

Planning the Software Project: Cost estimation: COCOMO model, Risk management, Project scheduling, Personnel planning, Team structure, Staffing, Software configuration management, Project monitoring.

## Software Project Planning

A Software Project is the complete methodology of programming advancement from requirement gathering to testing and support, completed by the execution procedures, in a specified period to achieve intended software product.

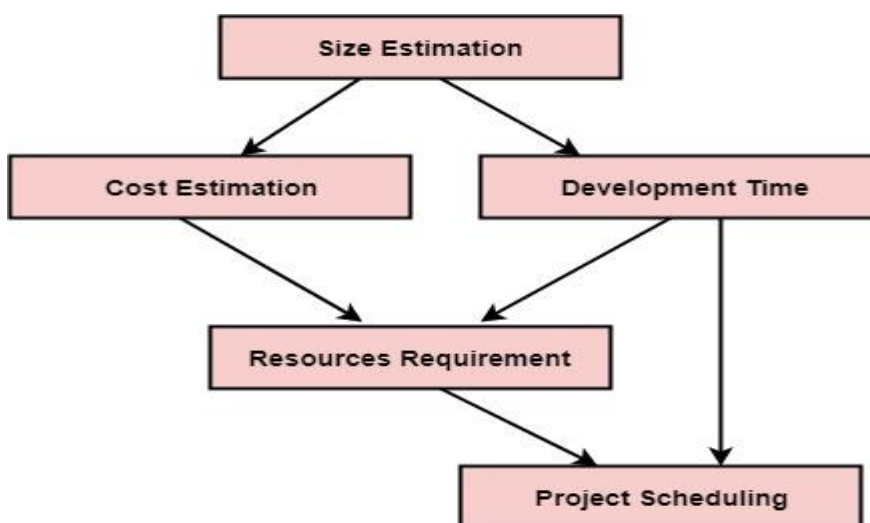
## Need of Software Project Management

Software development is a sort of all new streams in world business, and there's next to no involvement in structure programming items. Most programming items are customized to accommodate customer's necessities. The most significant is that the underlying technology changes and advances so generally and rapidly that experience of one element may not be connected to the other one. All such business and ecological imperatives bring risk in software development; hence, it is fundamental to manage software projects efficiently.

## Software Project Manager

Software manager is responsible for planning and scheduling project development. They manage the work to ensure that it is completed to the required standard. They monitor the progress to check that the event is on time and within budget. The project planning must incorporate the major issues like size & cost estimation scheduling, project monitoring, personnel selection evaluation & risk management. To plan a successful software project, we must understand:

- Scope of work to be completed
- Risk analysis
- The resources mandatory
- The project to be accomplished
- Record of being followed



Software Project planning starts before technical work start. The various steps of planning activities are:

The size is the crucial parameter for the estimation of other activities. Resources requirement are required based on cost and development time. Project schedule may prove to be very useful for controlling and monitoring the progress of the

project. This is dependent on resources & development time.

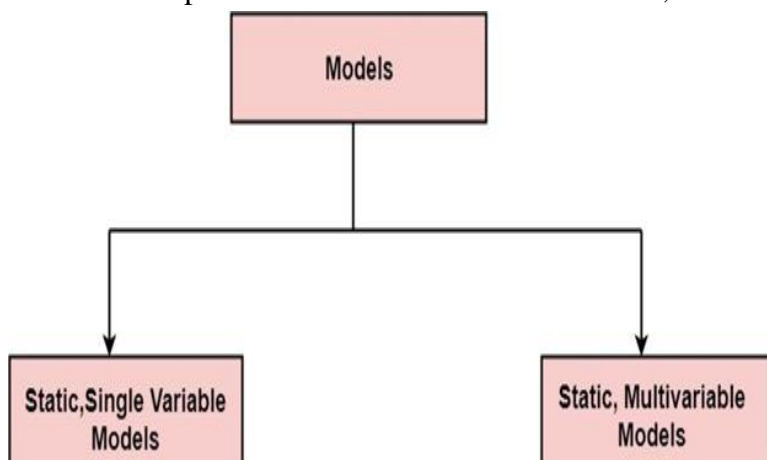
## Software Cost Estimation

For any new software project, it is necessary to know how much it will cost to develop and how much development time will it take. These estimates are needed before development is initiated, but how is this done? Several estimation procedures have been developed and are having the following attributes in common.

1. Project scope must be established in advanced.
2. Software metrics are used as a support from which evaluation is made.
3. The project is broken into small PCs which are estimated individually.  
To achieve true cost & schedule estimate, several option arise.
4. Delay estimation
5. Used symbol decomposition techniques to generate project cost and schedule estimates.
6. Acquire one or more automated estimation tools.

## Uses of Cost Estimation

1. During the planning stage, one needs to choose how many engineers are required for the project and to develop a schedule.
2. In monitoring the project's progress, one needs to access whether the project is progressing according to the procedure and takes corrective action, if necessary.



### Cost Estimation Models

A model may be static or dynamic. In a static model, a single variable is taken as a key element for calculating cost and time. In a dynamic model, all variable are interdependent, and there is no basic variable.

**Static, Single Variable Models:** When a model makes use of single variables to calculate

desired values such as cost, time, efforts, etc. is said to be a single variable model. The most common equation is:

$$C=aL^b$$

**Where** C = Costs  
L= size  
a and b are constants

The Software Engineering Laboratory established a model called SEL model, for estimating its software production. This model is an example of the static, single variable model.

$$E=1.4L^{0.93}$$

$$DOC=30.4L^{0.90}$$

$$D=4.6L^{0.26}$$

**Where** E= Efforts (Person Per Month)  
 DOC=Documentation (Number of Pages)  
 D = Duration (D, in months)  
 L = Number of Lines per code

**Static, Multivariable Models:** These models are based on method (1), they depend on several variables describing various aspects of the software development environment. In some model, several variables are needed to describe the software development process, and selected equation combined these variables to give the estimate of time & cost. These models are called multivariable models.

WALSTON and FELIX develop the models at IBM provide the following equation gives a relationship between lines of source code and effort:

$$E=5.2L^{0.91}$$

In the same manner duration of development is given by

$$D=4.1L^{0.36}$$

The productivity index uses 29 variables which are found to be highly correlated productivity as follows:

$$I = \sum_{i=1}^{29} W_i X_i$$

Where  $W_i$  is the weight factor for the  $i^{th}$  variable and  $X_i = \{-1, 0, +1\}$  the estimator gives  $X_i$  one of the values **-1, 0 or +1** depending on the variable decreases, has no effect or increases the productivity.

**Example:** Compare the Walston-Felix Model with the SEL model on a software development expected to involve 8 person-years of effort.

- Calculate the number of lines of source code that can be produced.
- Calculate the duration of the development.
- Calculate the productivity in LOC/PY
- Calculate the average manning

**Solution:**

The amount of manpower involved = 8PY=96persons-months

(a)Number of lines of source code can be obtained by reversing equation to give:

$$L = \left( \frac{E}{a} \right)^{1/b}$$

Then

$$L(\text{SEL}) = (96/1.4)^{1/0.93} = 94264 \text{ LOC}$$

$$L(\text{SEL}) = (96/5.2)^{1/0.91} = 24632 \text{ LOC}$$

(b) Duration in months can be calculated by means of equation

$$\begin{aligned} D(\text{SEL}) &= 4.6 (L)^{0.26} \\ &= 4.6 (94,264)^{0.26} = 15 \text{ months} \end{aligned}$$

$$\begin{aligned} D(\text{W-F}) &= 4.1 L^{0.36} \\ &= 4.1 (24,632)^{0.36} = 13 \text{ months} \end{aligned}$$

(c) Productivity is the lines of code produced per persons/month (year)

$$P(\text{SEL}) = \frac{94264}{8} = 11783 \frac{\text{LOC}}{\text{Person}} - \text{Years}$$

$$P(\text{Years}) = \frac{24632}{8} = 3079 \frac{\text{LOC}}{\text{Person}} - \text{Years}$$

(d) Average manning is the average number of persons required per month in the project

$$M(\text{SEL}) = \frac{96P-M}{15M} = 6.4 \text{ Persons}$$

$$M(\text{W-F}) = \frac{96P-M}{13M} = 7.4 \text{ Persons}$$

## COCOMO Model

Boehm proposed COCOMO (Constructive Cost Estimation Model) in 1981. COCOMO is one of the most generally used software estimation models in the world. COCOMO predicts the efforts and schedule of a software product based on the size of the software.

**The necessary steps in this model are:**

1. Get an initial estimate of the development effort from evaluation of thousands of delivered lines of source code (KDLOC).
2. Determine a set of 15 multiplying factors from various attributes of the project.
3. Calculate the effort estimate by multiplying the initial estimate with all the multiplying factors i.e., multiply the values in step1 and step2.

The initial estimate (also called nominal estimate) is determined by an equation of the form used in the static single variable models, using KDLOC as the measure of the size. To determine the initial effort  $E_i$  in person-months the equation used is of the type is shown below

$$E_i = a * (\text{KDLOC})^b$$

The value of the constant a and b are depends on the project type.

**In COCOMO, projects are categorized into three types:**

1. Organic
2. Semidetached
3. Embedded

**1.Organic:** A development project can be treated of the organic type, if the project deals with developing a well-understood application program, the size of the development team is reasonably small, and the team members are experienced in developing similar methods of projects. **Examples of this type of projects are simple business systems, simple inventory management systems, and data processing systems.**

**2. Semidetached:** A development project can be treated with semidetached type if the development consists of a mixture of experienced and inexperienced staff. Team members may have finite experience in related systems but may be unfamiliar with some aspects of the order being developed. **Example of Semidetached system includes developing a new operating system (OS), a Database Management System (DBMS), and complex inventory management system.**

**3. Embedded:** A development project is treated to be of an embedded type, if the software being developed is strongly coupled to complex hardware, or if the stringent regulations on the operational method exist. **For Example:** ATM, Air Traffic control.

For three product categories, Bohem provides a different set of expression to predict effort (in a unit of person month)and development time from the size of estimation in KLOC(Kilo Line of code) efforts estimation takes into account the productivity loss due to holidays, weekly off, coffee breaks, etc.

According to Boehm, software cost estimation should be done through three stages:

1. Basic Model
2. Intermediate Model
3. Detailed Model

**1. Basic COCOMO Model:** The basic COCOMO model provide an accurate size of the project parameters. The following expressions give the basic COCOMO estimation model:

$$\text{Effort} = a_1 * (\text{KLOC})^{a_2} \text{ PM}$$

$$\text{Tdev} = b_1 * (\text{efforts})^{b_2} \text{ Months}$$

Where

**KLOC** is the estimated size of the software product indicate in Kilo Lines of Code,

$a_1, a_2, b_1, b_2$  are constants for each group of software products,

**Tdev** is the estimated time to develop the software, expressed in months,

**Effort** is the total effort required to develop the software product, expressed in **person months (PMs)**.

### **Estimation of development effort**

For the three classes of software products, the formulas for estimating the effort based on the code size are shown below:

**Organic:** Effort = 2.4(KLOC) 1.05 PM

**Semi-detached:** Effort = 3.0(KLOC) 1.12 PM

**Embedded:** Effort = 3.6(KLOC) 1.20 PM

### Estimation of development time

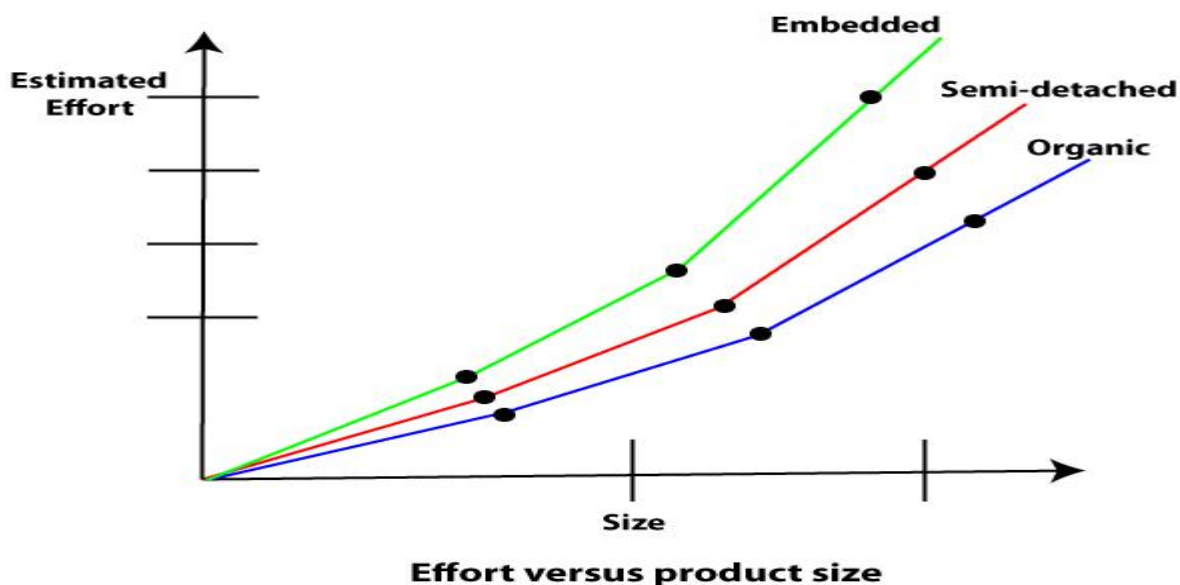
For the three classes of software products, the formulas for estimating the development time based on the effort are given below:

**Organic:**  $T_{dev} = 2.5(\text{Effort})^{0.38}$  Months

**Semi-detached:**  $T_{dev} = 2.5(\text{Effort})^{0.35}$  Months

**Embedded:**  $T_{dev} = 2.5(\text{Effort})^{0.32}$  Months

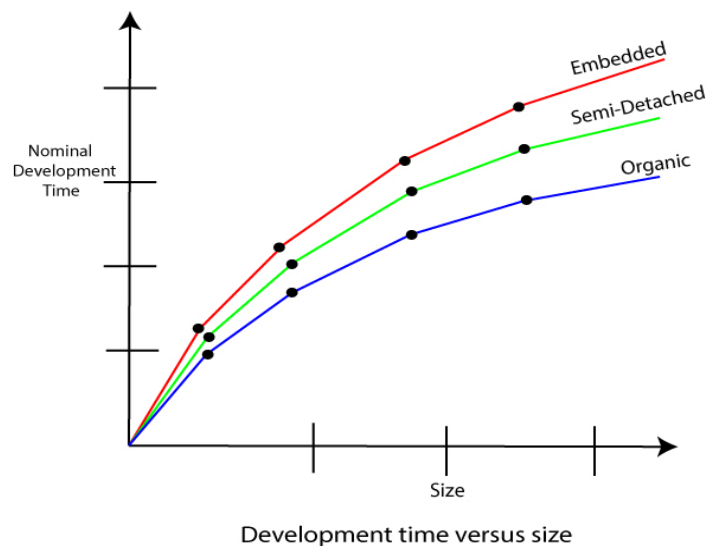
Some insight into the basic COCOMO model can be obtained by plotting the estimated characteristics for different software sizes. Fig shows a plot of estimated effort versus product size. From fig, we can observe that the effort is somewhat superlinear in the size of the software product. Thus, the effort required to develop a product increases very rapidly with project size.



The development time versus the product size in KLOC is plotted in fig. From fig it can be observed that the development time is a sub linear function of the size of the product, i.e. when the size of the product increases by two times, the time to develop the product does not double but rises moderately. This can be explained by the fact that for larger products, a larger number of activities which can be carried out concurrently can be identified. The parallel activities can be carried out simultaneously by the engineers. This reduces the time to complete the project. Further, from fig, it can be observed that the development time is roughly the same for all three categories of products. For example, a 60 KLOC program can be developed in approximately 18 months, regardless of whether it is of organic, semidetached, or embedded type.

From the effort estimation, the project cost can be obtained by multiplying the required effort by the manpower cost per month. But, implicit in this project cost computation is the assumption that the entire project cost is incurred on account of the manpower cost alone. In addition to manpower cost, a project would incur costs due to hardware and software required for the project and the company overheads for administration, office space, etc.

It is important to note that the effort and the duration estimations obtained using the COCOMO model are called a nominal effort estimate and nominal duration estimate. The term nominal implies that if anyone tries to complete the project in a time shorter than the estimated duration, then the cost will increase drastically. But, if anyone completes the project over a longer period of time than the estimated, then there is almost no decrease in the estimated cost value.



**Example1:** Suppose a project was estimated to be 400 KLOC. Calculate the effort and development time for each of the three model i.e., organic, semi-detached & embedded.

**Solution:** The basic COCOMO equation takes the form:

$$\text{Effort} = a_1 * (\text{KLOC})^{a_2} \text{ PM}$$

$$\text{Tdev} = b_1 * (\text{efforts})^{b_2} \text{ Months}$$

$$\text{Estimated Size of project} = 400 \text{ KLOC}$$

#### (i) Organic Mode

$$E = 2.4 * (400)^{1.05} = 1295.31 \text{ PM}$$

$$D = 2.5 * (1295.31)^{0.38} = 38.07 \text{ PM}$$

#### (ii) Semidetached Mode

$$E = 3.0 * (400)^{1.12} = 2462.79 \text{ PM}$$

$$D = 2.5 * (2462.79)^{0.35} = 38.45 \text{ PM}$$

#### (iii) Embedded Mode

$$E = 3.6 * (400)^{1.20} = 4772.81 \text{ PM}$$

$$D = 2.5 * (4772.8)^{0.32} = 38 \text{ PM}$$

**Example2:** A project size of 200 KLOC is to be developed. Software development team has average experience on similar type of projects. The project schedule is not very tight. Calculate the Effort, development time, average staff size, and productivity of the project.

**Solution:** The semidetached mode is the most appropriate mode, keeping in view the size, schedule and experience of development time.

$$\text{Hence } E = 3.0(200)^{1.12} = 1133.12 \text{ PM}$$

$$D = 2.5(1133.12)^{0.35} = 29.3 \text{ PM}$$

$$\text{Average Staff Size (SS)} = \frac{E}{D} \text{ Persons}$$

$$= \frac{1133.12}{29.3} = 38.67 \text{ Persons}$$

$$\text{Productivity} = \frac{\text{KLOC}}{E} = \frac{200}{1133.12} = 0.1765 \text{ KLOC/PM}$$

$$P = 176 \text{ LOC/PM}$$

**2. Intermediate Model:** The basic Cocomo model considers that the effort is only a function of the number of lines of code and some constants calculated according to the various software systems. The intermediate COCOMO model recognizes these facts and refines the initial estimates obtained through the basic COCOMO model by using a set of 15 cost drivers based on various attributes of software engineering.

### Classification of Cost Drivers and their attributes:

#### (i) Product attributes -

- Required software reliability extent
- Size of the application database
- The complexity of the product

#### Hardware attributes -

- Run-time performance constraints
- Memory constraints
- The volatility of the virtual machine environment
- Required turnabout time

#### Personnel attributes -

- Analyst capability
- Software engineering capability



- Applications experience
- Virtual machine experience
- Programming language experience

#### Project attributes -

- Use of software tools
- Application of software engineering methods
- Required development schedule

The cost drivers are divided into four categories:

Cost Drivers	RATINGS					
	Very low	Low	Nominal	High	Very High	Extra High
<b>Product Attributes</b>						
RELY	0.75	0.88	1.00	1.15	1.40	..
DATA	..	0.94	1.00	1.08	1.16	..
CPLX	0.70	0.85	1.00	1.15	1.30	1.65
<b>Computer Attributes</b>						
TIME	..	..	1.00	1.11	1.30	1.66
STOR	..	..	1.00	1.06	1.21	1.56
VIRT	..	0.87	1.00	1.15	1.30	..
TURN	..	0.87	1.00	1.07	1.15	..

Cost Drivers	RATINGS					
	Very low	Low	Nominal	High	Very high	Extra high
<b>Personnel Attributes</b>						
ACAP	1.46	1.19	1.00	0.86	0.71	..
AEXP	1.29	1.13	1.00	0.91	0.82	..
PCAP	1.42	1.17	1.00	0.86	0.70	..
VEXP	1.21	1.10	1.00	0.90	..	..
LEXP	1.14	1.07	1.00	0.95	..	..
<b>Project Attributes</b>						
MODP	1.24	1.10	1.00	0.91	0.82	..
TOOL	1.24	1.10	1.00	0.91	0.83	..
SCED	1.23	1.08	1.00	1.04	1.10	..

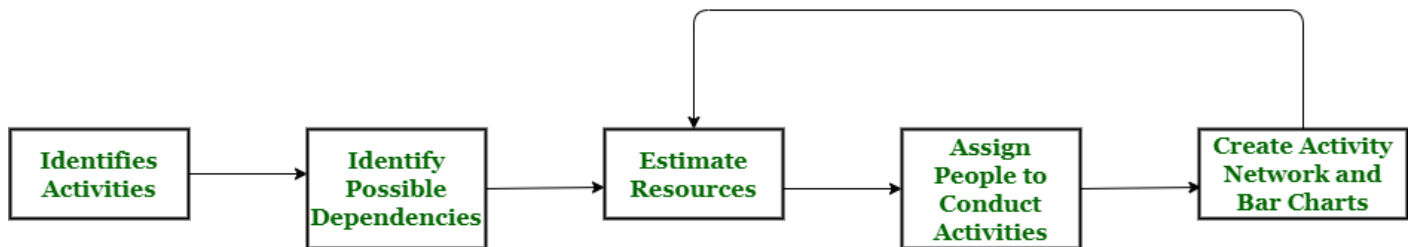
Intermediate COCOMO equation:

$$E = a_i (\text{KLOC})^{b_i} \cdot \text{EAF}$$

$$D = c_i (E)^{d_i}$$

#### Project schedule:

A schedule in your project's time table actually consists of sequenced activities and milestones that are needed to be delivered under a given period of time. **Project schedule** simply means a mechanism that is used to communicate and know about that tasks are needed and has to be done or performed and which organizational resources will be given or allocated to these tasks and in what time duration or time frame work is needed to be performed. Effective project scheduling leads to success of project, reduced cost, and increased customer satisfaction. Scheduling in project management means to list out activities, deliverables, and milestones within a project that are delivered. It contains more notes than your average weekly planner notes. The most common and important form of project schedule is Gantt chart.



## Project Scheduling Process

**Process :** The manager needs to estimate time and resources of project while scheduling project. All activities in project must be arranged in a coherent sequence that means activities should be arranged in a logical and well-organized manner for easy to understand. Initial estimates of project can be made optimistically which means estimates can be made when all favorable things will happen and no threats or problems take place. The total work is separated or divided into various small activities or tasks during project schedule. Then, Project manager will decide time required for each activity or task to get completed. Even some activities are conducted and performed in parallel for efficient performance. The project manager should be aware of fact that each stage of project is not problem-free. **Problems arise during Project Development Stage :**

- People may leave or remain absent during particular stage of development.
- Hardware may get failed while performing.
- Software resource that is required may not be available at present, etc.

The project schedule is represented as set of chart in which work-breakdown structure and dependencies within various activities are represented. To accomplish and complete project within a given schedule, required resources must be available when they are needed. Therefore, resource estimation should be done before starting development. **Resources required for Development of Project :**

- Human effort
- Sufficient disk space on server
- Specialized hardware
- Software technology
- Travel allowance required by project staff, etc.

**Advantages of Project Scheduling :** There are several advantages provided by project schedule in our project management:

- It simply ensures that everyone remains on same page as far as tasks get completed, dependencies, and deadlines.
- It helps in identifying issues early and concerns such as lack or unavailability of resources.
- It also helps to identify relationships and to monitor process.
- It provides effective budget management and risk mitigation.

Coefficients for intermediate COCOMO

Project	$a_i$	$b_i$	$c_i$	$d_i$
Organic	2.4	1.05	2.5	0.38
Semidetached	3.0	1.12	2.5	0.35
Embedded	3.6	1.20	2.5	0.32

**3. Detailed COCOMO Model:** Detailed COCOMO incorporates all qualities of the standard version with an assessment of the cost drivers effect on each method of the software engineering process. The detailed model uses various effort multipliers for each cost driver property. In detailed cocomo, the whole software is differentiated into multiple modules, and then we apply COCOMO in various modules to estimate effort and then sum the effort.

The Six phases of detailed COCOMO are:

1. Planning and requirements
2. System structure
3. Complete structure
4. Module code and test
5. Integration and test
6. Cost Constructive model

### Personnel Planning

Personnel Planning deals with staffing. Staffing deals with the appoint personnel for the position that is identified by the organizational structure.

It involves:

- Defining requirement for personnel
- Recruiting (identifying, interviewing, and selecting candidates)
- Compensating
- Developing and promoting agent

For personnel planning and scheduling, it is helpful to have efforts and schedule size for the subsystems and necessary component in the system.

At planning time, when the system method has not been completed, the planner can only think to know about the large subsystems in the system and possibly the major modules in these subsystems.

Once the project plan is estimated, and the effort and schedule of various phases and functions are known, staff requirements can be achieved.

From the cost and overall duration of the projects, the average staff size for the projects can be determined by dividing the total efforts (in person-months) by the whole project duration (in months).

Typically the staff required for the project is small during requirement and design, the maximum during implementation and testing, and drops again during the last stage of integration and testing.

Using the COCOMO model, average staff requirement for various phases can be calculated as the effort and schedule for each method are known.

When the schedule and average staff level for every action are well-known, the overall personnel allocation for the project can be planned.

This plan will indicate how many people will be required for different activities at different times for the duration of the project.

The total effort for each month and the total effort for each step can easily be calculated from this plan.

## Team Structure

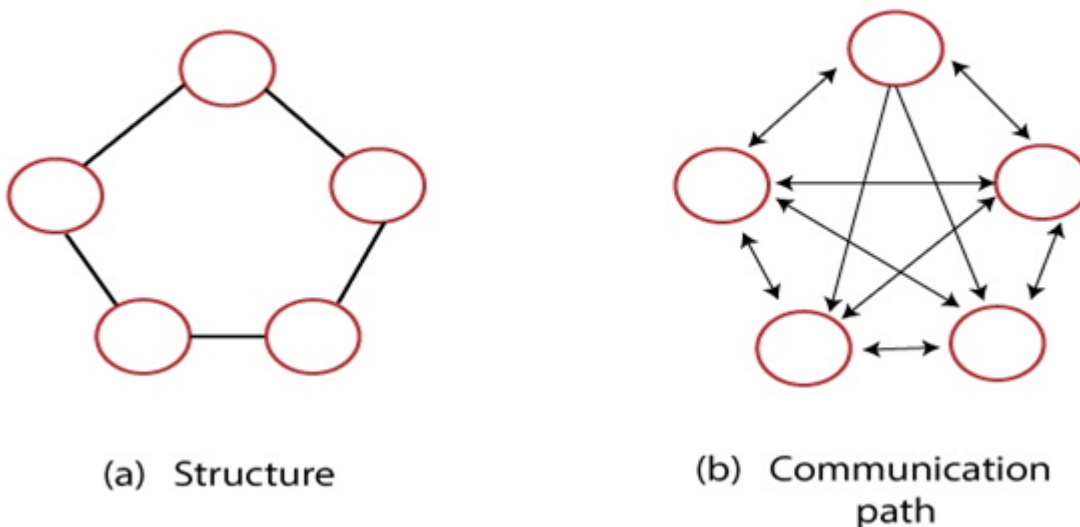
Team structure addresses the issue of arrangement of the individual project teams. There are some possible methods in which the different project teams can be organized. There are primarily three formal team structures: **chief programmer, Ego-less or democratic, and the mixed team organizations** even several other variations to these structures are possible. Problems of various complexities and sizes often need different team structures for the chief solution.

### Ego-Less or Democratic Teams

Ego-Less teams subsist of a team of fewer programmers. The objective of the group is set by consensus, and input from each member is taken for significant decisions. Group leadership revolves among the group members. Due to its nature, egoless teams are consistently known as democratic teams.

The structure allows input from all representatives, which can lead to better decisions in various problems. This suggests that this method is well suited for long-term research-type projects that do not have time constraints.

### Ego-Less Programming Team structure and communication paths



### Chief Programmer Team

A chief-programmer team, in contrast to the ego-less team, has a hierarchy. It consists of a chief-programmer, who has a backup programmer, a program librarian, and some programmers.

The chief programmer is essential for all major technical decisions of the project.

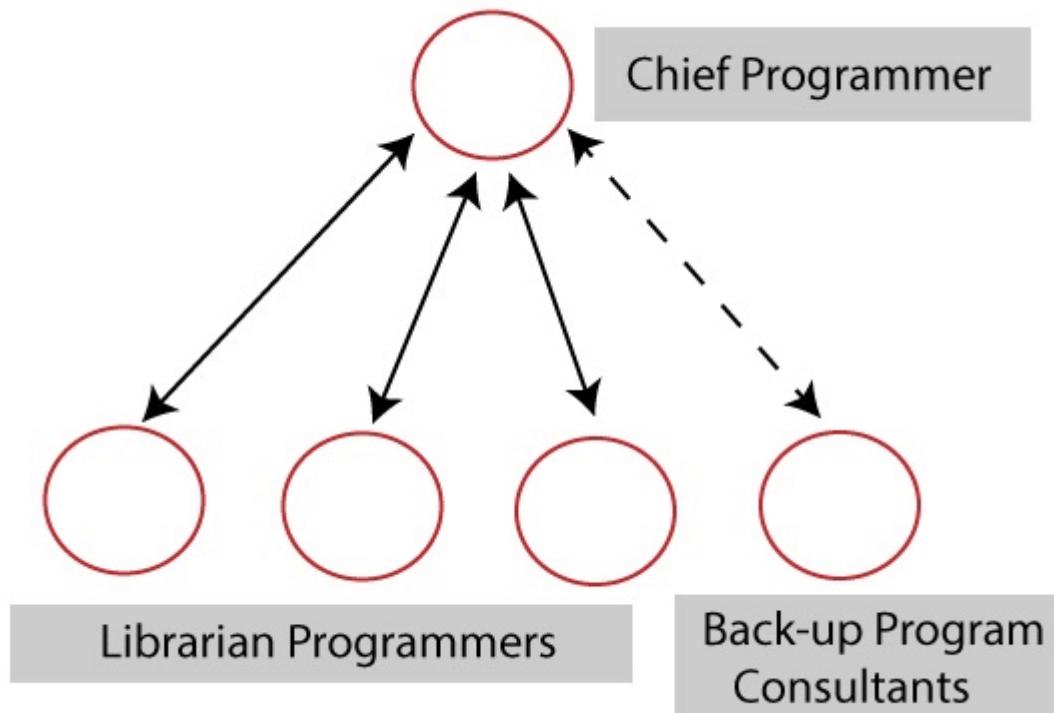
He does most of the designs, and he assigns coding of the different part of the design to the programmers.

The backup programmer uses the chief programmer makes technical decisions, and takes over the chief programmer if the chief programmer drops sick or leaves.

The program librarian is vital for maintaining the documentation and other communication-related work.

This structure considerably reduces interpersonal communication. The communication paths, as shown in fig:

### Chief Programmer Team structure and communication paths



### Controlled Decentralized Team

#### (Hierarchical Team Structure)

A third team structure known as the controlled decentralized team tries to combine the strength of the democratic and chief programmer teams.

It consists of project leaders who have a class of senior programmers under him, while under every senior programmer is a group of a junior programmer.

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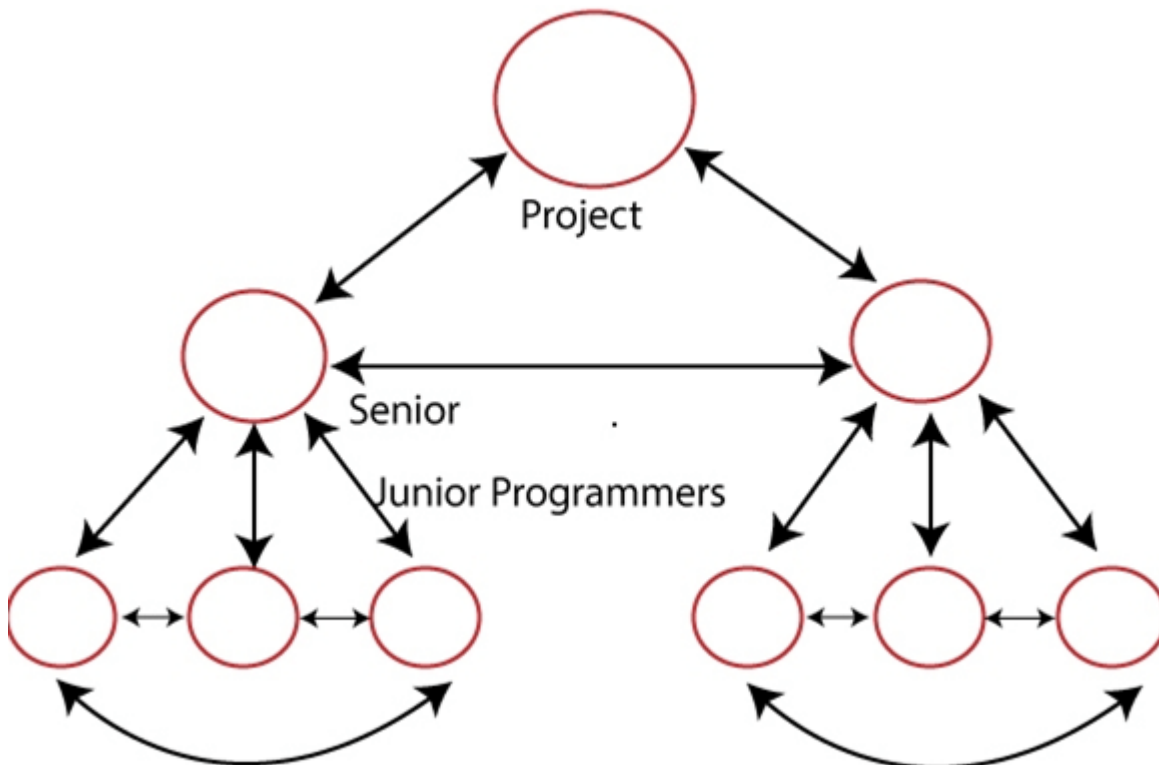
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The group of a senior programmer and his junior programmers behave like an ego-less team, but communication among different groups occurs only through the senior programmers of the group.

The senior programmer also communicates with the project leader.

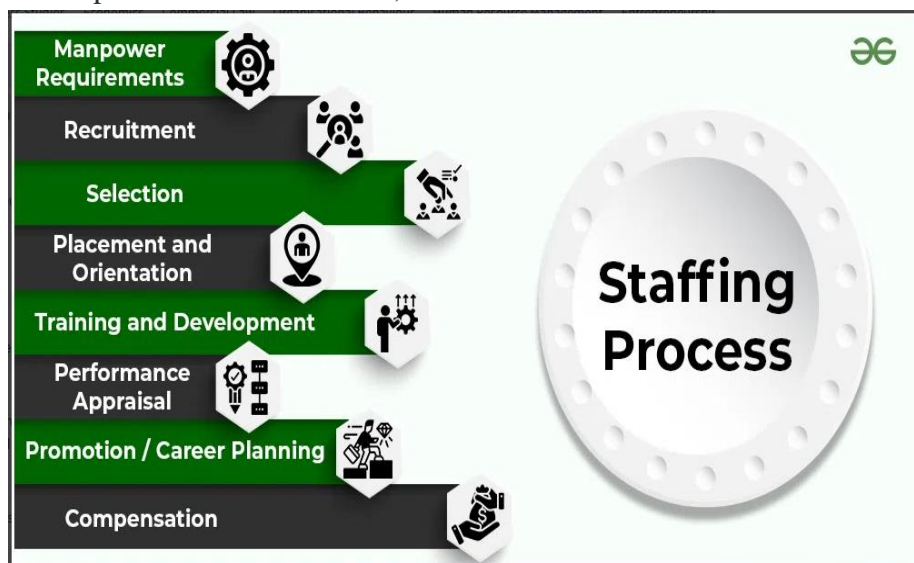
Such a team has fewer communication paths than a democratic team but more paths compared to a chief programmer team.

This structure works best for large projects that are reasonably straightforward. It is not well suited for simple projects or research-type projects.



## Staffing Process

Staffing is the art of acquiring, developing, and maintaining a satisfactory and satisfied workforce. Staffing is that function by which a manager builds an organization through the recruitment, selection, and development of the individual, which also includes a series of activities. It ensures that the organization has the right number of people at the right places, at the right time, and performing the right thing.



As we know, the prime concern of the staffing function in the management process is in the fulfilment of the manpower requirements within an organization. These requirements may arise in the case of starting a new enterprise or expanding the existing one. It may also arise as the need for replacing those who quit, retire, transfer, or are promoted from the job. In any

case, the need for ‘the right person for the right job, at the right time’ needs an emphasis.



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### Staffing Process

The process of staffing consists of several interrelated activities, such as planning for human resources requirements, recruitment, selection, training development, remuneration, and so on. These activities together make the staffing process. Therefore, these are called elements or steps of the staffing process.

#### 1. Manpower Planning

Human resource management is a process of determining the number and type of personnel required for filling the vacant job in an organization. Manpower requirements involve two kinds of analysis, i.e., workload analysis and workforce analysis. Workload analysis involves determining the number and type of employees required to perform various jobs and achieve organizational objectives. Workforce analysis shows the number and type of human resources available with an organization.

The difference between workload and workforce is calculated to determine shortage and surplus of manpower. Excess workload indicates understaffing, i.e., the need of appointing more people and excess workforce indicates overstaffing, i.e., need to remove or transfer some employees to other places.

#### 2. Recruitment

After estimating manpower requirements, the second step in the process of staffing is recruitment.

Recruitment refers to a process of searching for prospective employees and encouraging them to apply for jobs in the organization. It involves identifying various resources of human force and attracting them to apply for the job. The main purpose of a requirement is to create a pool of applicants by a large number of qualified candidates. Recruitment can be done by both internal and external sources of recruitment. Internal sources may be used to a limited extent, and to get fresh talent and a wider choice, external sources can be used.

#### 3. Selection

Selection is the process of choosing and appointing the right candidates for various job positions in the organization. It is treated as a negative process because it involves the rejection of some candidates. There are many steps involved in the process of employee selection. These steps include preliminary screening, filling-in application, written test, interviews, medical examination, checking references, and issuing a letter of appointment to the candidates. The most suitable candidates who meet the requirement of the vacant job are selected. The process of selection serves two important purposes, firstly, it ensures that the organization gets the best among the available candidates, and secondly, it boosts up the self-esteem and prestige of the candidates.

#### 4. Placement and Orientation

After selection, an appropriate job is assigned to each selected person. Placement is the process of matching the candidates with the jobs in the organization. Under this process, every selected candidate is assigned a job most suitable for him. The purpose of placement is to fit the right person to the right job so that the efficiency of work is high and the employees get personal satisfaction. Correct placement helps to reduce labour turnover and absenteeism. Here, orientation means introducing new employees to the organization. It is the process of introducing and familiarizing newly appointed candidates with their job, work groups and the organization so that they may feel at home in the new environment.

#### 5. Training and Development

People are in search of careers and not jobs. Every individual must be given a chance to rise to the top. The most favourable way for this to happen is to promote employee learning. For this, organizations either

provide training themselves within the organization or through external institutions. This is beneficial for the organization as well. If the employees are motivated enough, it will increase their competence and will be able to perform even better for the organization with greater efficiency and productivity. By providing such opportunities to its employees for career advancement, the organization captivates the interest and holds on of its talented employees. The majority of the organization has a distinct department for this purpose, that is, the Human Resource Department. Though in small organizations, the line manager has to do all the managerial functions viz, planning, organizing, staffing, controlling, and directing. The process of staffing further involves three more stages.

### **6. Performance appraisal**

After training the employees and having them on the job for some time, there should be an evaluation done on their performance. Every organization has its means of appraisal whether formal or informal. Appraisal refers to the evaluation of the employees of the organization based on their past or present performance by some pre-decided standards. The employee should be well aware of his standards and his superior is responsible for providing feedback on his performance. The process of performance appraisal, thus includes specifying the job, performing appraisal performance, and providing feedback.

### **7. Promotion and Career planning**

It has now become important for all organizations to deal with career-related issues and promotional routes for employees. The managers should take care of the activities that serve the long-term interests of the employees. They should be encouraged from time to time, which will help the employees to grow and find their true potential. Promotions are an essential part of any employee's career. Promotion refers to the transferring of employees from their current positions to a higher level increasing their responsibilities, authority and pay.

### **8. Compensation**

Every organization needs to set up plans for the salary and wages of the employees. There are several ways to develop payment plans for the employees depending upon the significance of the job. The worth of the job needs to be decided. Therefore, all kinds of payments or rewards provided to the employees is referred to as compensation. The compensation may be in the form of direct financial payments, such as salary, wages, bonuses, etc., or indirect payments like insurance or vacations provided to the employee.

Direct financial payments are of two kinds, that is, performance-based and time-based. In a time-based payment plan, the salary or wages are paid daily, weekly, monthly, or annually, whereas, the performance-based payment plan is the payment of salary or wages according to the set task. There are many ways in which the compensation of the employee based on their performance can be calculated. There are also plans, which are a combination of both time-based and performance-based. There are a few factors that affect the payment plan, such as legal, company policy, union, and equity. Thus, staffing is the process that includes possession, retention, promotion, and compensation of the human capital, that is, the most important resource of the organization. There are several factors such as the supply and demand of specific skills in the labour market, legal and political considerations, the company's image, policy, unemployment rate, human resource planning cost, labour market conditions, technological developments, general economic environment, etc., that may affect the execution of recruitment, selection, and training.

### **Aspects or Components of Staffing**

There are three aspects or components of staffing, namely, recruitment, selection, and training. They are defined below:

- **Recruitment:** It is the process of finding potential candidates for a particular job in an organization. The process of recruitment involves persuading people to apply for the available positions in the organization.
- **Selection:** It is the process of recognizing potential and hiring the best people out of several possible candidates. This is done by shortlisting and choosing the deserving and eliminating those who are not suitable for the job.
- **Training:** It is the process that involves providing the employees with an idea of the type of work they are supposed to do and how it is to be done. It is a way of keeping the employees updated on the way of work in an organization and the new and advanced technologies.



As we know, the prime concern of the staffing function in the management process is in the fulfilment of the manpower requirements within an organization. These requirements may arise in the case of starting a new enterprise or expanding the existing one. It may also arise as the need for replacing those who quit, retire, transfer, or are promoted from the job. In any case, the need for ‘the right person for the right job, at the right time’ needs an emphasis.

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### **Staffing Process**

The process of staffing consists of several interrelated activities, such as planning for human resources requirements, recruitment, selection, training development, remuneration, and so on. These activities together make the staffing process. Therefore, these are called elements or steps of the staffing process.

#### **1. Manpower Planning**

Human resource management is a process of determining the number and type of personnel required for filling the vacant job in an organization. Manpower requirements involve two kinds of analysis, i.e., workload analysis and workforce analysis. Workload analysis involves determining the number and type of employees required to perform various jobs and achieve organizational objectives. Workforce analysis shows the number and type of human resources available with an organization.

The difference between workload and workforce is calculated to determine shortage and surplus of manpower. Excess workload indicates understaffing, i.e., the need of appointing more people and excess workforce indicates overstaffing, i.e., need to remove or transfer some employees to other places.

#### **2. Recruitment**

After estimating manpower requirements, the second step in the process of staffing is recruitment.

Recruitment refers to a process of searching for prospective employees and encouraging them to apply for jobs in the organization. It involves identifying various resources of human force and attracting them to apply for the job. The main purpose of a requirement is to create a pool of applicants by a large number of qualified candidates. Recruitment can be done by both internal and external sources of recruitment. Internal sources may be used to a limited extent, and to get fresh talent and a wider choice, external sources can be used.

#### **3. Selection**

Selection is the process of choosing and appointing the right candidates for various job positions in the organization. It is treated as a negative process because it involves the rejection of some candidates. There are many steps involved in the process of employee selection. These steps include preliminary screening, filling-in application, written test, interviews, medical examination, checking references, and issuing a letter of appointment to the candidates. The most suitable candidates who meet the requirement of the vacant job are selected. The process of selection serves two important purposes, firstly, it ensures that the organization gets the best among the available candidates, and secondly, it boosts up the self-esteem and prestige of the candidates.

#### **4. Placement and Orientation**

After selection, an appropriate job is assigned to each selected person. Placement is the process of matching the candidates with the jobs in the organization. Under this process, every selected candidate is assigned a job most suitable for him. The purpose of placement is to fit the right person to the right job so that the efficiency of work is high and the employees get personal satisfaction. Correct placement helps to reduce labour turnover and absenteeism. Here, orientation means introducing new employees to the organization. It

is the process of introducing and familiarizing newly appointed candidates with their job, work groups and the organization so that they may feel at home in the new environment.

### **5. Training and Development**

People are in search of careers and not jobs. Every individual must be given a chance to rise to the top. The most favourable way for this to happen is to promote employee learning. For this, organizations either provide training themselves within the organization or through external institutions. This is beneficial for the organization as well. If the employees are motivated enough, it will increase their competence and will be able to perform even better for the organization with greater efficiency and productivity. By providing such opportunities to its employees for career advancement, the organization captivates the interest and holds on of its talented employees. The majority of the organization has a distinct department for this purpose, that is, the Human Resource Department. Though in small organizations, the line manager has to do all the managerial functions viz, planning, organizing, staffing, controlling, and directing. The process of staffing further involves three more stages.

### **6. Performance appraisal**

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## Software Configuration Management

When we develop software, the product (software) undergoes many changes in their maintenance phase; we need to handle these changes effectively.

Several individuals (programs) work together to achieve these common goals. This individual produces several work products (SC Items) e.g., Intermediate version of modules or test data used during debugging, parts of the final product.

The elements that comprise all information produced as a part of the software process are collectively called a software configuration.

As software development progresses, the number of Software Configuration elements (SCT's) grow rapidly.

**These are handled and controlled by SCM. This is where we require software configuration management.**

A configuration of the product refers not only to the product's constituent but also to a particular version of the component.

Therefore, SCM is the discipline which

- Identify change
- Monitor and control change
- Ensure the proper implementation of change made to the item.
- Auditing and reporting on the change made.

Configuration Management (CM) is a technic of identifying, organizing, and controlling modification to software being built by a programming team.

**The objective is to maximize productivity by minimizing mistakes (errors).**

CM is used to essential due to the inventory management, library management, and updation management of the items essential for the project.

## Why do we need Configuration Management?

Multiple people are working on software which is consistently updating. It may be a method where multiple versions, branches, authors are involved in a software project, and the team is geographically distributed and works concurrently. It changes in user requirements, and policy, budget, schedules need to be accommodated.

## Importance of SCM

It is practical in controlling and managing the access to various SCIs e.g., by preventing the two members of a team for checking out the same component for modification at the same time.

**It provides the tool to ensure that changes are being properly implemented.**

It has the capability of describing and storing the various constituent of software.

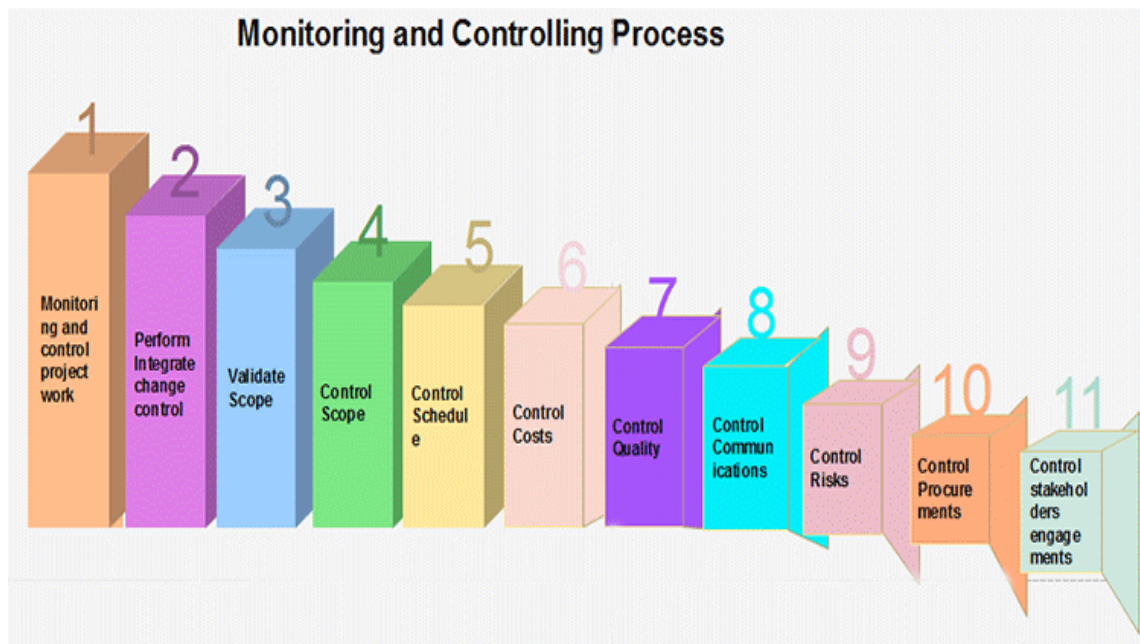
SCM is used in keeping a system in a consistent state by automatically producing derived version upon modification of the same component.

Project monitoring

### Project Monitoring and Control

Monitoring and Controlling are processes needed to track, review, and regulate the progress and performance of the project. It also identifies any areas where changes to the project management method are required and initiates the required changes.

The Monitoring & Controlling process group includes eleven processes, which are:



1. **Monitor and control project work:** The generic step under which all other monitoring and controlling activities fall under.
2. **Perform integrated change control:** The functions involved in making changes to the project plan. When changes to the schedule, cost, or any other area of the project management plan are necessary, the program is changed and re-approved by the project sponsor.
3. **Validate scope:** The activities involved with gaining approval of the project's deliverables.
4. **Control scope:** Ensuring that the scope of the project does not change and that unauthorized activities are not performed as part of the plan (scope creep).
5. **Control schedule:** The functions involved with ensuring the project work is performed according to the schedule, and that project deadlines are met.
6. **Control costs:** The tasks involved with ensuring the project costs stay within the approved budget.

7. **Control quality:** Ensuring that the quality of the project's deliverables is to the standard defined in the project management plan.
8. **Control communications:** Providing for the communication needs of each project stakeholder.
9. **Control Risks:** Safeguarding the project from unexpected events that negatively impact the project's budget, schedule, stakeholder needs, or any other project success criteria.
10. **Control procurements:** Ensuring the project's subcontractors and vendors meet the project goals.
11. **Control stakeholder engagement:** The tasks involved with ensuring that all of the project's stakeholders are left satisfied with the project work.