clarifications on transportation, writing and emailing vendors etc.

- **Special projects (Non routine):** In order to facilitate smooth purchasing in a highly competitive business environment, purchasing authorities have to keep building the capacity to do better by taking up as special projects

activities such as vendor development, vendor registration, value analysis, market studies, system studies etc

- **Routine:** Purchasing process or procedure involving routine or every day activities such as dealing with specific purchase file, placing orders, maintaining records of commodities, vendors etc.

PURCHASING POLICY AND PROCEDURES

Purchasing Policy : Every organization sets the purchasing policy. In order to accomplish the aims and objectives of the organization, the directives and instructions issued to purchase the materials are called the policy of purchasing. Policy means the set of principles, purposes and rules of action framed written or otherwise applied to fulfill the goals of organization.

Advantages and Disadvantages of Policies

Advantages

1. Policies define and clarify top management objectives.
2. The written instructions communicate views of management.
3. It provides guidance to the person to adopt the working method of the same type.
4. It provides a framework for decision-making.

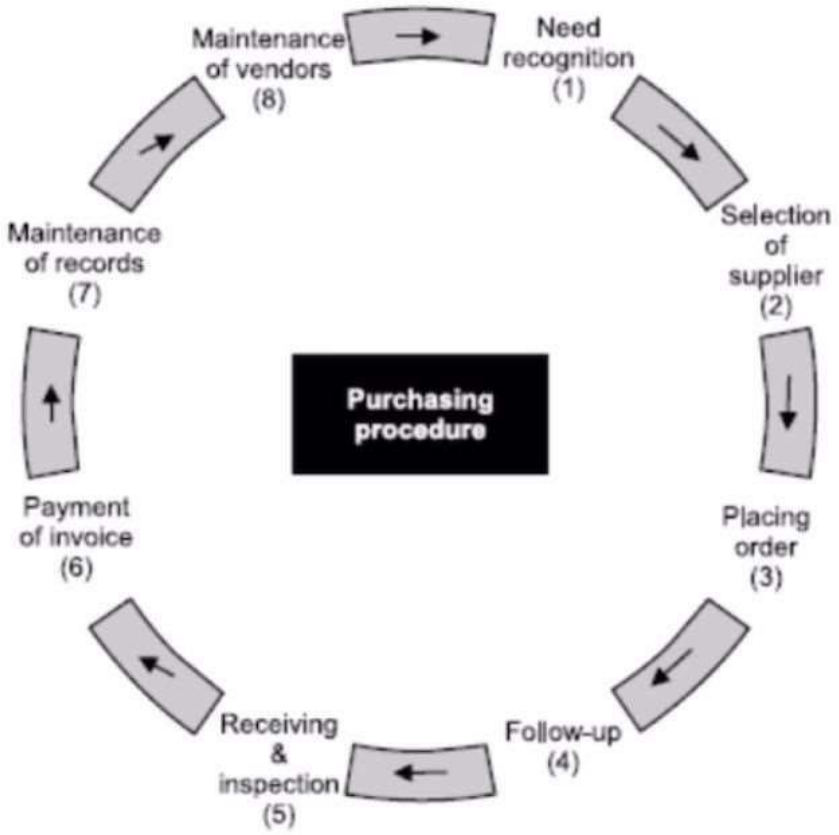
Disadvantages

1. In large size organizations it is difficult to communicate the policy and particularly the changes, which are made quite often.
2. All the employees may not be aware of the purpose of policy.
3. Greater the number of policies it is more difficult to create awareness

PROCEDURES OF PURCHASING

The policy statements are guidelines and they should be difficult to understand. Lengthy and too many policies have to be avoided. The purchasing policy provides the guidelines and direction in the following categories. It defines:

(a) Rules of purchasing
(b) Conduct of purchasing personnel
(c) Social and minority business objectives
(d) Operational issues



The procedure describes the sequence of steps leading to the completion of an identified specific task. The purchasing procedure comprises the following steps as indicated in Fig.

1. **Recognition of the need:** The initiation of procedure starts with the recognition of the need by the needy section. The demand is lodged with the purchase department in the prescribed Purchase Requisition Form forwarded by the authorised person either directly or through the Stores Department. The purchase requisition clearly specifies the details, such as, specification of materials, quality and quantity, suggested supplier, etc. Generally, the low value sundries and items of common use are purchased for stock while costlier and special items are purchased according the

production programmes. Generally, the corporate level executives are authorized signatories to such demands. Such purchases are approved by the Board of Directors. The reference of the approval is made on requisition and a copy of the requisition is sent to the secretary for the purpose of overall planning and budgeting.

2. **The Selection of the supplier:** The process of selection of supplier involves two basic aspects: searching for all possible sources and short listing out of the identified sources. The complete information about the supplier is available from various sources, such as, trade directories, advertisement in trade journals, direct mailing by the suppliers, interview with suppliers, salesmen,suggestions from business associates, visit to trade fair, participation in industries convention, etc. Identification of more and more sources helps in selecting better and economical supplier. It should be noted that the low bidder is not always the best bidder. When everything except price is equal, the low bidder will be selected. The important considerations in the selection are the price, ability to supply the required quantity, maintenance of quality standards, financial standing etc. It should be noted that it is not necessary to go for this process for all types of purchases. For the repetitive orders and for the purchases of low-value, small lot items, generally the previous suppliers with good records are preferred.

3. **Placing the order:** Once the supplier is selected the next step is to place the purchase order. Purchase order is a letter sent to the supplier asking to supply the said material. At least six copies of purchase order are prepared by the purchase section and each copy is separately signed by the

purchase officer. Out these copies, one copy each is sent to store-keeper, supplier, accounts section, inspection department and to the department placing the requisition and one copy is retained by the purchase department for record

4. **Follow-up of the order:** Follow-up procedure should be employed wherever the costs and risks resulting from the delayed deliveries of materials are greater than the cost of follow-up procedure, the follow-up procedure tries to see that the purchase order is confirmed by the supplier and the delivery is promised. It is also necessary to review the outstanding orders at regular intervals and to communicate with the supplier in case of need. Generally, a routine urge is made to the supplier by sending a printed post card or a circular letter asking him to confirm that the delivery is on the way or will be made as per agreement. In absence of any reply or unsatisfactory reply, the supplier may be contact through personal letter, phone, telegram and/or even personal visit.

5. **Receiving and inspection of the materials:** The receiving department receives the materials supplied by the vendor. The quantity are verified and tallied with the purchase order. The receipt of the materials is recorded on the specially designed receiving slips or forms which also specify the name of the vendor and the purchase order number. It also records any discrepancy, damaged condition of the consignment or inferiority of the materials. The purchase department is informed immediately about the receipt of the materials. Usually a copy of the receiving slip is sent to the purchase department.

6. **Payment of the invoice:** When the goods are received in satisfactory condition, the invoice is checked before it is approved for the payment. The invoice is checked to see that the goods were duly authorised to purchase, they were properly ordered, they are priced as per the agreed terms, the quantity and quality confirm to the order, the calculations are arithmetically correct etc.

7. **Maintenance of the records:** Maintenance of the records is an important part and parcel of the efficient purchase function. In the industrial firms, most of the purchases are repeat orders and hence the past records serve as a good guide for the future action. They are very useful for deciding the timings of the purchases and in selecting the best source of the supply. 8. Maintenance of vendor relations: The quantum and frequency of the transactions with the same key suppliers provide a platform for the purchase department to establish and maintain good relations with them. Good relations develop mutual trust and confidence in the course of the time which is beneficial to both the parties. The efficiency of the purchase department can be measured by the amount of the goodwill it has with its suppliers.

SELECTION OF SUPPLIER

Selection of the right supplier is the responsibility of the purchase department. It can contribute substantially to the fundamental objectives of the business enterprise. Different strategies are required for acquiring different types of materials. The selection of supplier for standardised products will differ from

non-standardised products. Following factors are considered for the selection of suppliers:

SELECTION OF SOURCES OF SUPPLIER AND VENDOR DEVELOPMENT

The best buying is possible only when the decision maker is familiar with all possible sources of supply and their respective terms and conditions. The purchase department should try to locate the appropriate sources of the supplier of various types of materials. This is known as survey stage'. The government department, large manufacturing and business companies like public sector firms keep the records of approved suppliers depending upon their

(i) Manufacturing capabilities

(ii) Financial conditions

(iii) Reputation

(iv) Service facility

(v) Quality of product produced by them

Trade Journals and Trade Directories

Trade journals or magazines routinely publish the information about different companies about their technical or innovative developments of a material, product, process or service. Advertisements in trade journals about the products and services also help in selection of suppliers. Almost all the industries publish the directories of firms and companies which produce their items and services required to facilitate to refer to the selection of supplier and vendors.

Industrial Exhibitions and Trade Fairs

These are the best ways of exposure directly for the industrial products to sell and purchase of items. It is also exhibiting the latest technological developments, introduction of new products and information about latest prices.

Internet Searches

Now the internet is providing lot of information and access to the remote suppliers. Ecommerce and EBusiness is helping to make direct purchase from the manufacturers to get the items worldwide.

Local or Distant Suppliers

The problems associated with distant supplies is that the cost of transportation, packing, insurance, sales tax and octroi etc. are high and the repair and maintenance become difficult by such suppliers. Therefore, it is always preferred to select local suppliers to purchase the materials provided their performance and prices are comparable to distance suppliers.

Small or Big Suppliers

There are various types of companies and manufacturers in India for example, large scale manufacturers, medium scale, small scale and mini-scale manufacturing concerns. Each one is having its own advantages and disadvantages for supplying their products. Large-scale manufacturers find large

potential buyers. They supply goods at cheaper cost. The small-scale manufacturers however render more attention to their clients and ensure about quality of items and delivery time

VENDOR

- Vendor means a person (or company) who sells and supplies his (or its) products.
- An intelligent purchasing involves the rational selection of sources from which materials can be obtained. Considerable efforts are needed in identifying, developing and evaluating the prospective suppliers. It is also essential to continuously appraise the performance of the current suppliers

- First Stage ⇒ survey stage
- Second Stage ⇒ enquiry stage
- Third Stage ⇒ negotiation & selection stage
- Fourth Stage ⇒ experience & evaluation stage

Survey stage-source of information on potential vendors

Survey stage-source of information on potential vendors Survey involves collecting information on different suppliers of the desired materials. *The following sources may be consulted:*

- **Trade directories:** These give information regarding dealers addresses, regional offices, names, types and range of products including spares. Electronic digital interchange, for example :- computer based trade directories, is useful source.

- **Trade journals:-** These contain advertisements of the materials related to specific industries, namely chemicals, plastic , steel etc. these journals can be subscribed, relevant information can be classified, indexed, updated and maintained in proper files by the buyer.

- **Telephone directories :-** These contain classified advertisement arranged alphabetically, item-wise or groupwise. Examples are, abrasives, air-conditioners, castings, diamonds and so on. It is an easy and fast means of collecting the sources.

- Suppliers catalogues many manufacturers periodically publish catalogues and pamphlets giving details of the products they manufacture. These catalogues contain considerable technical information, specifications, prices etc.

- **Salesmen :-** they trained person who continuously visit customers for the possible business and orders. Through their sales presentations, it is possible to collect the information and clarify doubts. They help in expanding the knowledge to a great extent.

Inquiry stage- selection of potential suppliers :

- After a list of possible suppliers is complied, the next step is to inquire a few of them further. It involves a detailed analysis of supplier's activities furnished by vendors or collected by the company.

- Accreditation, FDA approval and certifications namely ISO 9000, 9002 etc, facilitate the selection. A comparison may be made in regard to four aspects of competition
    - Technological competition
    - Service competition
    - Price competition

- Time based competition (TBC) i. e, response time for delivery.

- **Internal facilities of vendors:-** Adequate facilities are essential for the manufacture and quality control of items. These must be done under the

supervision of qualified and experienced staff. Additional facilities are to be explored for the supply of items in time. Modern equipment, quality of inputs, maintenance, size and capacity, layout , housekeeping and cleanliness are inspected

- **Financial adequacy and stability:-** the financial status of the vendor company and relations with his bankers should be explored, so that items can be produced and supplied without any financial difficulties at any stage. For this purpose, previous years balance sheets of the company are helpful.

- **Reputation of the vendor:** Methods of selling and distribution network are important. The supplier 's reputation in the market in regard to prices and promises of delivery dates should be considered.

- **Location of the vendor's factory:-** It should be nearer to the buyers factory. If it is located at a very distant town. Vendors representative should be available in the locality. after sales service :- In case of equipment, after sales service is essential. The availability of maintenance engineers in the locality or town should be advantageous

- **Industrial relations:** Industrial conflicts, frequent strikes, layoffs etc, seriously affect the supplies. The industrial climate, work culture, employer-employee relationship should be given consideration. Hence, one has to

very careful in dealing with such companies. In addition, several other factors should be considered.

- Is the supplier a direct manufacturer or only an agent?
- Is the buyer looking for one or more suppliers?
- Whether the supplier is small or big?

Hence, full enquiry into all factors should be made in order to arrive at a decision regarding the selection of sources.

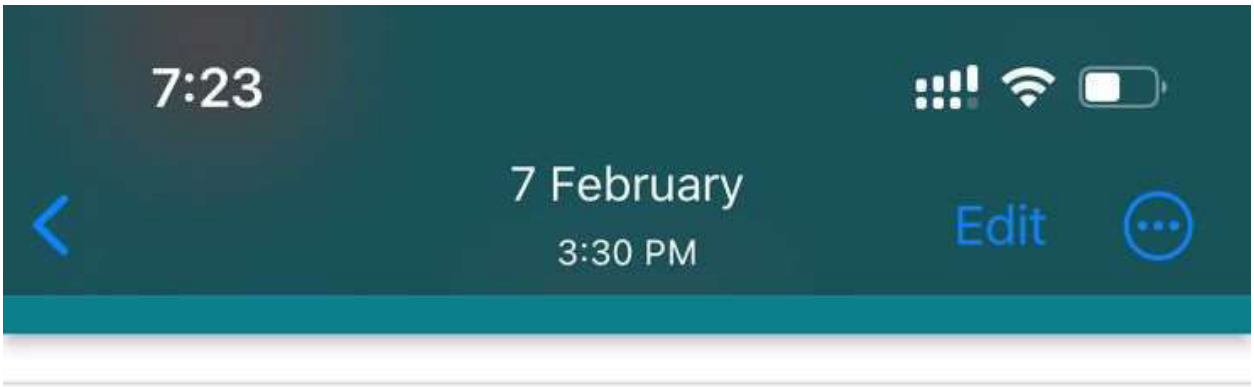
Thus shortlisted suppliers are considered for the third stage.

Negotiation and selection stagefinalization of vendors:

- The vendors who are successful in the enquiry stage may be called for negotiations in order to discuss business possibilities.
- During this stage, various terms namely credit, quantity discount, quality specifications etc, can be decided.
- Finally, a list of approved vendor's drawn.
- Accordingly, purchase orders are placed with the approved vendors.
- Several aspects of buying techniques are used at third stage.

Experience and evaluation stage:

- At this stage, the buyer evaluates and appraises the performance of the vendor. The objective is to improve the performance of vendors in which they are deficient.
- The evaluation is done especially on two counts, namely quality (judged by rejection of lot- size) and delivery (judged by delays on delivery).



VENDOR EVALUATION

The evaluation of the supplier is done through the weightage assigned by measuring their performance by purchase. The criteria are

1. Cost price
2. Quality
3. Delivery The following variables to be considered while evaluating the quotations of the suppliers:

- **Cost factors:** Price, transportation cost, installation cost if any, tooling and other operations cost, incidence of sales tax and excise duty, terms of payment and cash discount are considered in cost factor.

- **Delivery:** Routing and F.O.B. terms are important in determining the point at which the title to the goods passes from vendor to the buyer and the responsibility for the payment of the payment charges.

- **Design and specification factors:** Specification compliance, specification deviations, specification advantages, important dimensions and weights are considered in line with the demonstration of sample, experience of other users, after sale services etc.

- **Quality performance:** The buyer can compare the supplier quality and define supplier quality performance

- **Legal factors:** Legal factors include warranty, cancellation provision, patent protection, public liability, federal laws and reputation compliance

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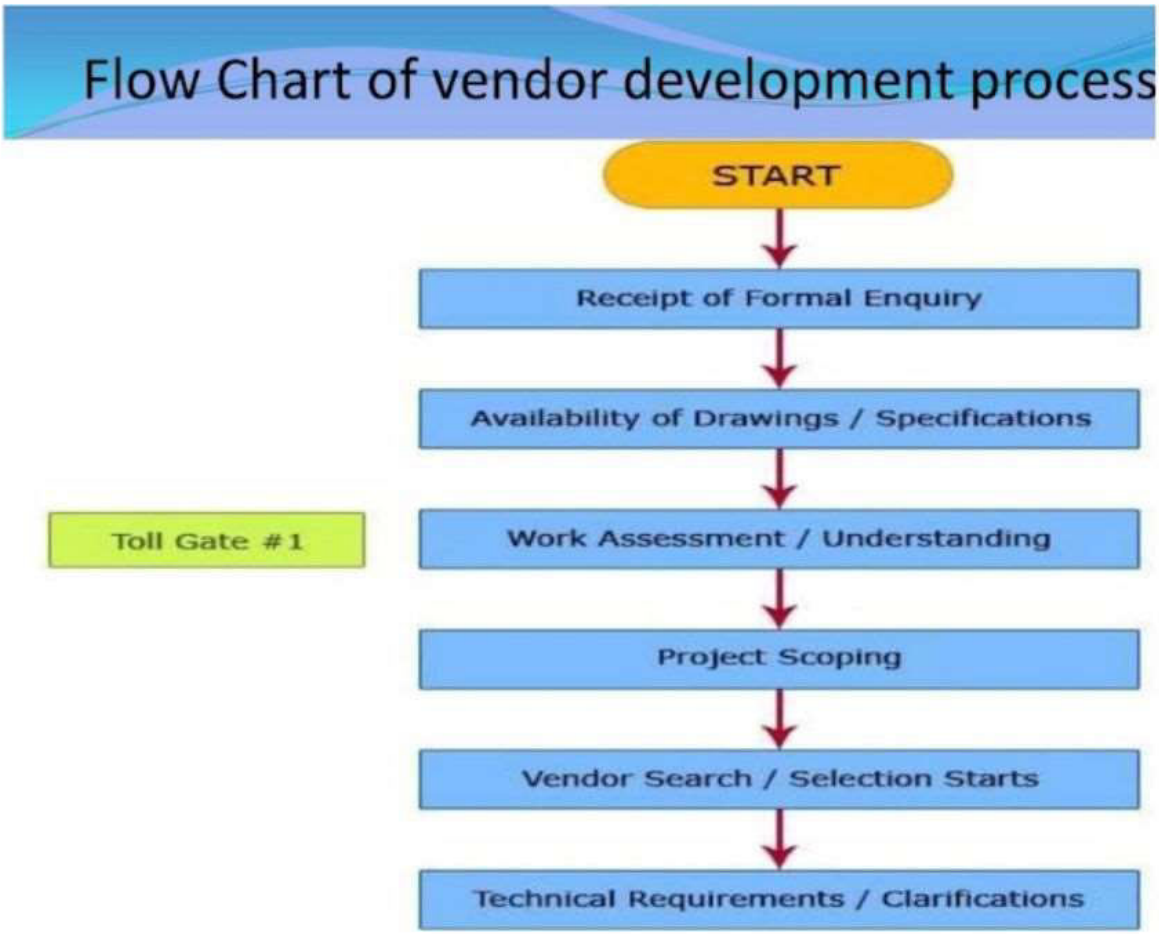
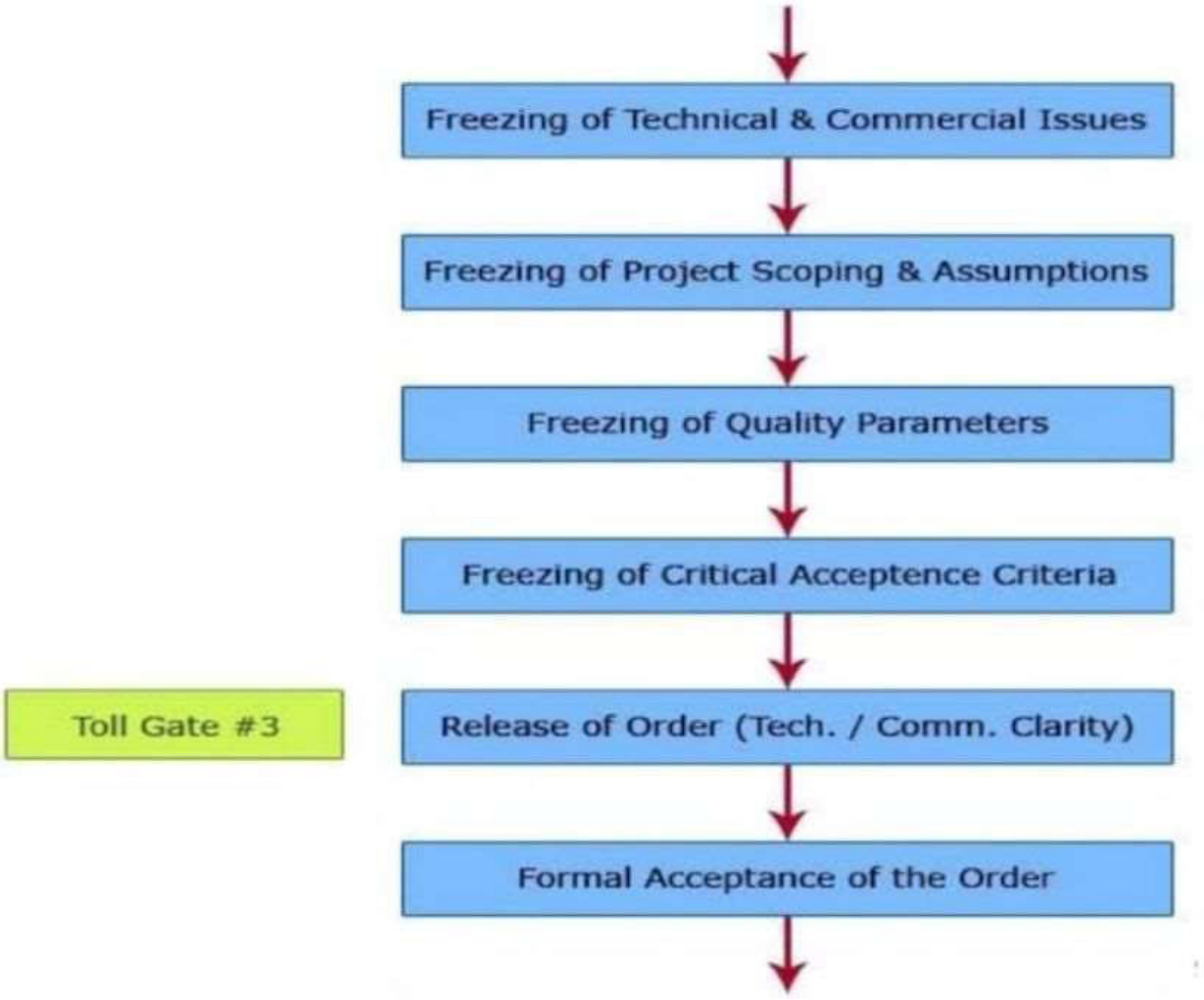
VENDOR DEVELOPMENT

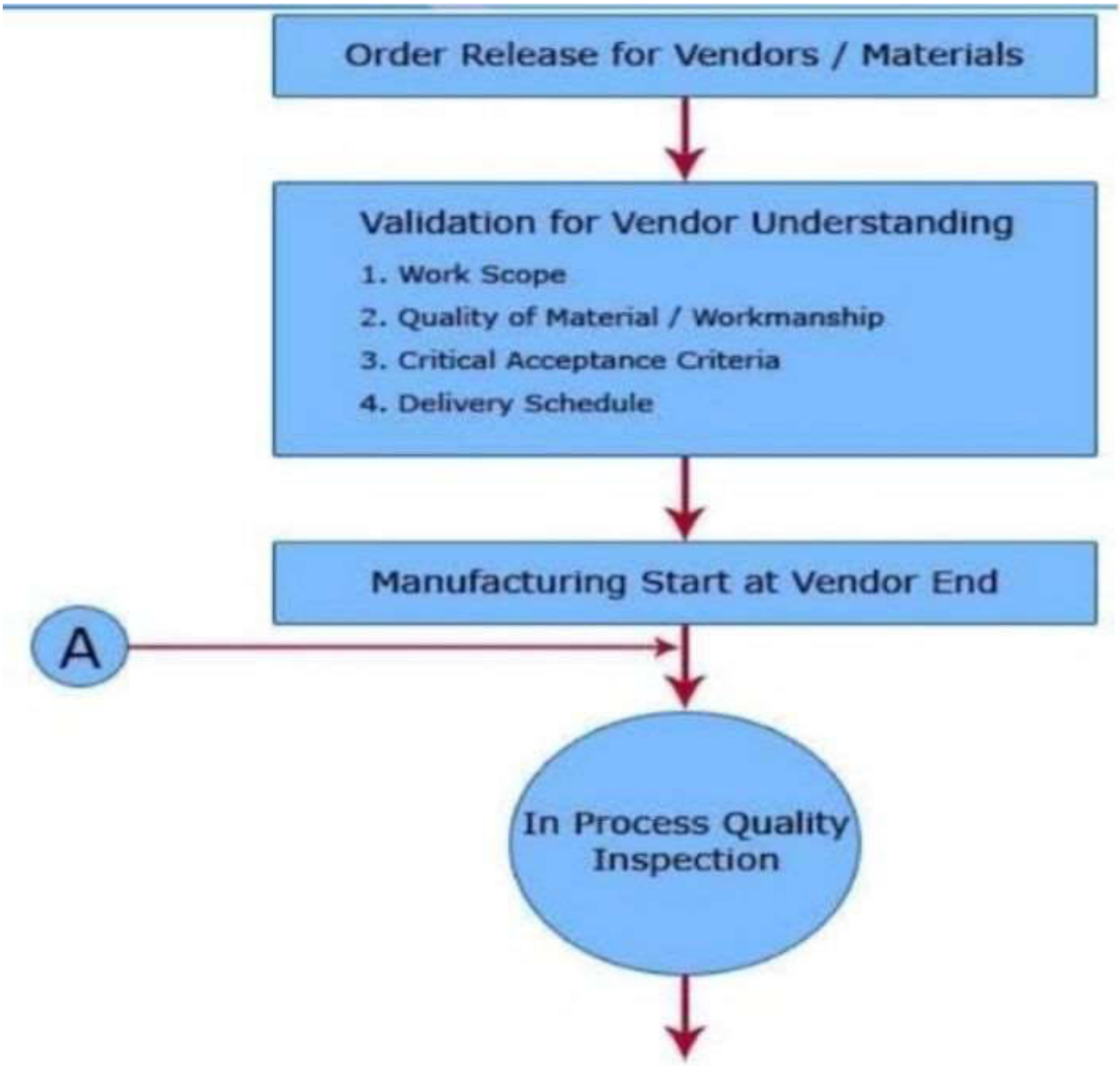
The survey stage highlights the existence of the source. A business inquiry is made with the appropriate supplier. It is known as the 'Inquiry Stage'. Here a short listing is made out of the given sources of suppliers in terms of production facilities and capacity, financial standing, product quality, possibility of timely supply, technical competence, manufacturing efficiency, general business policies followed, standing in the industry, competitive attitude, and interest in buying orders etc. A survey of the following will help in developing the possible sources of supply

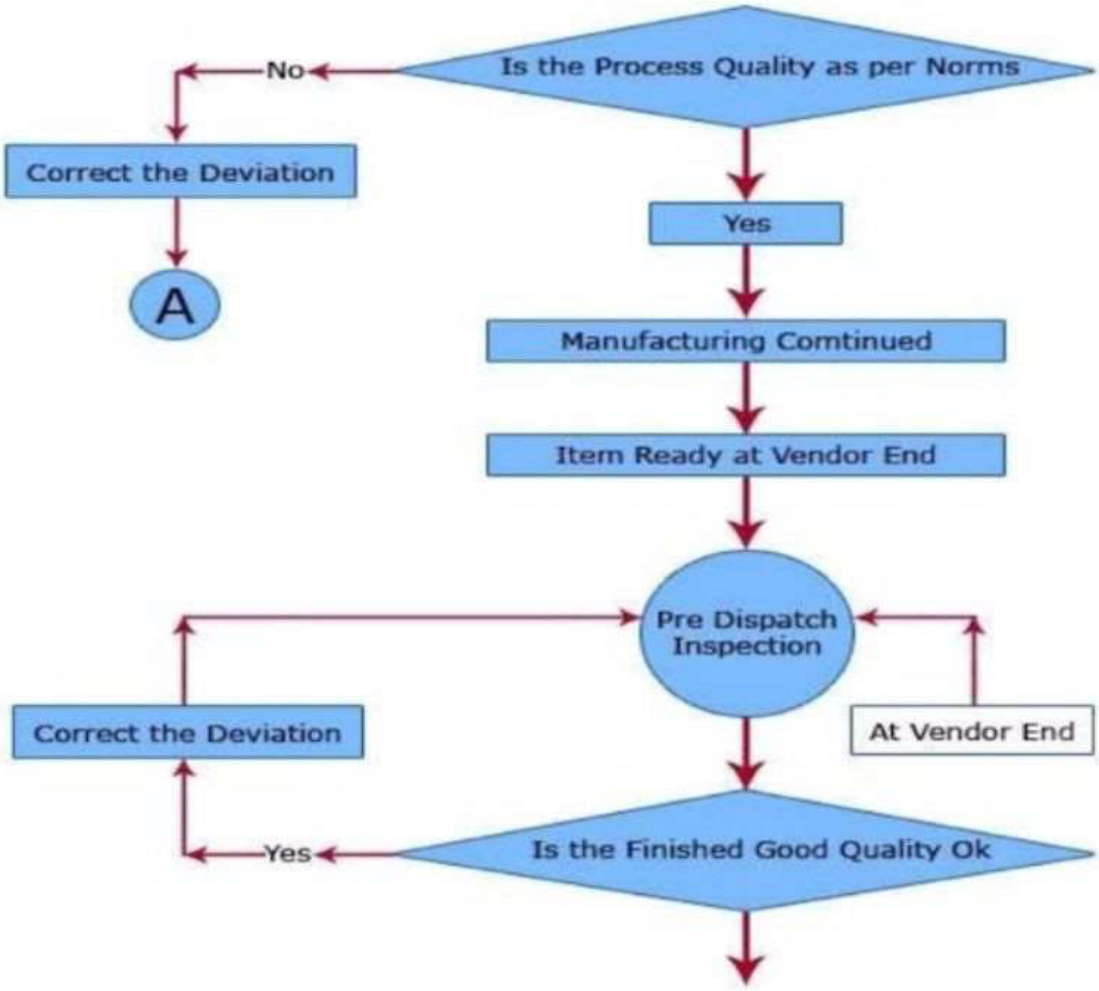
- Specialised trade directories.
- Assistance of professional bodies or consultants.
- The buyer's guide or purchase handbook.
- The manufacturer's or distributor's catalogue.
- Advertisements in dailies. Advertisement in specialised trade journals.
- Trade fair exhibitions.

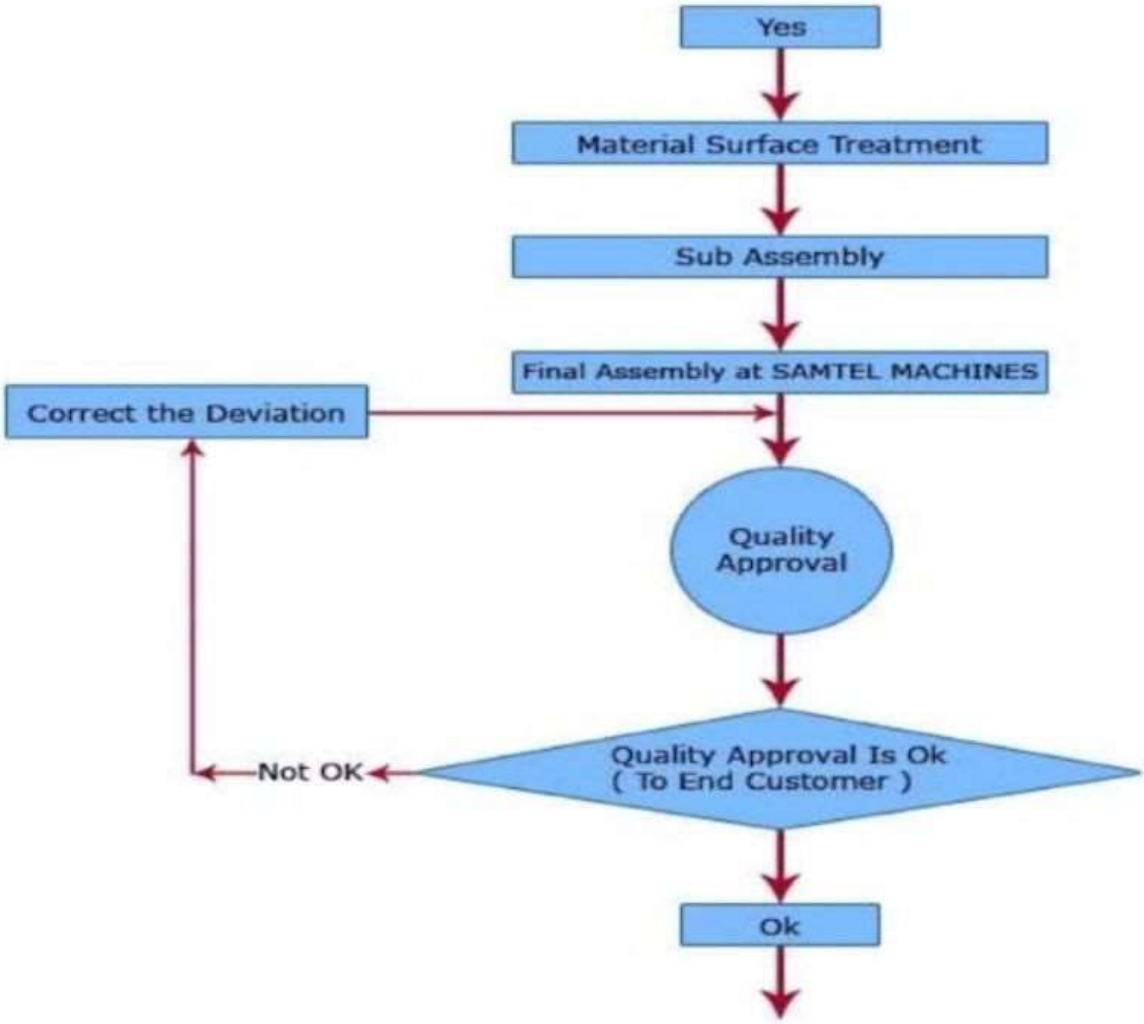
Hence these above plays a major role in vendor development

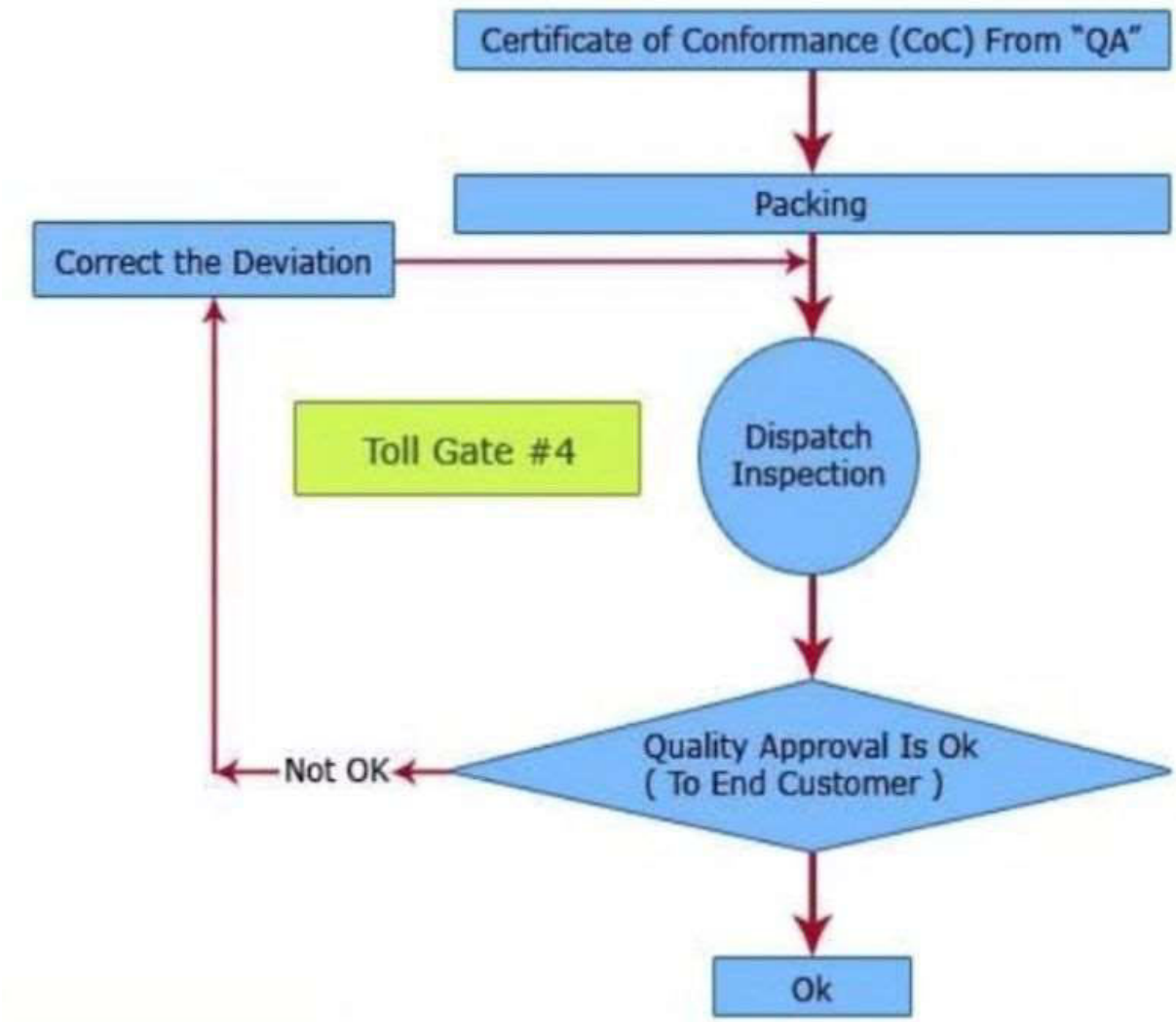

Flow Chart of vendor development process
START
Receipt of Formal Enquiry
Availability of Drawings / Specifications
Toll Gate #1
Work Assessment / Understanding
Project Scoping
Vendor Search / Selection Starts
Technical Requirements / Clarifications

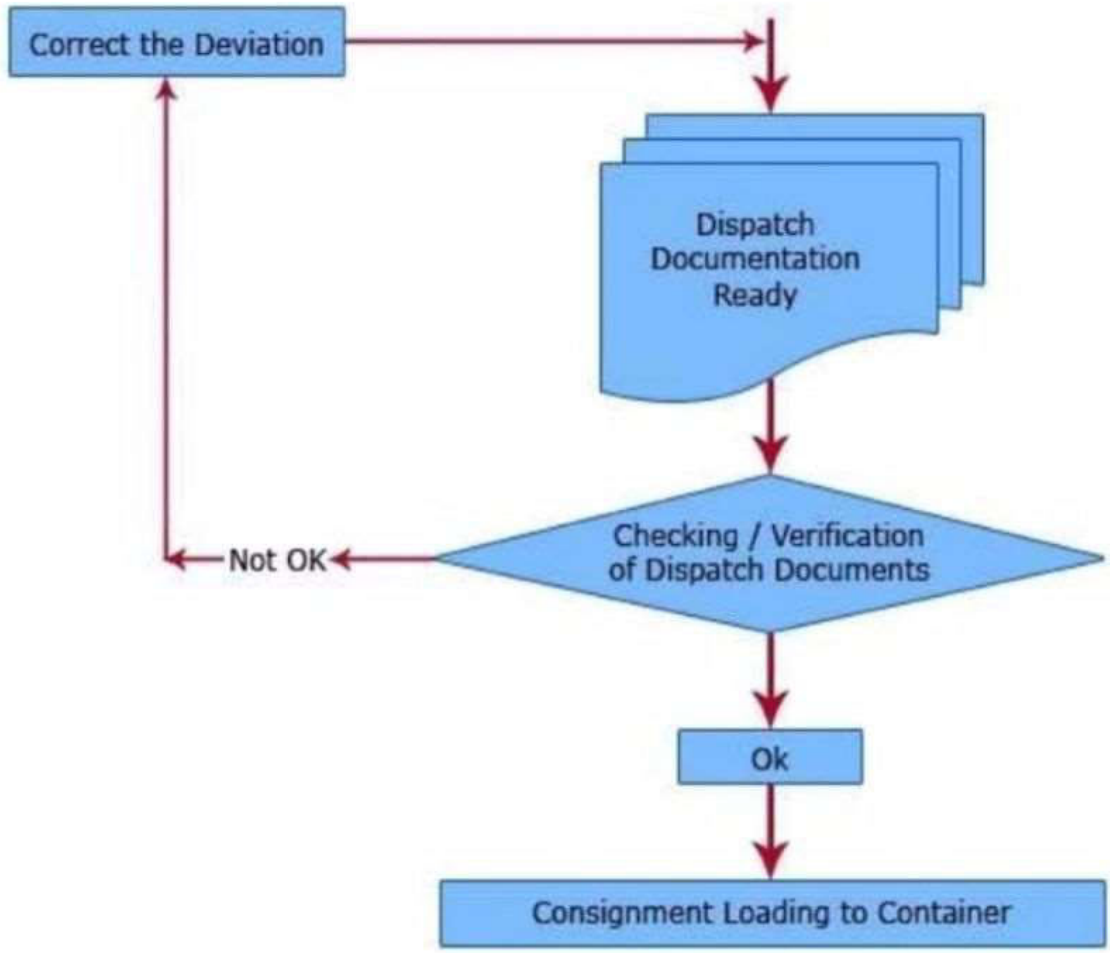

Freezing of Technical & Commercial Issues
Freezing of Project Scoping & Assumptions
Freezing of Quality Parameters
Freezing of Critical Acceptence Criteria
Toll Gate #3
Release of Order (Tech. / Comm. Clarity)
Formal Acceptance of the Order


Order Release for Vendors / Materials
Validation for Vendor Understanding
1. Work Scope
2. Quality of Material / Workmanship
3. Critical Acceptance Criteria
4. Delivery Schedule
Manufacturing Start at Vendor End
A
In Process Quality Inspection


Is the Process Quality as per Norms
No
Correct the Deviation
A
Yes
Manufacturing Comtinued
Item Ready at Vendor End
Pre Dispatch Inspection
At Vendor End
Correct the Deviation
Yes
Is the Finished Good Quality Ok


Yes
Material Surface Treatment
Sub Assembly
Final Assembly at SAMTEL MACHINES
Correct the Deviation
Quality Approval
Quality Approval Is Ok (To End Customer)
Not OK
Ok


Certificate of Conformance (CoC) From "QA"
Packing
Correct the Deviation
Toll Gate #4
Dispatch Inspection
Quality Approval Is Ok (To End Customer)
Not OK
Ok


Correct the Deviation
Dispatch Documentation Ready
Checking / Verification of Dispatch Documents
Not OK
Ok
Consignment Loading to Container

VENDOR RATING

Vendor rating: The evaluation of supplier or vendor rating provides valuable information which help in improving the quality of the decision. In the vendor rating three basic aspects are considered namely quality, service and price. How much weight should be given to each of these factors is a matter of judgment and is decided according to the specific need of the organization. Quality would be the main consideration in the manufacturing of the electrical equipments while price would be the prime consideration in the product having a tense competitive market and for a company procuring its requirements under

the blanket contract with agreed price, the supplier rating would be done on the basis of two variables namely quality and delivery. In order to compare the performance of various vendors, it is necessary to rate them. The rating of supplier (vendor) will be done on the following parameters.

(i) Quality performance
(ii) Delivery performance
(iii) Price performance

Quality Performance The supplier can be judged for quality performance from the view point of rejected lots. If a supplier has supplied 100 pieces and 10 pieces are rejected out of this lot, he has a rating of 90%.

$$\textbf{Weightage} = \frac{Number\ of\ lot\ accepted}{Number\ of\ lot\ supplied} \times 100$$

Delivery Performance

Delivery performance can be made in two ways

$$\text{Adherence to time schedule} = \frac{Number\ of\ deliveries\ made\ in\ time \times weightage}{Total\ number\ of\ scheduled\ delivery}$$

$$\text{Adherence to quantity schedule} = \frac{Quantity\ supplied \times weightage}{Scheduled\ delivery}$$

Price Performance

Price is very important criterion for evaluating a vendor which is as = Minimum price offered × weightage vendor's price.

Purchase Requisition

Purchase Requisition is an indication given to the purchases department to purchase certain material. It is issued either by the storekeeper (in respect of material required for regular production purposes) or by production department (in respect of special materials required).

Following particulars must appear in purchase requisition:

- Material to be purchased: It should be clearly specified. To make it more specific, in addition to the description of the material required, the code number should also be specified.
- When it is required: Unless the material is required for regular production purposes (when the storekeeper himself will place the purchase requisition as soon as it reaches the ordering level), purchase requisition should mention the last date by which the material is required. Ideally the material should be purchased whenever the market for the same is favourable.
- How much to be purchased: Purchase requisition should state the quantity of the material required.

Types of Purchase Requisitions

Different kinds of requisitions used are as follows:

Standard requisition

Also called as indent for material (or service), materials requisition plan etc., a requisition is made by an authorised person in the concerned department. However, it has to be countersigned by a senior officer who checks the entries made in. Normally a requisition, in a pre-printed format, contains particulars such as, the detailed description of materials or services to be purchased, desired quantity, schedule for receipt of such material/service, the estimated price, possible sources and the account head, requisitioner's identity

In any organisation, only a limited number of personnel are empowered to countersign the requisition as it amounts to authorisation of the expenditure. Purchase department usually maintains a list of such officers so as to check the validity of the purchase requisitions. Normally, there is a delegation of power of authority for authorising a requisition. This is expressed in terms of the financial limits up to which an officer can authorise a requisition for a capital or revenue item. These details must also be available with the purchase department.

Travelling requisition

As the name suggests, this requisition form travels from the requisitioning department to the purchaser directly who then only authorises the supplier through a purchase order to deliver the required material. This document is generally used for requisitioning items that are required frequently in bulk quantities over a long period of time. Usually, for repeat items such as, in inventory, a card containing the details of previous supply containing material specifications, suppliers details, last purchased price, reorder point, usage details are written permanently and provisions for entering date, quantity required,

names of requisitioned and authoriser are available. On getting it, the purchaser only has to take these details for placement of order. The travelling requisition which is a permanent document of the originating department is returned to it. It reduces the paper work and eases the operation.

Bills of materials

Bill of material is a comprehensive list of materials needed to produce a product or service. It is basically the details of materials needed, theirspecification, quantity, required delivery schedule, etc. It is often used as a sequel to firming of a production plan, a stage where the exact material/service needs are known.

Lead Time

Lead time is the amount of time that passes from the start of a process until its conclusion. Companies review lead time in manufacturing, supply chain management, and project management during pre-processing, processing, and post-processing stages. By comparing results against established benchmarks, they can determine where inefficiencies exist.

Reducing lead time can streamline operations and improve productivity, increasing output, and revenue. By contrast, longer lead times negatively affect sales and manufacturing processes.

1. **Customer Lead Time –** the amount of time taken between order confirmation and order fulfillment (either pick up or delivery depending on the agreement with the customer).

2. **Material Lead Time –** the amount of time it takes to place an order with a supplier and receive it, from confirmed order to having it on hand.
3. Factory/Production Lead Time – the amount of time it takes to build and ship a product if all the materials are available.
4. **Cumulative Lead Time** – the total amount of time it would take from confirmed order to delivery of product if you had to order all the materials (if none were on hand). It is the summation of material lead time and factory lead time.

Importance of Lead Time

- Lead Time is an important factor for customer satisfaction. Typically customers want goods or service as fast as possible with minimal effort.
- For manufacturing and assembly the concept of Lead Time is married to and has a direct relationship with the amount of inventory that exists at different points in the overall supply chain.
- If Customer Lead Time is less than: Material Lead Times, Production Lead Times, or Cumulative Lead Times it will result in the holding of inventory within the supply chain at some or all points. Variation and inconsistency will often compound this issue – it will cause the holding of stock or inventory to mitigate risks in the supply chain.

Purchase order

A purchase order is a contract between the buyer and the seller and it gives specific information like product or services to be delivered, delivery date, and

any other terms and conditions including the price. The purchase order is also called as 'PO'

Purchase order procedure

The purchase order procedure commences with the order approval which is enacted by the approver on the request raised by the department which is in need of the raw material.

Once the approval is given, the PO is sent back to the requisitioner i.e., the concerned department and from there it is sent to the supplier for his acceptance.

Once the purchase order is accepted by the vendor, it becomes a legally binding document which outlines the required items, the agreed-upon price, delivery expectations and payment terms.

The journey mentioned above is a complete cycle that you get to see in bigger business and business who are well-organized. It is also possible one may simply raise a purchase order without the need for approval because the procurement process followed by the business does not need it.

There is no question of right or wrong, as long it meets the business needs, you are free to follow any purchase order cycle.

Details of purchase order

Purchase orders contain the details ranging from products that are ordered to shipping address. Below are details that usually forms part of purchase order:

- Products that are ordered
- Quantities i.e., (kg, meters, numbers etc.,)

- **MROInventories:** Maintenance, Repair, and Operating supplies which are consumed in the production process but which do not become the part of the product. (e.g. lubricating oil, soap, machine repair parts)

- **In-process Inventories:** Semi-finished products found at various stages in the production operation.

- **Finished goods Inventories:** Completed products ready for shipment.

PROCESS OF INVENTORY MANAGEMENT AND CONTROL

Inventory management and control refers to the planning for optimum quantities of materials at all stages in the production cycle and evolving techniques which would ensure the availability of planned inventories. Following four steps are involved in the process:

a) **Determination of optimum inventory levels and procedures of their review and adjustment:** It is a significant step but a difficult one. Too much inventory results in locking up of working capital accompanied by increased carrying costs (but reduced ordering costs). Excess inventories, however, guarantee uninterrupted supply of materials and components, to meet production schedules and finished goods to meet customers demand. Too less of inventory releases working capital for alternative uses and reduces carrying costs and increases ordering costs. But there is the risk of stock out costs.

b) **Determination of the degree of control that is required for the best results:**The second aspect of inventory management is to decide just how much control is needed to realize the objectives of inventory management. The difficulty is best overcome by categorization of inventory on the basis of value. Popularly called the ABC categorization, this approach is useful in deciding the degree of control. 'A' class items are 'high' in value but 'low' in quantity, 'C' class inventories are the opposite of 'A' group i.e. 'high' in quantity and 'low' in value. In between are the 'B' group stocks which are more or less equal in quantity and value proportion to the total inventory. Tight control is exercised on 'A' category items through accurate records of receipts and issues and by co-ordination of incoming shipments with production managements.

c) **Planning and design of the Inventory control system:** An inventory system provides the organizational structure and the operating policies for maintaining and controlling goods to be inventoried. The system is responsible for ordering and receipt of goods, timing the order placement, and keeping track of what has been ordered, how much, and from whom.

SCOPE OF INVENTORY CONTROL

a) **Formulation of Policy:** First of all, the policies of investment procurement, storage, handling, shortage and stock-outs, deterioration obsolescence etc. are to be formulated under the scientific system of inventory control. What, when and how much of purchasing and fixation of minimum and maximum levels is also to be determined for a given period of time.

b) **Organization structure:** After determining inventory policy, the next step is to decide the location, layout and types of storehouse. It will facilitate the movement of materials and thus minimize he storage and handling cost of stores.

c) **Determination of Economic Order Quantity:** Economic order quantity or economic lot size (if it related to production) refers to that quantity ordered in a single purchase or number of units should be manufactured in a single run, so that the total costs-ordering or set up costs and inventory carrying costs are at the minimum. So, the determination of E.O.Q. is also within the scope of inventory control.

d) **Determination of Safety Stock:** Safety Stock is defined as the difference between the amount stocked to satisfy demand during a certain time interval and the mean expected demand for that period. It is for the purpose of providing protection against depletion. If demand remained constant and lead time, usage value, variability of lead time demand, carrying charges and the importance of its stock out cost. Again, determination of buffer stock reserve stock is included in the management of inventory.

e) **Determination of Lead Time:** By lead time is the time that lapse between the raising of an indent by the stores as well as users and the receipt of materials by them. Lead time is of fundamental importance in determining inventory levels.

f) **Minimum Material Handling and Storage Cost:** Stores Organization activities are arranged in such a manner that the cost of bringing in the

storehouse and issuing from the storehouse of the various stores will minimize the storage and material handling cost of stores.

g) **Effectiveness towards running stores:** The determination of policies of the location, layout and material storage handling equipment will certainly help in the effective working of storage organization.

INVENTORY CONTROL TECHNIQUES

Inventory control techniques are employed by the inventory control organization within the framework of one of the basic inventory models, viz., fixed order quantity system or fixed order period system. Inventory control techniques represent the operational aspect of inventory management and help realize the objectives of inventory management and control. Several techniques of inventory control are in use and it depends on the convenience of the firm to adopt any of the techniques. What should be stressed, however, is the need to cover all items of inventory and all stages, i.e. from the stage of receipt from suppliers to the stage of their use. The techniques most commonly used are the following:

ABC Analysis

ABC analysis is a business term used to define an inventory categorization technique often used in materials management. It is also known as 'Selective Inventory Control.' ABC analysis provides a mechanism for identifying items which will have a significant impact on overall inventory cost whilst also providing a mechanism for identifying different categories of stock that will require different management and controls. When carrying out an ABC analysis, inventory items are valued (item cost multiplied by quantity issued/consumed in period) with the

results then ranked. The results are then grouped typically into three bands. These bands are called ABC codes;

"A class" Inventory will typically contain items that account for 80-85% of total value, or 05-10% of total items.

"B class" Inventory will have around 15% of total value, or 10-20% of total items.

"C class" Inventory will account for the remaining 05-10%, or 80-85% of total items.

ABC Analysis is similar to the Pareto principle in that the "A class" group will typically account for a large proportion of the overall value but a small percentage of the overall volume of inventory.

A-Class	**B-Class**	**C-Class**
Very Strict Control	Moderate Control	Loose control
Handled by Senior Executives	Low safety stock	High safety stock
Maximum efforts to reduce lead time	Order once in 3-months	Bulk Ordering can be made

Accurate forecast	Quarterly review	Rough estimate
No safety stock	Moderate efforts	Annually review

VED Analysis

VED stands for vital, essential and desirable. This analysis relates to the classification of maintenance spare parts and denotes the essentiality of stocking spares. The spares are split into three categories in order of importance. From the view-points of functional utility, the effects of non-availability at the time of requirement or the operation, process, production, plant or equipment and the urgency of replacement in case of breakdown. Some spares are so important that their non-availability renders the equipment or a number of equipment in a process line completely inoperative, or even causes extreme damage to plant, equipment or human life. On the other hand some spares are non-functional, serving relatively unimportant purposes and their replacement can be postponed or alternative methods of repair found. All these factors will have direct effects on the stocks of spares to be maintained.

V: Vital items which render the equipment or the whole line operation in a process totally and immediately inoperative or unsafe; and if these items go out of stock or are not readily available, there is loss of production for the whole period.

E: Essential items which reduce the equipment's performance but do not render it inoperative or unsafe; nonavailability of these items may result in temporary

loss of production or dislocation of production work; replacement can be delayed without affecting the equipment's performance seriously; temporary repairs are sometimes possible.

D: Desirable items which are mostly non-functional and do not affect the performance of the equipment. As the common saying goes "Vital Few — trivial many", the number of vital spares in a plant or a particular equipment will only be a few while most of the spares will fall in 'the desirable and essential' category. However, the decision regarding the stock of spares to be maintained will depend not only on how critical the spares are from the functional point of view (VED analysis) but also on the annual consumption (user) cost of spares (ABC — analysis) and, therefore, for control of spare parts both VED and ABC analyses are to be combined

FSN Analysis

The FSN Analysis is based on the rate of issue or rate of usage of spare parts and the alphabets F S and N stands for Fast Moving, Slow Moving and Non Moving items. The FSN classification system categorizes the items based on how frequently the parts are issued and how frequently they are used.

Usual classification of Items at Inventory can be classified based on the following criteria

Fast Moving – Items which are frequently issued from inventory which are more than once for a specific time period

Slow Moving – Items which are less frequently issued which might be once in a specific time period

Non-Moving – Items which are not issued from the inventory at all in a specific time period

The FSN classification system is extremely helpful in distributing spare parts which are kept near the dispensing are having items which belong to the fast-moving category. The items which fall into the non-moving category can be discontinued if the further scope of use is not expected. As companies in production for a longer period have a specific percentage of non-moving spare parts which are usually disposed of at regular intervals. Selling the spare parts or reusing the same can be again in the capital which can be used for other uses.

Economic Order Quantity (EOQ)

Economic order quantity (EOQ) is that size of the order which gives maximum economy in purchasing any material and ultimately contributes towards maintaining the materials at the optimum level and at the minimum cost.

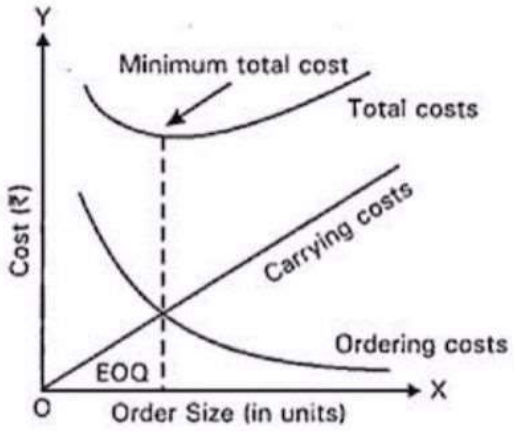
In other words, the economic order quantity (EOQ) is the amount of inventory to be ordered at one time for purposes of minimizing annual inventory cost.

The quantity to order at a given time must be determined by balancing two factors: (1) the cost of possessing or carrying materials and (2) the cost of acquiring or ordering materials. Purchasing larger quantities may decrease the unit cost of acquisition, but this saving may not be more than offset by the cost of carrying materials in stock for a longer period of time.

The carrying cost of inventory may include:

- **Interest on investment of working capital**
- **Property tax and insurance**
- **Storage cost, handling cost**
- **Deterioration and shrinkage of stocks**
- **Obsolescence of stocks**

Formula of Economic Order Quantity (EOQ): The different formulas have been developed for the calculation of economic order quantity (EOQ). The following formula is usually used for the calculation of



EOQ can be determined by the following formula :

$$EOQ = \sqrt{\frac{2 \times A \times O}{C}}$$

where

A = Annual purchase requirement in units
O = Ordering cost per order
C = Carrying cost per unit

Quantity Discounts in EOQ Model

In the EOQ model, the purchasing cost per unit item is neglected in the analysis because it is constant and hence should not affect the level of inventory.

However, it often happens that the purchasing price per unit depends on the size of the quantity purchased. This situation usually occurs in the form of discrete price breaks or quantity discounts. In such cases, the purchasing price should be considered in the inventory model.

All quantity discount

Consider the inventory model with instantaneous stock replenishment and no shortage. Assume a discount of 2% is offered on order quantities in excess of 2000 units and a 3% discount on orders in excess of 5000 units. Calculating total costs

When Q = 2000,

T C = Rs. 201420.00

When Q = 1224.74,

T C = Rs. 204898.00

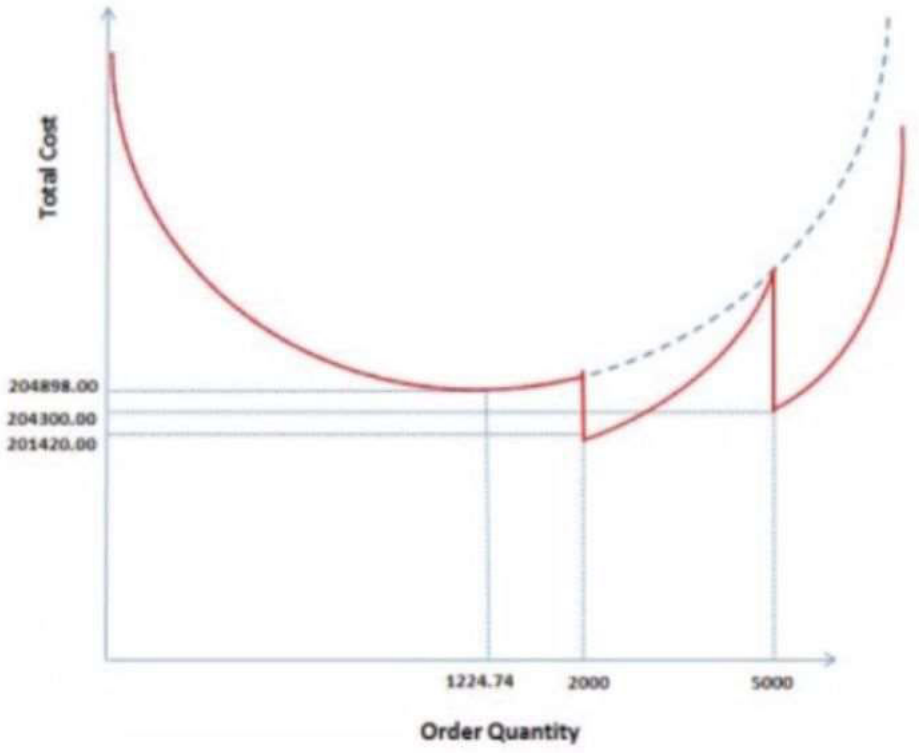
When Q = 5000,

T C = Rs. 204300.00

The above values of discount are plotted on a chart. It is inferred that it might be economical to order inventory at the first discount price offered, rather that the computed optimal level (though a case to case evaluation is warranted). This first discount offer (2000 in this example) is called price break. Assuming another discount of 0.5% is offered at an order quantity of 1200, which is less than the

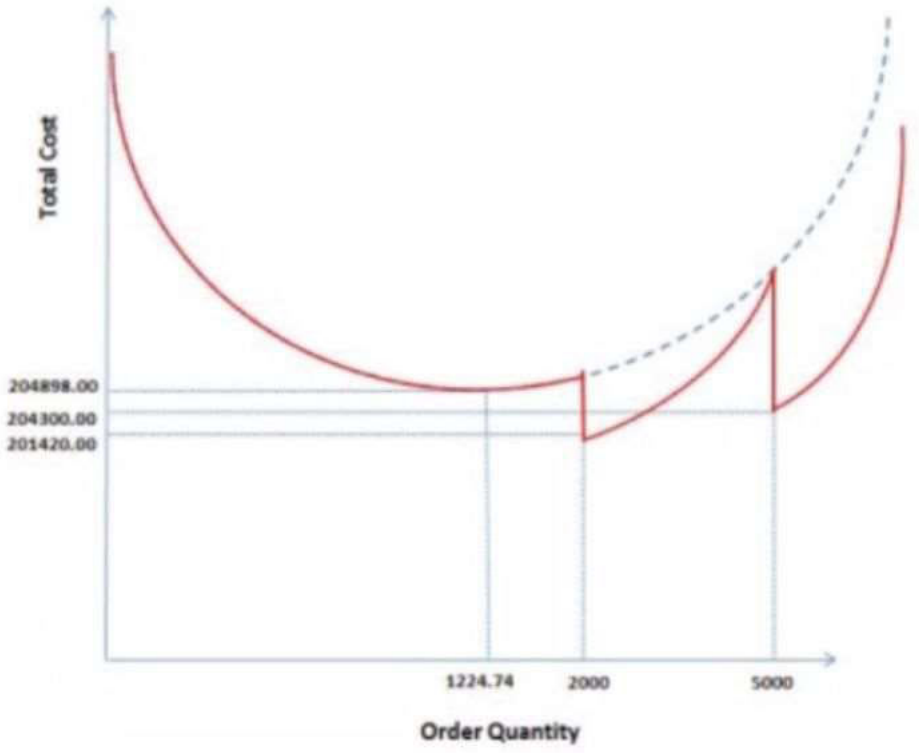
computed optimal order quantity; then it might be economical to avail that discount of 0.5% at the optimal order quantity of 1224.74. Verification of this statement is left as an exercise.

In summary, if discounts are offered at levels higher than the optimal order quantity, the first discount offer must be chosen and if the discount is at a level lesser than the optimal order quantity, that discount must be availed at the optimal order quantity level. Such discount mechanisms are also known as all quantity discounts, as discount is offered on all items when the quantity exceeds a specified level. An alternate scheme is a marginal discount scheme.



computed optimal order quantity; then it might be economical to avail that discount of 0.5% at the optimal order quantity of 1224.74. Verification of this statement is left as an exercise.

In summary, if discounts are offered at levels higher than the optimal order quantity, the first discount offer must be chosen and if the discount is at a level lesser than the optimal order quantity, that discount must be availed at the optimal order quantity level. Such discount mechanisms are also known as all quantity discounts, as discount is offered on all items when the quantity exceeds a specified level. An alternate scheme is a marginal discount scheme.



Safety stock in inventory management and control

Safety stock is the inventory ordered or carried in stock in excess of what the expected demand will be. Its purpose is to absorb any internal or external supply and demand shocks to the supply chain. It can also help mask or cover other problems present in the supply chain temporarily such as excessive downtime and maintenance issues.

Safety stock can be determined in many ways. Some businesses or operations determine safety stock levels by past history of events, a certain number of days of demand, as a percentage of periodic order sizes, or through a probabilistic model.

If operations or the supply chain is fairly reliable or not as complex, historical safety stock levels or a certain number of days as buffer stock is as reliable measure to establish the required safety stock. If demand is unstable and the supply chain is complex and relies on several third party providers then it could be beneficial to use a probabilistic model in determining the required safety stock.

Safety stock Probability model

Calculating the required safety stock using a simple probability model can be easily done in Microsoft excel, on a statistics calculator or a cumulative distribution table. The data needed before performing the calculation is:

-The average demand per time period.

-The standard deviation of demand per time period

-The assumption that demand is normally distributed

Calculating the safety stock level:

- Decide to what level of probability you would like not to run out of stock. For example if it is required that 95% of the time stock doesn't run out, this also means that only 5% of the time stock will actually run out.

- Using Microsoft excel enter the following formula into a blank cell:=normsinv(p)
  Where p is the probability of not running out, in this case 95% or 0.95

- The number of standard deviations will be displayed required to achieve this probability level. In this example this would evaluate to 1.6448 standard deviations

- Multiply the number obtained in step 4, the number of standard deviations, times the standard deviation of demand obtained during the initial data collection.

This is a simple but effective safety stock calculation model which can also be integrated into other inventory management models such as EOQ or any other multiple order or single order inventory models. It can also be found in some inventory software packages.

When safety stock is present in inventory warehouses and it is rarely used or there is an excess safety stock holding, it can incur large inventory and holding costs that can outweigh the advantages of having it in the first place. It is important that most of this stock is also correctly rotated and managed in order to reduce write-offs and obsolesce.