

DARBHANGA COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

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Unit 1: Construction and fabrication methods

1. **Modular co-ordination of construction means proper**

- A. planning
- B. designing
- C. execution
- D. all the above.

Answer: D

2. **The first stage of a construction, is**

- A. preparation of estimate
- B. survey of the site
- C. initiation of proposal
- D. preparation of tender
- E. allotment of funds.

Answer: C

3. **Define construction and construction management.**

Answer:

Construction management is the process of planning, coordinating and providing monitoring and controlling of a construction project. This style of project management is designed for the, as the name implies, construction industry. There are few types of construction that use construction management, they are industrial, civil, commercial, environmental and residential. Each category has its own way of running projects, but all will follow the construction management methodology.

Construction management is the overall planning, coordination, and control of a construction process from the start to the end. The objectives of project management are to produce a project that meets client requirements on budget and schedule, and at acceptable risk, quality, and safety.

Construction management has five stages, where project management has five phases. The stages are design, pre-construction, procurement, build, and owner occupancy.

- **Design Stage:** The design stage is where the project begins. This stage has to look at more than the planning stage in project management. It will look at concepts, schematics, contracts, design and regulatory and industry codes.
- **Preconstruction Stage:** During the preconstruction stage the owner has given permission to begin the project. The construction team is assembled and documents are reviewed. The team will analyze all requirements and will need to perform a

walkdown of the construction site. This walkdown will detail actual conditions and help identify any areas that were not identified in the design stage. The earlier issues are identified with the site, the easier they are to get corrected.

- Procurement stage: During this stage, items are purchased and sub-vendors are selected and retained. Many companies can and will perform all needed job functions, but some will sub-contract items like electrical or plumbing. A construction manager has to properly vet a sub-contractor and ensure they are properly licensed and insured. Many construction managers selected cheap sub-contractors, only to find out that the work is subpar. For example, Joe is the construction manager for a new mall in New Jersey. Joe's company can handle everything except asphalt paving. Joe contacts a few asphalt companies in the area and arranges for a bid meeting. During the bid meeting, Joe discusses the project and hands out a project information packet. A week later bids are due and Joe selects the best value.

4. Describe financial aspects related to construction equipments.

Answer:

Construction financial managers sometimes wonder how their duties, responsibilities and relations with others within the organization compare to other construction financial managers. Similarly, construction company owners sometimes wonder what skills are needed and what expectations should be held of their construction financial manager. This information will help provide the answers to such questions. We will review how a construction financial manager works with the senior management team to accomplish financial goals while helping other managers accomplish their goals, how financial managers administer the finance department, their responsibilities to the company's owners and creditors, their administrative responsibilities and the related ethical considerations.

In today's environment, the role of the financial manager in a construction organization is essential to organizational success, and more importantly, is vital to avoiding failure. That may sound extreme, but in many circumstances, competition is so fierce and margins are so thin, reliable financial information and analysis certainly can make the difference between success and failure.

The construction financial manager's role may vary from company to company, partly because different financial managers have different skills and personalities. The role also varies depending on the size of the company. A construction financial manager's background often indicates the areas in which the manager will concentrate. For example, a construction financial manager whose background is in construction operations (estimating and project management) initially will concentrate on the proper recording of job costs. A construction financial manager whose background is in public accounting probably will initially emphasize financial reporting and income tax planning. The financial manager should recognize these influencing factors and make efforts to compensate for any deficiencies.

The skills and personalities of the other members of the management team also affect the role of the construction financial manager. The majority of a company's administrative work can be performed in any department and will be allocated among departments partly based on the skills and personalities of the respective department managers. For example, most construction financial managers feel that cash management is their responsibility. If the other management team members share this feeling, responsibility for cash management probably will be assigned to the finance department. However, if another management team member feels that responsibility for cash management should be shared, some compromise will be made. To a great extent, sharing of responsibilities depends on the skills and personalities of

the management team members. Successful financial managers respect the need for compromise in sharing responsibilities.

As already mentioned, the size of the company frequently affects the role of the financial manager, because roles and responsibilities are more specialized in larger companies than in smaller companies. In small companies, responsibilities are assigned to a smaller group of managers and, accordingly, each manager must handle a wider range of responsibilities. For example, the financial manager in a small company with three senior managers (owner, operations manager and finance manager) will typically be responsible for all administrative and financial tasks. The other two senior managers will typically concentrate on marketing, estimating and project management. In larger companies, with responsibilities assigned to a larger group of managers, each manager will be assigned more specialized responsibilities. For example, the financial manager of a large company with several senior managers often has limited responsibility for administrative tasks involving contact with customers and subcontractors. The department with primary responsibility for customer and subcontractor relations (usually the construction operations department) will prefer to be the primary contact in order to minimize the possibility of misunderstandings between the parties. Because there is no one standard set of construction financial manager responsibilities, each financial manager should be alert for areas of responsibility that are not clearly defined in the organization. The financial manager should take the initiative in assuring that all significant responsibilities are assigned.

5. State advantages and disadvantages of hiring construction equipments.

Answer:

Advantages

Low risk, increased safety

By 'sub-contracting' out the provision of equipment to a rental company, the responsibility of the equipment being compliant and ready to use is placed with them – lowering the risk for the contractor or customer. Therefore, the rental company is more likely to keep the equipment fleet up-to-date and regularly serviced. (Eg. recently inspected to LOLER or PUWER standards.)

More cost effective

Renting construction equipment is a better financial decision as it requires minimal upfront investment. This is particularly important if you are completing a specific task or project and you're not likely to use a specific piece of equipment again.

Low / no maintenance

By hiring directly from an equipment supplier, the cost of asset management and equipment maintenance is with them. Not only does this mean you don't need to invest in equipment to clean, repair and repaint the equipment it also means you do not need space for storage or suitable lifting equipment to move it around a storage facility.

Equipment disposal

If you hire equipment you are obviously do not have to worry about selling or disposing of the equipment when it is no longer useful to you. The hassle that is associated with this

process, using auction sites or similar, often results in a low return on investment and not realising the true value of the equipment.

Disadvantages

- You are responsible for transporting, maintaining, repairing, and storing the equipment. You will also be responsible for disposing of it at the end of its working life.
- If you have to make a large down payment or high monthly payments, it can put a strain on your company's bank account.
- Buying turns liquid assets into fixed assets. Liquidity is used to determine your ability to pay obligations.
- If the equipment sees a lot of hard use, the trade-in value will shrink.
- It is possible the machinery will become obsolete during your ownership, making it nearly impossible to trade-in or sell.
- If you are already writing off a lot of depreciation, more may cause you to pay Alternative Minimum Tax penalties.
- You are stuck with it whether there is growth or retraction of the construction industry or its customers.

6. Describe some common causes of accidents in construction site.

Answer:

The Occupational Safety & Health Administration (OSHA) reports that there were 3,945 worker fatalities in private industry in 2012. Of that number, 775 or 19.6% were in construction. There are many causes of an accident on a construction site. The top causes of construction worker deaths on the job were falls, followed by struck by object, electrocution, and caught-in/between. These "Fatal Four" were responsible for nearly three out of five of the construction worker deaths.

Many accidents may be attributed to some type of negligence and may involve unsafe work site conditions, improper use of tools and-or equipment, and lack of protective safeguards.

Some examples of construction site accidents are more common than others. Below is a list of the more common ones starting with the Fatal Four.

1. Falls. Falls accounted for 278 out of 775 (36%) total deaths in construction in 2012, according to OSHA. An injury of this type may occur when a worker near an open-sided floor steps backwards or sideways without looking. Falling hazards also commonly occur on stairwells with no guardrails. Since high elevations often play a role in these falls, the results can be catastrophic to workers who sustain serious injuries. The main cause of death in construction occurs where inadequate or no fall protection is provided.
2. Struck by object. Seventy-eight construction workers died as a result of being struck by an object in 2012. A number of these deaths may have been prevented if the workers

had undergone proper training and used equipment and machinery properly. Employees must remember to use parking brakes on nonmoving vehicles, reverse vehicle alarms, tool guards, personal protection equipment, debris nets, catch platforms and more.

3. **Electrocutions.** In 2012, 66 workers (9%) were seriously injured or killed by electrocution. Electrocution is when a person, tool or piece of equipment comes into contact with power lines or exposed electrical sources. Sometimes, these types of accident occur because workers are simply unaware of all energized power sources, from overhead and underground power lines to damaged receptacles and connectors. As an example, a construction worker carrying a metal ladder may strike an overhead power line.
4. **Caught-in/between.** Although it seems obvious to never stand between a piece of heavy equipment and an immovable object, sometimes workers concentrating on their jobs find themselves in unexpected danger. Caught in/between accidents are when a worker's body part is caught, crushed, squeezed, compressed or pinched between two or more objects. Examples include cave-ins or collapsing materials, body parts caught in the moving parts of an unguarded piece of machinery, equipment rollovers and getting pinned between fixed objects, like a wall, and piece of heavy equipment.
5. **Slip and falls.** These are among the most common accidents on a construction site. These accidents may be linked to unsafe conditions including uncovered holes or trenches and exposed stakes.
6. **Ladder accidents.** This is one of the leading causes of injury and long-term disability. Most ladder accidents, including falls, happen because workers use the wrong type of ladder for their job or they set up the ladder improperly, perhaps on a slippery or unstable surface, and the ladder unexpectedly shifts or slips. Workers also may experience a foot slip, or they may lose their balance, or overreach. Ladders may also be defective or improperly maintained.
7. **Scaffolding accidents.** Despite strict regulations, scaffolding accidents occur. In a Bureau of Labor and Statistics (BLS) study, 72% of workers injured in scaffold accidents attributed the accident either to the planking or support giving way, or to the employee slipping or being struck by a falling object. In a general sense, most scaffolding accidents are caused by improper construction or negligent maintenance.
8. **Power tool and machinery accidents.** Power tool and machinery injuries may occur for reasons that include mechanical defects, electrical failure, inadequate training and failure or lack of proper safety equipment. A significant number of injuries are caused by the use of power tools and large equipment.
9. **Musculoskeletal disorders.** A leading cause of injuries, disability claims and medical costs in construction are sprains and strains of the muscles. Construction work can also cause injuries to the joints, bones, and nerves. These injuries often stem from job demands that constantly wear and tear on the body.
10. **Vehicle Accidents.** Dangerous construction site vehicles include forklifts, graders, backhoes and dump trucks. A common forklift accident occurs when the vehicle is turned or maneuvered with the load raised. Large trucks all too often back up and hit a pedestrian. Another hazard on construction sites is falling from a vehicle.

While construction sites may appear to be dangerous, many of these accidents can be avoided through common sense and protective measures. Prevention begins with adequate awareness and a properly maintained working environment that is safe and secure.

7. Classify the equipments required in construction industry.

Answer:

There are several equipment that is been used in the Construction Industry. These are used for both large and small scale purposes. Various types of Equipment are been used for Building & structural Construction, Road construction, underwater and other marine

construction work Power projects etc. There are various operations that are involved in construction projects, whether it's a large scale or a small scale; Excavation and digging of large quantities of earth, Placement of construction materials (eg:-Bricks, concrete) Compacting and leveling, Dozing, Grading, Hauling etc...

Construction equipment can be categorized in to 4 main sections based on purpose and use, they are:

1. Earth Moving equipment
2. Construction vehicle
3. Material Handling Equipment
4. Construction Equipment

NOTE:- There can be several types of classification base on techniques, purpose, types, brands etc...

EARTH MOVING EQUIPMENT

- Excavators
- Graders
- Loaders
- Skid loader
- Crawler loaders
- Backhoe
- Bulldozers
- Trenchers
- Scrapers
- Wheeled loading shovels

CONSTRUCTION VEHICLE

- Tippers
- Dumbers
- Trailers
- Tankers

MATERIAL HANDLING EQUIPMENT

- Crane
- Conveyors
- Hoists
- Fork Lifts

CONSTRUCTION EQUIPMENT

- Concrete Mixture
- Compactors
- Pavers
- Road Rollers

TUNNELING EQUIPMENT

- Road Headers
- Tunnel Boring Machines (TBM)

OTHER CONSTRUCTION EQUIPMENT

8. Discuss various costs parameters that are considered and analyzed in order to formulate equipment replacement policy.

Answer:

Organizations use equipment in production and testing which must be maintained or replaced on planned basis. Manufacturing industries are facing fierce competition therefore

companies invest in highly automated production system with good quality equipment. It is necessary to utilize equipment in best way to stay in the global market, and maintain the production operation thus leading to the economical sustainability as well as increase company profit. When an unplanned interruption occurs due to machines or equipment failure, this disturbs the production operation.

- Equipment Replacement

The replacement of productive equipment is important strategic decisions faced by both manufacturing and service firms because purchasing a new piece of equipment often involves more cost and can affect the productivity and effectiveness of the firm. Currently, this issue is highlighted in fast changing technologies and good equipment purchase can soon become obsolete. Under these situations, the driving motivation to take replacement decisions is likely to be technological outmodedness instead of physical deterioration, of the existing equipment. This situation is typical of microcomputers, computerized numerically controlled machines, and other electronics technologies.

Bulk of management studies have been done in equipment replacement. The customary approach to the equipment replacement problem emphasizes the physical deterioration of the existing equipment. The main concept is to replace the equipment when the cost of operating and maintaining it become sufficiently high, in net expected present value terms, to substantiate a replacement. In most conventional models, technology is supposed to remain constant over time (Derman, and Hatoyama, 1984). The approach of Derman, and Hatoyama would lead to inappropriate decisions if technology does change. Currently, researchers started to model the equipment replacement problem due to technological change under vagueness. Goldstein, Ladany and Mehrez introduce uncertainty using stationary forecasts. Hopp and Nair developed a model using non-stationary technology forecasts but where the revenue generated by various technologies is different but constant over time (1991).

The replacement problems are associated with the issues that develops when the performance of an item decreases, failure or breakdown occurs. The decline in performance or breakdown may be gradual or sometimes sudden. There is a need for replacement of items when;

1. The existing item or system has become inefficient or require more maintenance.
2. The existing equipment has failed due to accident or otherwise and does not work at all.
3. The existing equipment is expected to fail shortly.
4. The existing equipment has become obsolete due to the availability of equipment with latest technology and better design. The solution to replacement problem is to device best policy that determines the time at which the replacement is most economical instead of continuing at an increased maintenance cost.

The Main objective of replacement policy is to guide the organization in many situations so that it can take correct decision such in a situations when waiting for complete failure of item or to replace earlier at the expense of higher cost of the item, whether to replace the underperforming equipment with the similar kind of item or by different kind of item. The problem of replacement occurs in the case of both men and machines.

There are numerous reasons for equipment replacement. The first reason is the equipment is depleted of function. Second reason for replacing equipment is if the equipment becomes obsolete. For example, older computers are much slower and have fewer features than their modern counterparts. In addition, older computers are harder to maintain because replacement parts and qualified technicians are much harder to find. Another reason for replacement is deterioration due to aging. Equipment is inadequate and does not meet needs, increased demand. Then it is replaced with a larger asset.

There are many types of failure in equipment:

1. Gradual Failure: In this, the failure mechanism is progressive. As an equipment becomes old, its performance deteriorates. This results in increased operating cost, decreased productivity of the item and decrease in resale value of item.
2. Sudden Failure: This type of failure occurs in equipment that do not deteriorate gradually with age but which fail suddenly after some period of service. The time period between installations and failure will not be constant for any particular equipment. However the failure pattern will follow certain frequency distribution that may be progressive, retrogressive or random in nature.
3. Progressive failure: progressive failure occurs when probability of failure increases with the age of an item.
4. Retrogressive failure: Certain items will have more probability of failure in the early years of their life and with the increase in the life of an item the chances of failure become less. That is, the ability of the item to survive in the initial years of life increases its expected life.
5. Random failure: Random failure occurs when continuous probability of failure is related with equipment that fails because of random causes such as physical shocks that are independent of age. In the case of random failure, virtually all items fail before aging has any effect.

The replacement situations are categorized into the following four types:

1. Replacement of capital equipment whose performance decreases with time.
2. Group replacement items that fail completely: Some system usually composed of a large number of low cost items that are prone to failure with age such as failure of a resistor in television, radio, computer etc. In some cases the failure of a component may cause the complete failure of the system. In such cases, the cost of overall failure will be quite higher than the cost of component itself. In such situations, two types of replacement procedures must be considered. First is Individual replacement. In this policy, an item is replaced immediately after its failure. Secondly, Group replacement in which, decision is about the age when all the items should be replaced, irrespective of whether the items have failed or not. In this policy, the items that fail before the optimal time, will be replaced individually.
3. Problem of mortality and staffing.
4. Miscellaneous problems.

Replacement Planning Process:

1. Assess clinical needs
2. Use multidisciplinary approach
3. Assess technical/maintenance/safety/regulatory needs/indicators

4. Review equipment database
5. Review maintenance criteria and calculations
6. Assess budget

9. Explain different type of construction equipments being used in India along with safety features associated with it.

Answer:

Different types of construction equipment commonly used in the construction area in India are as follows:

1. Excavators
2. Backhoe
3. Dragline Excavator
4. Bulldozers
5. Graders
6. Wheel Tractor Scraper
7. Trenchers
8. Loaders
9. Tower Cranes
10. Pavers
11. Compactors
12. Telehandlers
13. Feller Bunchers
14. Dump Trucks
15. Pile Boring Machine
16. Pile Driving Machine

1. Excavators

Excavators are important and widely used equipment in construction industry. Their general purpose is to excavation but other than that they are also used for many purposes like heavy lifting, demolition, river dredging, cutting of trees etc.

Excavators contains a long arm and a cabinet. At the end of long arm digging bucket is provided and cabinet is the place provided for machine operator. This whole cabin arrangement can be rotatable up to 360° which eases the operation. Excavators are available in both wheeled and tracked forms of vehicles.

2. Backhoe

Backhoe is another widely used equipment which is suitable for multiple purposes. The name itself telling that the hoe arrangement is provided on the back side of vehicle while loading bucket is provided in the front.

This is well useful for excavating trenches below the machine level and using front bucket loading, unloading and lifting of materials can be done.

3. Dragline Excavator

Dragline excavator is another heavy equipment used in construction which is generally used for larger depth excavations. It consists a long length boom and digging bucket is suspended from the top of the boom using cable.

For the construction of ports, for excavations under water, sediment removal in water bodies etc. can be done by dragline excavator.

4. Bulldozers

Bulldozers are another type of soil excavating equipment which are used to remove the topsoil layer up to particular depth. The removal of soil is done by the sharp edged wide metal plate provided at its front. This plate can be lowered and raised using hydraulic pistons.

These are widely used for the removal of weak soil or rock strata, lifting of soil etc.

5. Graders

Graders also called as motor graders are another type of equipment used in construction especially for the construction of roads. It is mainly used to level the soil surface. It contains a horizontal blade in between front and rear wheels and this blade is lowered in to the ground while working. Operating cabin is provided on the top of rear axle arrangement.

Motor Graders are also used to remove snow or dirt from the roads, to flatten the surface of soil before laying asphalt layer, to remove unnecessary soil layer from the ground etc.

6. Wheel Tractor Scrapers

Wheel Tractor Scrapers are earth moving equipment used to provide flatten soil surface through scrapping. Front part contains wheeled tractor vehicle and rear part contain a scrapping arrangement such as horizontal front blade, conveyor belt and soil collecting hopper.

When the front blade is lowered onto the ground and vehicle is moved, the blade starts digging the soil above the blade level and the soil excavated is collected in hopper through conveyor belt. When the hopper is full, the rear part is raised from the ground and hopper is unloaded at soil dump yard.

10. Explain and analyse different safety regulations for the construction projects.

Answer:

Working on a construction site is one a dangerous occupation. According to recent findings from the Bureau of Labor Statistics, construction-related fatalities accounted for around 21.4% of all worker fatalities in 2015. With nearly, 6.5 million people working at over 250, 000 construction sites across the US on any given day, it's easy to see why enforcing preventative construction site safety procedures is critical.

Some of the potential hazards that construction workers face every day include:

- Falls from heights
- Scaffold collapse
- Electrocution and arc blast/flash
- Trench collapse
- Repetitive motion injuries
- Failure to use the required PPE (Personal Protective Equipment)

Every employer is required by law to ensure the safety and health of their workers, regardless of the industry or their occupation. Construction workers are particularly exposed to high-risk environments that pose dangers which need to be addressed. If you're a construction site manager or project manager, it's your responsibility to take the right safety measures to safeguard the work site from unnecessary dangers or hazards.

Here are the top construction site safety procedures you should have in place for construction sites:

Do a Thorough Worksite Evaluation

Analyze Your Worksite or Worksites

Regularly analyze your work site to identify any potential hazards and come up with an effective way or plan to eliminate them. Be aware of the main potential hazards in construction sites:

- Electrocutation
- Falls
- Caught-between or caught-in
- Struck-by

If workers are carrying out their work without the proper protective equipment, identify the problem and let them know. If workers are struggling to complete certain tasks safely, prioritize on the specific issue in your training program.

Before any work commences, you should always check construction equipment, tools and machines in the construction site to ensure they're safe for use. For instance, conducting proper planning and staging before starting the day ensures that employees have the right tools and equipment they need for their work.

Use Clear Signage

It's important to use clear signage so that all construction site safety procedures are known, including a 24-hour emergency number and clear directions to the site office. Visible signage helps workers remember and understand safety protocols that need to be followed at all times. There should be clear signage for site amenities as well as first aid and emergency fire equipment.

Site Security

Ensure proper construction site security. Restricted site access is not just about preventing equipment theft or damage. You should have security measures in place that restrict access to the work site outside of working hours to protect workers or any other person from potential construction hazards. Strict safety and security protocols must always be followed.

Entry and Exit Points

Construction sites must also have separate entry and exit points for vehicle access and heavy machinery to ensure safety at high-traffic areas in the construction site.

Provide Proper Training

Training is a key part of ensuring workplace safety in all industries. Many project managers assume that all workers are aware of the construction site safety procedures of a working site. Failing to provide training to workers, whether working only for a few days or months to come, is one of the contributing factors to rising cases of injuries and fatalities in construction sites.

Develop a Simple but Effective Training Plan

Based on worksite analysis, develop a simple training plan for your workers. It's advisable to have more than one category. E.g.

- Safety training on new equipment
- Safety training for new workers
- Safety training refresher courses for existing workers
- Safety training updates for all employees

Your training plan should prioritize on the most common mistakes, safety risks and incidents that you've noted in a specific area. The training program should be simple but effective.

Provide Training in an Easy Format

It's one thing to offer training and another to offer it in an easy-to-understand format. Workers will be more engaged if they can understand the training you're offering. Whether you're offering training to address certain violations or on construction site safety procedures for a new construction project, you should deliver training in an accessible and flexible model.

You can use a learning management system to deliver short and precise courses that can be accessed online on any device so that workers can access them anywhere and at any time.

Tailor Your Training for Your Workers

It's common to find construction workers speaking multiple languages in construction sites across the United States. Even though all your workers may speak some English, you should tailor your training program to fit all your workers. That's why adopting a learning management system that you can develop and modify courses to fit your workers' needs is recommended.

For one, you can create training courses in different languages, or you can have specific courses for specific workers like those using heavy machinery or working at height.

Train Workers on First Aid

In the construction industry, you're required to have at least one qualified first aid officer per 25 workers. On top of that, it's best to train your workers on basic first aid in case of an emergency. First aid kits and equipment must also be provided and placed in easily accessible areas in the construction site.

Supply Workers with Personal Protective Equipment (PPE)

As part of construction site safety procedures, all construction workers should be provided with the proper personal protective equipment and clothing. If you're a worker and don't have the right protective clothing or gear, you have the right to demand them from the people in charge or your employer. Here are some of the PPE requirements for construction sites.

Minimum PPE requirements for Construction Sites

- A helmet has to be supplied and worn at all times at the construction site
- Safety glasses must be provided to protect workers against debris in the air
- Safety/high-visibility vests must be provided and worn to keep workers visible
- Protective gloves should be supplied and worn to protect against cuts
- Proper clothing is a must for worker protection both indoors and outdoors
- Anti-slip footwear is also necessary

Additional PPE Requirements

- Hearing protection must be worn near any tool, machine or equipment that produces loud noises
- Respiratory protection is needed to protect against dust and other air contaminants
- Face shields are a must for welding operations and other debris/spark producing operations
- Safety harnesses must be used as a safety procedure to prevent falls

Quality, well-fitting and comfortable personal protective equipment and gear must be provided to construction workers. The gear and equipment should be stored properly after use and be inspected and maintained on a regular basis.

Promote and Enforce Good Practices

In every working environment, promoting and enforcing good practices and construction site safety procedures plays a huge role in ensuring safety for everyone. Ensure that the top management, site supervisors, and even workers are enforcing rules, observing working protocols and encouraging positive behavior.

Empower Workers to be Part of the Safety Program

You should also encourage your workers to be part of the construction site safety program. They can contribute by offering ideas on improving their own safety. Encourage workers to report safety concerns and risks to supervisors and project managers. The management is expected to take immediate action on any reported hazards. Most incidents can be easily avoided if someone speaks up, so remind workers to be open when they see something.

Don't Become Complacent

Construction sites present new safety challenges every other day. You must be vigilant in maintaining safety at all times. For instance, good site housekeeping practices like cleaning up working areas after a day's work can help avoid trips and falls that could cause injuries. If there is a damaged or broken fence, have it fixed to protect workers.

Environmental Conditions

Let your workers know the right time to work and when to stop working due to environmental conditions. Extreme weather conditions can easily cause safety hazards in construction sites. You should have in place clear construction site safety procedures for workers to follow in the event of an emergency.

Minimize and Manage Risk

Due to the nature of working at construction sites, it's hard to eliminate all safety risks. While enforcing good practices in construction sites may help prevent safety issues, it's always best to minimize and manage risks in construction sites. This can be done by regularly conducting safety audits and having in place protocols to report, evaluate and address potential hazards.

Ensure Proper Material Handling and Storage

All personnel working at a construction site should be aware of the proper material handling and storage procedures. For manual material handling, the expected lifting techniques should be made clear to avoid injuries. For handling of mechanical materials, operators need

to be aware of the weight lifting capacity of equipment like cranes and forklifts to avoid potential accidents.

All construction materials and equipment should be stored properly when not in use to prevent materials damage, accidents or injuries. Ensure safe loading limits for materials stored inside a building. All passageways should be kept clear for workers.

11. List down the factors which affect the selection of construction equipment.

Most of the construction projects involve laborious work which is to be handled by men and the equipment designed for doing the work undersigned.

It is difficult for workers to accomplish all things in a project and so there comes the need for machines particularly the construction equipment (machinery) that is widely used nowadays almost everywhere in the world.

For speedy and economic construction of a project, proper choice of equipment is of preliminary importance for civil engineers. The versatile range of equipment available commercially involves the decision of people. There are few basic things that are considered in selection of suitable equipment. They are as follows:

Use of Available Construction Equipment:

Where the full utilization of new equipment for its entire working life is not foreseen, or its utilization on further projects is uncertain, it may be desirable to use existing old equipment even if its operation is somewhat more expensive. The depreciation cost of the new machine is likely to be high, and this would raise the owning cost of the equipment and thus the unit cost of work.

Suitability for Job Conditions:

The equipment chosen should suit the conditions of the job, soil, valley, working conditions and climate of the region.

Uniformity in Type:

A minimum number of types should be acquired so that there is uniformity in the type of equipment on a job. A common type of engine should be selected for the different types machines such as excavators, dump trucks, tractors and scrapers that are on the project.

Size of Construction Equipment:

Larger equipment gives higher output on full load, but its cost of production on part load is usually greater than that of smaller units working on full load. Larger equipment needs correspondingly larger size of matching units, and shutting down of one primary unit may render several other large units idle.

Transportation to works is generally difficult and costly. Servicing, maintenance and repair facilities have to be greater for larger units. However, larger machines are usually more sturdy and suitable for tough working conditions.

It is desirable to have equipment of same size on the project. With standbys, the cost of larger size standby equipment is more than that of smaller size.

Use of Standard Construction Equipment:

Standard equipment is commonly manufactured and is available. Such equipment is manufactured in large numbers and so readily available and moderately priced. Spare parts of standard equipment are easily available and are less costly. After the work is over, disposing off standard equipment and its spare parts is generally easier than disposing off non-standard or specialized equipment.

Unit Cost of Production:

The economics of equipment is one of the most important considerations in the selection of equipment.

When calculating owning cost, all items of expenses, like freight, packing and forwarding, insurance, erection, commissioning, etc. should be included with the price paid to the supplier.

Country of Origin:

For imported equipment, it is preferable to import from a soft currency rather from a hard currency area, to save foreign currency reserves.

Availability of Spare Parts:

The availability of spare parts at reasonable costs during the entire working life of the equipment should be ensured while selecting a particular type or make of equipment, especially of imported equipment. Downtime due to shortage of spare parts commonly accounts for long idle periods during the working life of equipment. If specialists are needed, their availability should also kept in mind.

Versatility:

The machine selected should, if possible, be able to do more than one function and should be inter-convertible wherever possible.

Selection of Manufacturer:

It is good to have equipment of the same manufacturer on a project as far as possible and to have minimum number of different makes of equipment. The quality and commitment of local dealers is important. They should be sincere and capable of extending prompt after sales service.

Suitability of Local Labour:

The locally available operators and technicians should be able to handle the equipment selected. A special equipment may have excellent performance but it may be difficult to handle it through available know-how.

Adaptability for Future Use:

If the machine is required to work for only a part of its useful life then possibility on of disposing it off or its employment some other job should be considered. Obsolescence of the machine should not be overlooked.

12. What is prefabrication? What is the scope of prefabricated system of building construction in India?

Answer:

Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site, and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. The term is used to distinguish this process from the more conventional construction practice of transporting the basic materials to the construction site where all assembly is carried out.

The term prefabrication also applies to the manufacturing of things other than structures at a fixed site. It is frequently used when fabrication of a section of a machine or any movable structure is shifted from the main manufacturing site to another location, and the section is supplied assembled and ready to fit. It is not generally used to refer to electrical or electronic components of a machine, or mechanical parts such as pumps, gearboxes and compressors which are usually supplied as separate items, but to sections of the body of the machine which in the past were fabricated with the whole machine. Prefabricated parts of the body of the machine may be called 'sub-assemblies' to distinguish them from the other components.

“Prefabrication will be a key enabler in mission “Digital India” and play a vital role in all infrastructural development.” ‘Building it brick by brick’ to ‘build it before you build it’, transformative technologies being led primarily by Prefabrication are now beginning to blur lines between the construction and manufacturing sectors in India. Slated to have the world’s third largest construction industry by 2025, India is witnessing a high uptake of modular techniques with its construction sector slowly transforming and behaving more like the business of manufacturing.

The last two decades are testament to the fact that from Supercomputing to Space and Pharma to Biotech, India has always taken the lead to brace innovation and tech adoption be it any sector or industry. Today, the way things are being made is causing widescale disruption across industries including construction of buildings and infrastructure – Future of Manufacturing Things (FoMT). Riding the prefabrication wave and clocking a CAGR of 7-8 per cent, the Indian construction sector today stands at the threshold of a huge opportunity to leapfrog into FoMT and prefabrication or modular construction remain at the heart of it.

Process of Manufacturing Buildings

As a manufacturing process, Prefabrication is a method of construction that includes assembling components of a structure at a separate production site and then transporting complete or partial assemblies to the actual site where the structure is being constructed. It is basically a combination of superior design with modern high-performance components and quality-controlled manufacturing procedures. Therefore, prefabrication not just ensures faster completion of a project but also brings down its overall cost. From residential high rises in New York to low cost hotels in Europe, Prefabrication allows engineers to blur lines between design and manufacturing process and create products for the future. Over the next few years, India would feature amongst the fastest-growing countries in terms of construction output, making technology intervention a key component of this.

Barriers & Challenges in Adoption of Prefab

Globally, prefabrication has already seen significant adoption by the construction sector – Burj Khalifa in Dubai and the Sydney Opera House being two of the finest examples. According to a report published by Technavio, a global technology research and advisory firm, the global prefabricated construction market is expected to grow at a CAGR of 6-7 per cent until 2020. However, in India the uptake of modular technologies continues to remain slow and prefabricated buildings comprise only 1 per cent of India's \$100 Billion Real Estate Market. The main reason for this being that Prefabrication as a technology is still battling a mindset blockade in India, with most developers averse to investing in modular methods of construction and hesitant to incorporate prefabrication in their new and ongoing projects.

The Indian construction marketplace today stands plagued by constricted space, overcrowding, delay in completion and clearance snarls. In addition to this the sector continues to be labour intensive and heavily reliant on traditional construction practices. While, upfront the cost of switching over to prefab is a lot higher but in the long term it is prefabrication that can give developers the benefit of time, safety and quality, enabling them to churn out buildings faster and capture the demand.

Rise of BIM, Green Buildings and Lean Construction

The surge of prefab and modular as a 'trend' is significantly tied to the rise of advanced technology platforms such as Building Information Modelling – BIM. The application of BIM in prefabricated construction has multiple benefits – while it helps to ease the design flow it also provides data-centric information based on design, specification and construction issues. Additionally, BIM can also enable developers to track time, errors, and cost. Also, the industry recognizes contribution of modular technologies in meeting green goals. Apart from waste reduction benefits, working off-site reduces habitat and site disturbance; protects raw materials from rain and extreme weather contributing to the development of a more adaptive building. Similarly, lean construction, the new buzzword these days mainly focusses on eliminating waste, leading to significant savings in both schedules and budgets.

Confluence of Manufacturing and Construction

The uptake of transformative technologies was slow in the initial years as majority of tech innovation was focused on manufacturing construction equipment but over the last few years it is the process of construction and design that has become the focal point. It is now officially the age of manufactured buildings where constructing 3 floors a day or 57 floors in 19 days as built by China's Broad Sustainable Building (BSB) company is no longer an aspirational feat but a target easily achievable.

Most of the delay in construction happens at Stage – 1 due to faulty design. 3D Printing and designing everything on the cloud takes care of that problem with most of the iteration happening on the cloud itself. Big data and cloud computing are expected to have an immense impact on the design and management of construction projects. More frequent use of 3D printing technology, increased applications coupled with various kinds of materials and project types could completely change the process of physical delivery in coming years.

The next decade belongs to prefabrication with the Indian construction sector expected to expand to a size of \$1 trillion and contribute over 15 per cent to the overall GDP. The government's ambitious project of building 20 million affordable houses and 98 smart cities

by 2022 will see the construction and manufacturing industries confluence further to create an ecosystem for increased innovation and technology adoption. Thus, prefabrication will be a key enabler in mission "Digital India" and play a vital role in all infrastructural development.

13. Explain the design principles of the prefabricated system of building construction.

Answer:

The Main reasons to choose Precast Construction method over conventional in method:

- Economy in large scale project with high degree of repetition in work construction.
- Special requirement in finishing.
- Consistency in structural quality control.
- Fast speed of construction.
- Constraints in availability of site resources (e.g. materials & Laborites)
- Other space & environmental constraints.
- Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over convention method.

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6. Other space & environmental constraints.
7. Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over conventional method

The following details gives the cost implications of precast construction & conventional in situ method.

Prefabrication Elements :

1. Flooring / Roofing system.
2. Priciest Beams
3. Precast Columns
4. Precast walk panels.
5. recast Stabs.

Classification: The Prefabrication is classified as follow from the view of degree of Precast construction.

1. Small prefabrication
2. Medium Prefabrication
3. Large Prefabrication

4. Cast in Site Prefabrication
5. Off-Site (or) factory Prefabrication
6. Open system of prefabrication
7. Closed system of prefabrication
8. Partial prefabrication
9. Total prefabrication

Small Prefabrication: The first 3 types are mainly classified according to their degree of precast elements using in that construction for eg.: brick is a small unit precast and used in building. This is called as small prefabrication. That the degree of precast element is very low.

Medium Prefabrication: Suppose the roofing systems and horizontal members are provided with pretested elements those construction are known as medium prefabricated construction here th degree of precast elements are moderate.

Large Prefabrication: In large prefabrication most of the members like wall panels, roofing / flooring Systems, beams and columns are prefabricated. Here degree of precast elements are high.

Cast - in - site prefabrication : OFF - site (factory) prefabrication : One of the main factor which affect the factory prefabrication is transport. The width of mad walls, mode of transport, vehicles are the factors which prefabrication is to be done on site on factory.

Suppose the factory situated at a long distance from the construction site and the vehicle have to cross a congested traffic with heavy weighed elements the cost in side prefabrication is preferred even though the same condition are the cast in site prefabrication is preferred only when number of houses and more for small elements the conveyance is easier with normal type of lorry and trailers. Therefore we can adopt factory (or) OFF site prefabrication for this type of construction.

Open system of prefabrication: In the total prefabrication systems, the space framers are casted as a single unit and erected at the site. The wall fitting and other fixing are done on site. This type of construction is known as open system of prefabrication.

Closed system of prefabrication: In this system the whole things are casted with fixings and erected on their position.

Partial prefabrication: In this method of construction the building element (mostly horizontal) required are precast and then erected. Since the costing of horizontal elements (roof / floor) often take there time due to erection of from work the completion of the building is delayed and hence this method is restored. In most of the building sites this method is popular more.

This method is efficient when the elements are readily available when the building reached the roof level. The delay caused due to erection of formwork, delay due to removal eliminated completely in this method of construction Suitable for any type of building provided lifting and erection equipments are available.

Total Prefabrication: Very high speed can be achieved by using this method of construction. The method can be employed for frame type of construction or for panel type of or the total prefabrication can be on site or off-site. The choice of these two methods depend on the situations when the factory produced elements are transported and erected site we call if off-site prefabrication. If this method is to be adopted then we have a very good transportation of the products to site. If the elements are cast near the building site and erected, the transportation of elements can be eliminated, but we have consider the space availability for establish such facilities though it is temporary. The choice of the method of

construction also depends on the following;

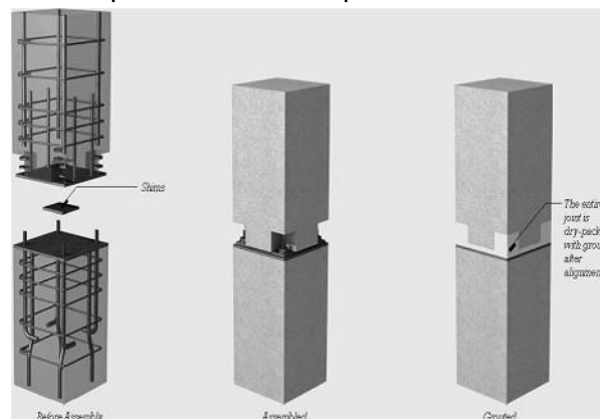
1. Type of equipment available for erection and transport.
2. Type of structural scheme (linear elements or panel)
3. Type of connections between elements.
4. Special equipment devised for special method construction.

14. Discuss the various prefabricated elements with sketch.

Answer:

Prefab Building Components

Some of the prefabricated components are as explained below



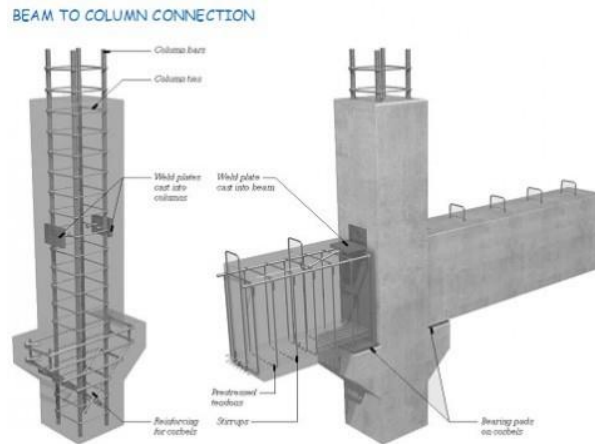
Prefab Column to Column Connection

Columns: – A column is a vertical member carrying the beam and floor loadings to the foundation. It is a compression member and therefore the column connection is required to be proper. The main principle involved in making column connections is to ensure continuity and this can be achieved by a variety of methods.

Beams: – Beams can vary in their complexity of design and reinforcement from the very simple beam formed over an isolated opening to the more common encountered in frames where the beams transfer their loadings to the column. Methods of connecting beams and columns are

- A precasting concrete haunch is cast on to the column with a locating dowel or stud bolt to fix the beam.
- A projecting metal corbel is fixed to the column and the beam is bolted to the corbel.
- Column and beam reinforcement, generally in the form of hooks, are left exposed. The two members are hooked together and covered with insitu concrete to complete the joint. This is as shown in the figure.

Waffle unit for flooring / roofing: – These are suitable for roofs / floors spanning in two directions. They are laid in a grid pattern. These units are cast in moulds. The saving achieved is not much. Also Shuttering are complicated and costly. Time consumption for construction is less



Prefab Column to Beam Connection

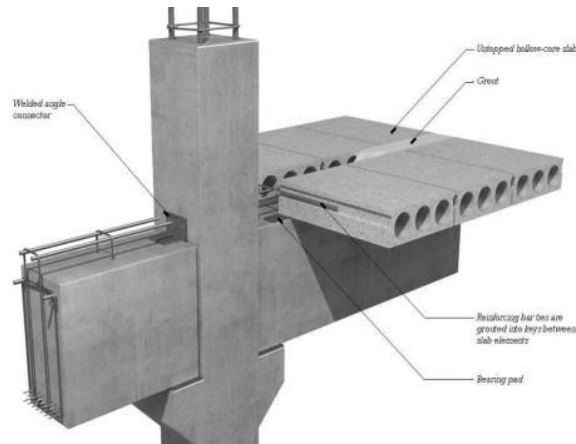
Advantages and Disadvantages

Advantages:

1. Saving in cost, material, time & manpower.
2. Shuttering and scaffolding is not necessary.
3. Installation of building services and finishes can be done immediately.
4. Independent of weather condition.
5. Components produced at close supervision .so quality is good
6. Clean and dry work at site.
7. Possibility of alterations and reuse
8. Correct shape and dimensions and sharp edges are maintained.
9. Very thin sections can be entirely precast with precision.

Disadvantages:

- Handling and transportation may cause breakages of members during the transit and extra provision is to be made.
- Difficulty in connecting precast units so as to produce same effect as monolithic. This leads to non-monolithic construction.
- They are to be exactly placed in position, otherwise the loads coming on them are likely to get changed and the member may be affected.
- Disadvantages:
 - High transport cost
 - Need of erection equipment
 - Skilled labour and supervision is required.



Prefabricated Slab To Beam Connection

The prefab components and prefab structures eliminate space and time over conventional constructions. Although prefabrication is employed to a large extent in a wide variety of countries, in India, construction industry, in spite of its expansion continues to adopt same conventional methods. The root of the economic problem is the fact that the majority of the households do not have the confidence needed to construct prefab houses. These structures are easy to erect as it is light material. This type of prefab buildings were constructed in earthquake prone areas of Lature and Gujarat.

15. What are the disadvantage and advantage of Prefabrication technique?

Answer:

Advantages of Pre-Fabricated Buildings

Prefabricated homes can be ordered and transported straight to your block. You can organize the stumping and plumbing and electrical connections or have it pre-ordered into the overall package.

Prefabricated homes cause less damage to the environment than conventional brick homes. They can be mass-produced or fabricated to your design and are quick to build so it will save you rent as brick homes tend to be dragged out with different contractors' being involved.

They will cost a lot less, than a double brick home by far. They can be insulated to reduce the cost of heating and cooling. Not only that they are environmentally friendly.

The real beauty of one of these is if you have a really bad neighbor you can up and take your home and chattels to another town without any problems.

- As it saves time
- It saves money and labor
- Enables money and standardization.
- It enhances aesthetic appeal.
- It is lightweight and easy to transport.
- Easy to installing and maintaining: i.e. rust, fire, and pest retardant and insulated.
- It is re-locatable and eco-friendly.

The disadvantages of prefabricated homes

The cost of your prefabricated home will depend on the size your home will be put on. Site costs will vary from block to block. If you are doing the stumping etc yourself then that is not a problem. If they need to factor that into the price they will need to make varying changes to prices due to the level and position of the block where the prefabricated home will be built.

Your choice of prefab metal buildings Canada home will be affected by your particular budget. Low-cost designs may suit those on a tight budget. Then if you can afford the better styles, then the price may not affect your decision.

The better high-quality designs are made for the higher-income families and could be out of your price range.

Prefabricated homes are improving like other forms of buildings and the main advantage of a prefabricated home is the potential to reduce the harmful impact on our environment. This is one of the world's biggest concerns these days.

17. What is the role of standardization in prefabrication?

Answer:

Standardization may be defined as adoption (selection) of generally accepted procedures, dimensions, materials, parts, principles, workplace arrangements for designing a product or facility. Standardization helps in reducing the varieties in size of similar components to facilitate assembly at the site to make the components interchangeable between different manufacturers. In prefabrication plant, standardization mainly focuses on making standards in manufacturing processes, materials, fits and tolerance. Standardization makes it possible to manufacture interchangeable parts.

The established standards are recorded for the future reference in the form of formulae, descriptions, details, drawings and models. Standardization helps for easy communication between the supplier and customer of prefabrication parts and also it reduces the conflict between supplier and customer.

In the prefabrication industry, some of the standardized components are doors, stairs, windows, walls, floors, roof trusses, columns, beams and even entire building. Co-operation required from designers, suppliers and builders is essential for standardizing the prefabricated components. Prefabricated parts are suitable only for large volume required prefabricated components with a minimum number of standard sizes. Standardization is nothing but making the use of guidelines for the production of interchangeable parts. It helps to sell the products in global marketing. Standardization not only helps the manufacturer but also benefited by customers in terms of choice, availability and interchangeability. It establishes the limits within which the products or components must fall. Then only the parts will be useful, if the parts fall outside the limit, then the parts are said to be not standard/interchangeable.

Quality control and testing are used to measure the achievement of standards. Standardization promotes clear communication within and among the organization, it can also lower the cost of the product, labour and repair. National and international organizations play an important role for establishing the standardization. Standardization promotes the chances for globalization of business.

Standard implies the component or part fit for any particular use. It helps the organization to focus on their attention on delivering excellence to customer and compete globally. Components are standardized based on size, weight, function, shape, material.

Levels of standardization:

Compatibility (Designed to work with another system without modification), interchangeability (Capability of the part replacing the other without the need for attention and adjustments), commonality (Degree of similarity between parts or system that allows interchangeability), reference (A source of information is used for future reference).

Advantages of standardization:

1. Able to reduce the number of varieties of components, need to maintain large inventories.
2. Lowering the installation and starting cost, down time, maintenance cost.
3. Enabling the interchangeability of parts.
4. Improving the design with less effort, communication.
5. Provides opportunity to use specialized machines.
6. Reducing the erection and assembly time, additional alterations.
7. Increase the chances for global marketing, productivity.

Unit 2: Value Analysis

18. Define following terms

- a. Indirect cost
- b. Direct cost

Indirect costs:

It represents the expenditure on those items which are shared by more than one activity and cannot be directly allocated to individual activity of a project.

Indirect costs of a project are those expenditures which cannot be apportioned or clearly allocated to the individual activity. These include the expenditure related to the administration and establishment charges, overhead, supervision, loss of revenue etc.

Indirect cost rises with increased duration. Relationship between indirect cost and project duration is shown in Fig. 29.1. This relationship would be represented by a straight line, with a slope equal to daily overhead.

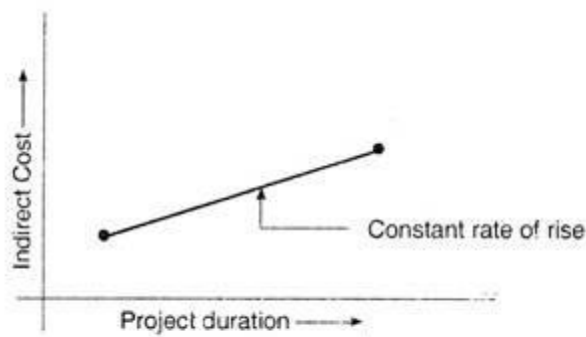


Fig. 29.1. Relationship between indirect cost and project duration.

When there is a loss of profits due to inability to meet the demand or some penalty due to delay, a corresponding cost increase (known as outage loss), must be added to the cost of overheads.

Direct cost:

It represents the expenditure which can be allocated to different activities in a project, like manpower, material etc.

19. For a network shown in Fig. 29.6, Normal time, Crash time, Normal cost and Crash costs are given in the table. Contract the network by crashing it to optimum value and calculate the optimum project cost. Indirect cost is given as Rs. 100 per day.

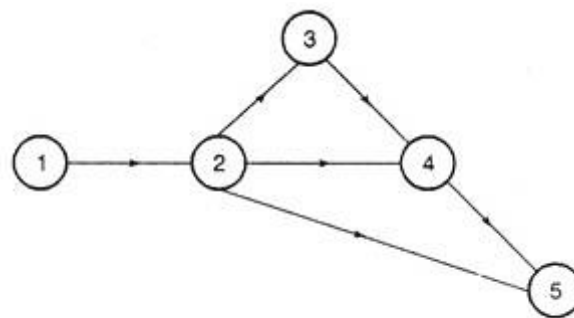


Fig. 29.6.

Solution:

By drawing the network with normal duration, we see (from following figure) that critical path is 1-2-3-4-5.

The project duration is, therefore, equal to 18 days. On this path, Crash time = 13 days (from given data on critical path).

Activity	Normal		Crash	
	Time in days	Cost in Rs.	Time in days	Cost in Rs.
1-2	3	300	2	400
2-3	6	480	4	520
2-4	7	2100	5	2500
2-5	8	400	6	600
3-4	4	320	3	360
4-5	5	500	4	520

Normal cost and crash cost can now be calculated by adding values of all the activities, given in the table.

Normal cost = Rs. 4100 and Crash cost = Rs. 4900.

To construct the network, in first stage we should identify those activities on critical paths, which have cost-slopes less than the indirect cost. For this purpose cost slopes are calculated hereunder

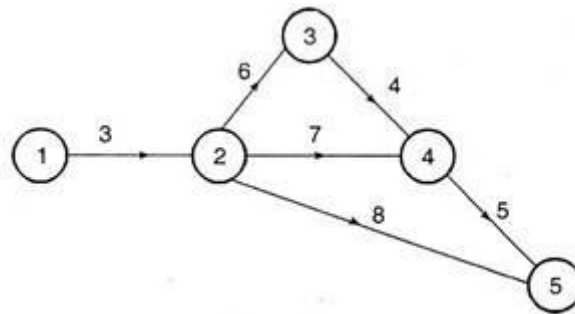


Fig. 29.7.

Activity	Normal		Crash		Cost-slope		
	Time in days	Cost in Rs	Time in days	Cost in Rs.	ΔC	ΔT	$\frac{\Delta C}{\Delta T}$
1-2	3	300	2	400	100	1	100
2-3	6	480	4	520	40	2	20
2-4	7	2100	5	2500	400	2	200
2-5	8	400	6	600	200	2	100
3-4	4	320	3	360	40	1	40
4-5	5	500	4	520	20	1	20

Critical path activities 2-3 and 4-5 have least cost slopes. Therefore, these activities are first crashed and network is again drawn (Refer Fig. 29.8).

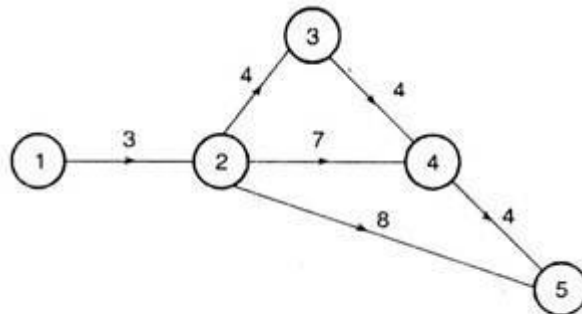


Fig. 29.8.

This network shows that, after crashing activities 2-3 by 2 days and 4-5 by 1 day, the critical path is same, i.e. 1-2-3-4-5 and have 15 days duration.

Now in second stage, the least cost slope in remaining activities is for activity 3-4 on the critical path.

By crashing this activity, we see that two paths become critical path, 1-2-3-4-5 and 1-2-4-5 as shown in Fig. 29.9 below:

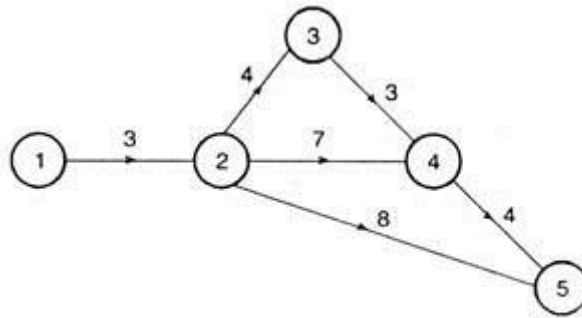


Fig. 29.9.

Now we see that after crashing activities 2-3, 4-5 and 3-4, there is no other activity on both the critical paths which have cost slopes less than indirect cost. This shows that this is the optimum network and hence optimum project duration is 14 days.

Total direct project cost for this optimum duration

= Direct cost for all activities on the network

= Cost on activities 1-2; 2-3; 2-4; 2-5; 3-4; 4-5

= 300 + 520 + 2100 + 400 + 360 + 520 = Rs. 4200.

And indirect cost for 14 days @ Rs. 100 per day = Rs. 1400

Total project cost after crashing = 4200 + 1400 = 5600.

Whereas total cost with all normal activities was (i.e. without crashing)

= Normal cost + Indirect for 18 days = 4100 + 1800

= Rs. 5900.

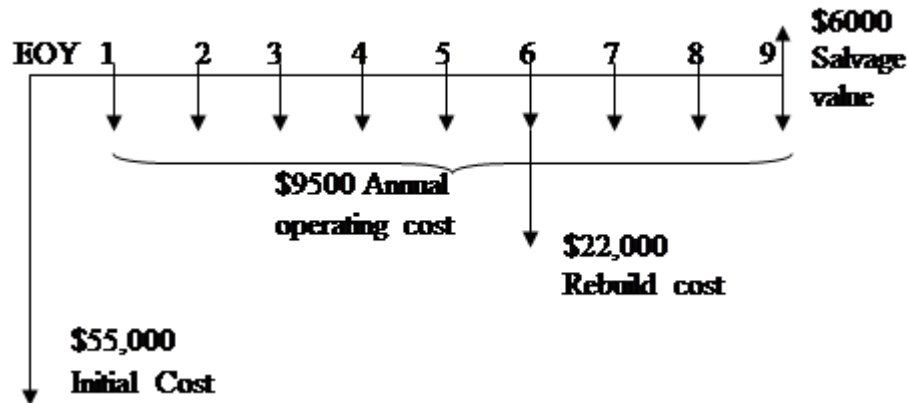
Thus the optimum cost of the project is Rs. 5600. By crashing to optimum value, we could save Rs. 300. If we further crash the project beyond optimum value, the project shall become costlier.

20. Explain cash flow diagram and its importance with simple example.

Cash flow diagrams visually represent income and expenses over some time interval. The diagram consists of a horizontal line with markers at a series of time intervals. At appropriate times, expenses and costs are shown.

Note that it is customary to take cash flows during a year at the end of the year, or EOY (end-of-year). There are certain cash flows for which this is not appropriate and must be handled differently. The most common would be rent, which is normally taken at the

beginning of a cash period. There are other pre-paid flows which are handled similarly. For example, consider a truck that is going to be purchased for \$55,000. It will cost \$9,500 each year to operate including fuel and maintenance. It will need to have its engine rebuilt in 6 years for a cost of \$22,000 and it will be sold at year 9 for \$6,000. Here is the cash flow diagram:



Note that the initial cost, the purchase price, is recorded at the beginning of Year 1, sometimes referred to as end-of-year 0, or EOY 0. Also, operating and maintenance costs actually will occur during a year, but they are recorded at EOY, and so forth.

21- 24. Common data to question (21) to (24):-

The initial cost of a piece of construction equipment is Rs.30,00,000 having a useful life of 10 years. The estimated salvage value of the equipment at the end of the useful life is Rs.450,000.

21. The book value of the construction equipment at the end of 5th year using Straight - line method is

Solution:

Given: Original cost of equipment (V) = Rs. 30, 00,000

Salvage value of equipment (Vs) = Rs. 4, 50,000

Useful life (n) = 10 years

Calculate:

Annual depreciation and book value of the construction equipment at the end of 5th year i.e. d₅ and BV₅ respectively.

Using straight line method-

As in this method annual depreciation $d_1 = d_2 = d_3 = \dots = d$.

Therefore,

Annual depreciation (d) = $d_5 = \frac{\text{Original value of equipment (V)} - \text{Salvage value of equipment (Vs)}}{\text{service life (n)}}$

$d = d_5 = \frac{3000000 - 450000}{10} = \text{Rs. } 2,55,000$

Book Value (V₅) after 5 years = $V - d \cdot a = 3000000 - 255000 \cdot 5 = \text{Rs. } 1,72,5000$

22. The book value of the construction equipment at the end of 5th year (BV₅) and depreciation (d₅) for 5th year using Double-declining balance method are:

Solution:

Given: Original cost of equipment (V) = Rs. 30, 00,000

Salvage value of equipment (Vs) = Rs. 4, 50,000

Useful life (n) = 10 years

Calculate:

Annual depreciation and book value of the construction equipment at the end of 5th year i.e. d5 and BV5 respectively.

Using Double-declining balance method

Amount to be depreciated = (V-Vs) = 3000000-450000= Rs.2550000

Using straight line depreciation method

Annual depreciation = 2550000/10= Rs.255000 per year

Annual depreciation (in terms of fraction of original cost) = 255000/3000000 =0.085

Thus for double decline method annual depreciation will be =2*0.085 =0.17

Thus for 1st year depreciation amount will be = 3000000*0.17= Rs. 510000

Book value at the end of 1st year (V1) = (3000000-510000) = Rs. 2490000

For 2nd year depreciation amount will be= Recent Book value*0.17 =2490000*0.17 = Rs.423300

Book value at the end of 2nd year (V2) = (2490000-423300) = Rs. 2066700

For 3rd year depreciation amount will be= Recent Book value*0.17 =2066700*0.17= Rs.351339

Book value at the end of 3rd year (V3) = (2066700-351339) = Rs. 1715361

For 4th year depreciation amount will be= Recent Book value*0.17 =1715361*0.17= Rs.291611.37

Book value at the end of 4th year (V4) = (1715361-291611.37) = Rs. 1423749.63

For 5th year depreciation amount will be= Recent Book value*0.17 =1423749.63*0.17= **Rs.242037.44**

Book value at the end of 5th year (V5) = (1423749.63-242037.44) =**Rs. 1181712.19**

23. Determine the book value (BV5) of the construction equipment at the end of 5th year and depreciation (d5) for 5th year using Sum-of-the-years-digits method?

Solution:

Given: Original cost of equipment (V) = Rs. 30, 00,000

Salvage value of equipment (Vs) = Rs. 4, 50,000

Useful life (n) = 10 years

Calculate:

Annual depreciation and book value of the construction equipment at the end of 5th year i.e. d5 and BV5 respectively.

Using Sum of years digits method

Depreciable cost = Rs.3000000-Rs.450000=Rs.2550000

Sum of the years' digits for n years = 1 + 2 + 3 + + (n-1) + n

= (n+1) x (n / 2) = (10+1)*10/2= 55

or Sum of the years' digits = 1+2+3+...+10 = 55

Depreciation for 1st year = (2550000) x 10/55 = 10*46363.63636=Rs.463636.36

Book value at the end of 1st year= (3000000-463636.36) = Rs. 2536363.64 Depreciation for 2nd

year= (2550000) x 9/55 =9*46363.63636=Rs.417272.73

Book value at the end of 2nd year= (2536363.64-417272.73) = Rs. 2119090.91

Depreciation for 3rd year = (2550000) x 8/55 = 8*46363.63636=Rs. 370909.09

Book value at the end of 1st year= (2119090.91-370909.09) = Rs. 1748181.82

Depreciation for 4th year= (2550000) x 7/55 = 7*46363.63636=Rs. 324545.45

Book value at the end of 1st year= (1748181.82-324545.45) = Rs. 1423636.37

Depreciation for 5th year = (2550000) x 6/55 = 6*46363.63636=Rs. 278181.82

Book value at the end of 5th year= (1423636.37-278181.82) = **Rs. 1145454.54**

24. Determine accumulated depreciation at the end of 5th year using Sinking fund method, if interest rate is 8.2 % per year?

Solution:

Given: Original cost of equipment (V) = Rs. 30, 00,000

Salvage value of equipment (Vs) = Rs. 4, 50,000

Useful life (n) = 10 years

Calculate:

Annual depreciation and book value of the construction equipment at the end of 5th year i.e. d5 and BV5 respectively.

Interest rate (i) = 8.2 % per year = 0.082

V-Vs= 2550000, is the depreciable cost which should be accumulated at the end of 10th year or it can be called the future value at the end of 10th year which needs to be generated through constant equal installments (R). R is the annual equal amount of depreciation.

$$R = (V - V_s) * \left[\frac{i}{(1 + i)^n - 1} \right]$$

Annual depreciation=R = 2550000*0.0684 = Rs. 174420

Book value at the end of 1st year = (3000000-174420) = Rs. 2825580

Interest earned at the end of 2nd year = 174420*0.082= Rs.14302.44

Increased in fund value for 2nd year= (174420+14302.44) = Rs. 188722.44

Accumulated depreciation at the end of 2nd year = (174420+188722.44)
= Rs. 363142.44

Book value at the end of 2nd year = (2825580-188722.44) = Rs. 2636857.56

Interest earned at the end of 3rd year =363142.44*.082 =Rs. 29777.68

Increased in fund value for 3rd year= (174420+29777.68) = Rs. 204197.68

Accumulated depreciation at the end of 3rd year = (363142.44+204197.68)
= Rs. 567340.12

Book value at the end of 3rd year = (2636857.56-204197.68) = Rs. 2432659.88

Interest earned at the end of 4th year = 567340.12*.082 = Rs. 46521.89

Increased in fund value for 4th year= (174420+46521.89) = Rs. 220941.89

Accumulated depreciation at the end of 4th year = (567340.12+220941.89)
= Rs. 788282.01

Book value at the end of 4th year = (2432659.88-220941.89) = Rs. 2211717.99

Interest earned at the end of 5th year = 788282.01*.082 = Rs.64639.12

Increased in fund value for 5th year= (174420+64639.12) = Rs. 239059.12

Accumulated depreciation at the end of 5th year = (788282.01+239059.12)
= **Rs. 1027341.13**

Book value at the end of 5th year = (2211717.09-239059.12) = **Rs. 1972657.96**

25. The original cost of a heat exchanger is Rs.1, 00,000. It has a useful life of 10 years. The estimated salvage value of the heat exchanger at the end of useful life is zero. Calculate the book value at the end of 3rd year, using repair provision method, if the repairs and maintenance charges together were estimated to be Rs. 18,000 during the lifetime of the equipment. And also determine the annual depreciation to be provided?

Solution:

Given:

Original cost of heat exchanger (V) = Rs. 1,00,000

Salvage value of equipment (V_s) = 0

Useful life (n) = 10 years

Estimated total cost of repair = Rs. 18,000

Calculate:

Annual depreciation and book value of the heat exchanger at the end of 3rd year

Solution:

Annual amount to be provided for depreciation (d):

= [(original cost - salvage value) + Estimated total cost of repair] / expected useful life

= [(100,000 - 0) + 18,000] / 10 = **Rs. 11,800**

Book value at the end of 3rd year = V - a * d = 100,000 - 3 * 11,800 = **Rs. 64,600**

26. There are two plans for a new godown construction for storage. We can either go in for a new concrete building (Plan-1) or have an extension to the existing building (Plan-2). The new concrete building is estimated to cost Rs. 60,000 with a permanent life. Its annual maintenance, insurance and tax cost is expected to be Rs. 500. The extended building will cost Rs. 20,000 and annual maintenance, insurance, and tax cost being Rs. 800. Both plans have life spans of 20 year. Assuming 10% as an attractive return, and using the annual cost method, choose the correct statement-

Solution:

Given:

	Plan-1	Plan-2
Capital investment (Rs.)	60000	20000
maintenance, insurance, and tax cost per year (Rs.)	500	800
Useful life (years), n	20	20
Rate of return (%), i	10	10

Annual cost of the capital recovery is the annuity based on time value of money that one has to pay throughout the useful life, which will be equal to the capital investment at the start of the 1st year.

Annual cost of capital recovery = Capital investment * i / [1 - (1+i)⁻ⁿ]

For Plan-1

Annual cost of Capital recovery = $60000 \cdot 0.1 / [1 - (1 + 0.1)^{-20}] = \text{Rs. } 7047.58$

For Plan-2

Annual cost of Capital recovery = $20000 \cdot 0.1 / [1 - (1 + 0.1)^{-20}] = \text{Rs. } 2349.19$

	Plan-1	Plan-2
Capital investment	Rs.60,000	Rs.20,000
Estimated useful life	20	20
Maintenance, insurance, and tax cost per year	Rs.500	Rs.800
Rate of return	10%	10%
Solution given below		
Annual cost of capital recovery	Rs.7047.58	Rs.2349.19
Total annual cost(annual cost of capital recovery + annual operating cost)	Rs.7547.58	Rs.3149.19

Decision: We should go in for Plan-2 in comparison to Plan-1 as its total annual cost is low.

27. A restaurant buys a wood-burning stove for Rs. 20,000. The stove has a lifetime of 4 years and a salvage value of Rs. 1500. What is the accumulated depreciation (D3) and book value (BV3) at the end of 3rd year by Sinking fund method, if annual interest rate is 9%?

Solution:

Given: Original cost of wood burning stove (V) = Rs. 20000

Salvage value of equipment (Vs) = Rs. 1500

Useful life (n) = 4 years

Calculate:

Accumulated Depreciation for 3rd year and asset value of the wood burning stove at the end of 3rd year

Interest rate (i) = 9 % per year = 0.09

V-Vs=Rs. 18500, is the depreciable cost which should be accumulated at the end of 4th year or it can be called the future value at the end of 4th year which needs to be generated yearly investment of Rs.

R. R is the annual equal amount of depreciation.

$$R = (V - V_s) * \left[\frac{i}{(1 + i)^n - 1} \right]$$

Annual depreciation=R = $18500 \cdot 0.2187 = \text{Rs. } 4045.37$

Book value at the end of 1st year = $(20000 - 4045.37) = \text{Rs. } 15954.63$

Interest earned at the end of 2nd year = $4045.37 \cdot 0.09 = \text{Rs. } 364.08$

Increased in fund value for 2nd year= $(4045.37 + 364.08) = \text{Rs. } 4409.45$

Accumulated depreciation at the end of 2nd year = $(4045.37 + 4409.45) = \text{Rs. } 8454.82$

Book value at the end of 2nd year = (15954.63-4409.45) = Rs. 11545.18

Interest earned at the end of 3rd year = 8454.82*.09 =Rs. 760.93

Increased in fund value for 3rd year = Rs. 4806.30

Accumulated depreciation at the end of 3rd year = (8454.82+4806.3)

= **Rs. 13261.12**

Book value at the end of 3rd year = (11545.18-4806.30) = **Rs.6738.88**

Year	Annual Dep. Computed(Rs.)	Interest earned (Rs.)	Increase in fund value (Rs.)	Accumulated Depreciation (Rs.)	Book Value (Rs.)
0					20000
1	4045.37	-	4045.37	4045.37	15954.63
2	4045.37	364.08	4409.45	8454.82	11545.18
3	4045.37	760.93	4806.30	13261.12	6738.88
4	4045.37	1193.51	5238.88	18499.99	1500.00

28. Explain meaning of cash flow analysis. Discuss purpose of cash flow analysis. Also differentiate between cash flow for contractor and cash flow for owner.

Answer:

Definition: The amount of cash or cash-equivalent which the company receives or gives out by the way of payment(s) to creditors is known as cash flow. Cash flow analysis is often used to analyse the liquidity position of the company. It gives a snapshot of the amount of cash coming into the business, from where, and amount flowing out.

Description: As discussed cash flows can either be positive or negative. It is calculated by subtracting the cash balance at the beginning of a period which is also known as opening balance, from the cash balance at the end of the period (could be a month, quarter or a year) or the closing balance.

If the difference is positive, it means you have more cash at the end of a given period. If the difference is negative it means that you have less amount of cash at the end of a given period when compared with the opening balance at the starting of a period.

To analyse where the cash is coming from and going out, cash flow statements are prepared. It has three main categories – operating cash flow which includes day-to-day transactions, investing cash flow which includes transactions which are done for expansion purpose, and financing cash flow which include transactions relating to the amount of dividend paid out to stockholders.

However, the level of cash flow is not an ideal metric to analyse a company when making an investment decision. A Company's balance sheet as well as income statements should be studied carefully to come to a conclusion.

Cash level might be increasing for a company because it might have sold some of its assets, but that doesn't mean the liquidity is improving. If the company has sold off some of its assets to pay off debt then this is a negative sign and should be investigated further for more clarification.

If the company is not reinvesting cash then this is also a negative sign because in that case it is not using the opportunity to diversify or build business for expansion.

29. A machine was purchased two years ago at a cost of Rs. 2,00,000 to be useful for eight years with salvage value at the end of its life as Rs. 25,000. The annual maintenance cost is Rs. 25,000. The market value of the present machine is Rs. 1,20,000. Now, a new machine to cater to the need of the present machine is available at Rs. 1,50,000 to be useful for six years. Its annual maintenance cost is Rs. 14,000. The salvage value of the new machine at the end of its life is estimated to be Rs. 20,000. Using an interest rate of 12%, the decision regarding whether to continue services of existing equipment or replace it.

Solution:

Defender: $P = 120000$, $F = 25000$, $n = 6$, $MC = 25000$, $i = 12\%$

$CR(i) = (120000 - 25000) (A/P, 12, 6) + (25000 \times 0.2) + 25000 = 51104$

Challenger: $P = 150000$, $F = 20000$, $n = 6$, $MC = 14000$, $i = 12\%$

$CR(i) = (150000 - 20000) (A/P, 12, 6) + (20000 \times 0.2) + 14000 = 48016$

Since, $CR(i)$ of challenger is lower than defender hence, existing machine should be replaced.

30. Discuss network crashing.

For any given activity a point will reach beyond which no further reduction in time will be possible irrespective of the resources spent on this activity. The time for the activity at which minimum cost is called normal time and the minimum time for the activity is called crash time. The cost associated with these times are called normal cost and crash cost respectively.

The total direct cost of the project can be determined by adding the direct costs of each individual activities. Initially, for all activities, normal time estimates are assumed and the total project duration is computed using the computational procedure.

If the project duration has to be reduced, then time of one or more activities has to be reduced. The activities selected should be such that the total project duration is reduced at the least cost. This process can be repeated till no further reduction in the project duration can be achieved.

The reduction in the project duration can be achieved by reducing the time requirement of few selected activities from their normal time, the maximum reduction in time possible for any activity being upto its crash time. This process of reducing the total project duration by reducing activity timing is known as crashing project network.

Crashing Procedure:

Crashing of a network can be done in following steps:

1. Critical path:

Find the normal critical path and identify the critical activity.

2. Cost slope:

Calculate the cost slope for the different activities by using the formula.

Cost slope = $\frac{\text{Crash cost} - \text{Normal cost}}{\text{Crash time} - \text{Normal time}}$

The cost slope indicates the extra cost required to expedite an activity per unit time.

3. Ranking:

Rank the activities in the ascending order of cost slope . The activity having the minimum cost slope have to be crashed first, crash the selected activity to its minimum duration.

4. Crashing:

Crash the activities in the critical path as per the ranking i.e., activity having lower cost slope would be crashed first to the maximum extent possible. Calculate the new direct cost by cumulative adding the cost of crashing to the normal cost.

5. Parallel crashing:

As the critical path duration is reduced by the crashing in step 3, other paths also become critical, i.e., we get parallel critical path. This means that project duration can be reduced duly by simultaneous crashing of activity on the parallel critical path.

6. Total cost:

Crashing as per steps 3 and 4, one reaches a point when further crashing is either not possible or does not result in the reduction of project duration. For the different project durations total cost is found up to total cost is got by adding corresponding fixed cost to the direct cost, and the direct cost is got by adding the expediting crashing cost commutative to the normal cost.

31. Define capitalized cost and salvage value.

Answer:

Capitalized cost:

Capitalized cost represents the present worth of an alternative for a project that is going to serve for a longer period of time i.e. for an infinite period of time. As the name indicates, it refers to the present worth of mainly cost or expenditures (cash outflows) of the alternative over infinite period of time. Capitalized worth refers to present worth of expenditures and revenues of an alternative over infinite period of time. The capitalized cost method is used for comparison of mutually exclusive alternatives which have perpetual service life (assumed to serve forever). The examples of this kind of projects are bridges, dams, irrigation projects, water supply systems for cities, pipeline projects etc. This method can also be used for finding out the capitalized cost of permanent fellowship/scholarship endowment in educational institutes and other organizations. As already stated, capitalized cost/worth is the present worth of an alternative that has a perpetual or permanent cash flow series.

The capitalized cost of a single amount occurring at regular intervals in future period of time is calculated by first finding out the equivalent uniform annual worth 'A' of the uniform series and then dividing by the interest rate 'i'.

Salvage value:

It is the estimated amount that a company will receive at the end of a plant asset's useful life. It is the amount of an asset's cost that will not be part of the depreciation expense during the years that the asset is used in the business.

Salvage value is also referred to as *disposal value*, *residual value*, or *scrap value*.

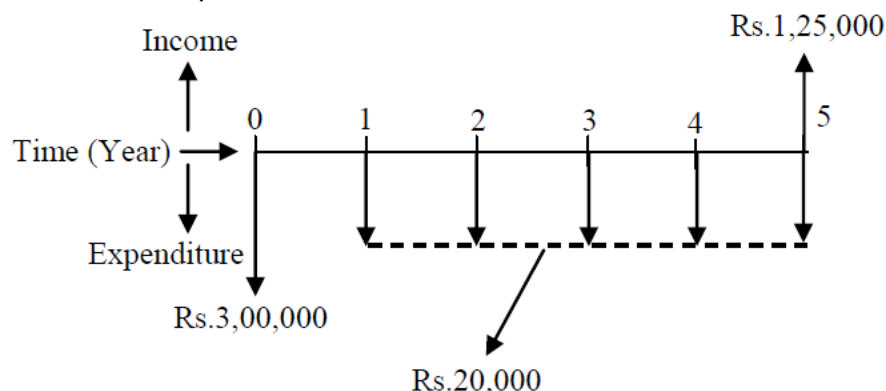
Example of Asset Salvage Value

Perhaps the most common calculation of an asset's salvage value is to assume there will be no salvage value. As a result, the entire cost of the asset used in the business will be charged to depreciation expense during the years of the asset's expected useful life.

A salvage value of zero is reasonable since it is assumed that the asset will no longer be useful at the point when the depreciation expense ends. Even if the company receives a small amount, it may be offset by costs of removing and disposing of the asset.

32. There are two alternatives for purchasing a concrete mixer. Both the alternatives have same useful life. The cash flow details of alternatives are as follows; **Alternative-1: Initial purchase cost = Rs.3,00,000, Annual operating and maintenance cost = Rs.20,000, Expected salvage value = Rs.1,25,000, Useful life = 5 years. Alternative-2: Initial purchase cost = Rs.2,00,000, Annual operating and maintenance cost = Rs.35,000, Expected salvage value = Rs.70,000, Useful life = 5 years. Using present worth method, find out which alternative should be selected, if the rate of interest is 10% per year.**

Solution: Since both alternatives have the same life span i.e. 5years, the present worth of the alternatives will be compared over a period of 5 years. The cash flow diagram of Alternative-1 is shown in Fig. 2.1. As already mentioned Module-1, the cash outflows i.e. costs or expenditures are represented by vertically downward arrows whereas the cash inflows i.e. revenue or income are represented by vertically upward arrows. The same convention is adopted here.



The equivalent present worth of Alternative-1 i.e. PW_1 is calculated as follows;

The initial cost, $P = \text{Rs.}3,00,000$ (cash outflow),

Annual operating and maintenance cost, $A = \text{Rs.}20,000$ (cash outflow),

Salvage value, $F = \text{Rs.}1,25,000$ (cash inflow).

$$PW_1 = -3,00,000 - 20,000(P/A, i, n) + 1,25,000(P/F, i, n)$$

$$PW_1 = -3,00,000 - 20,000(P/A, 10\%, 5) + 1,25,000(P/F, 10\%, 5)$$

Now putting the mathematical expressions of different compound interest factors (as mentioned in Module-1) in the above expression for PW_1 (in Rs.) results in the following;

$$PW_1 = -3,00,000 - 20,000 \times \frac{(1+i)^n - 1}{i(1+i)^n} + 1,25,000 \times \frac{1}{(1+i)^n}$$

$$PW_1 = -3,00,000 - 20,000 \times \frac{(1+0.1)^5 - 1}{0.1(1+0.1)^5} + 1,25,000 \times \frac{1}{(1+0.1)^5}$$

$$PW_1 = -3,00,000 - 20,000 \times 3.7908 + 1,25,000 \times 0.6209$$

$$PW_1 = -3,00,000 - 75,816 + 77,613$$

$$PW_1 = -\text{Rs.}2,98,203$$

33- 34 The following should be used for both the questions 33 and 34

A project manager is relegated to a venture ahead of schedule in the venture lifecycle. Something that must be done is to do a justification for the project. Since very little information is known about the project, the estimates are considered to be rough estimates. The accompanying table is the project manager's gauge of the income that will occur throughout the following five years:

End of Year	Cash Flow In	Cash Flow Out
1	0	500,000
2	300,000	90,000
3	400,000	100,000
4	100,000	175,000
5	50,000	35,000

33. What is the payback period for this project?

Explanation:

End of Year	Cash Flow In	Cash Flow Out	Net (Yearly)	Net (overall)
1	0	500,000	(500,000)	(500,000)
2	300,000	90,000	210,000	(290,000)
3	400,000	100,000	300,000	10,000
4	100,000	175,000	(75,000)	(65,000)
5	50,000	35,000	15,000	(50,000)

Payback period for this project is three years.

34. If the net present value for each of the cash flows were calculated at a 10% interest rate, the net present value cash flow at the end of five years would be:

Explanation:

$$NPV = \left(-\frac{500,000}{(1+0.1)^0} \right) + \left(-\frac{290,000}{(1+0.1)^1} \right) + \left(\frac{10,000}{(1+0.1)^2} \right) + \left(\frac{-65,000}{(1+0.1)^3} \right) + \left(\frac{-50,000}{(1+0.1)^4} \right)$$

$$= -838,358$$

$$\text{Cash flow without NPV} = -500,000 - 290,000 + 10,000 - 65,000 - 50,000 = -895,000$$

35. A project manager is dealing with a venture. The first extension standard of the venture was planned at \$100,000. Since work on the venture began there have been seventeen approved and affirmed changes to the venture. The progressions have an estimation of \$17,000 and the cost of exploring them before their endorsement was \$2,500. What is the present spending plan for the venture?

Solution:

Initial Cost: \$100,000

Progressions: \$17,000

Cost of Exploring: \$2500

Total = \$119,500

36. Explain Work breakdown structure.

Answer:

Dividing complex projects to simpler and manageable tasks is the process identified as Work Breakdown Structure (WBS). Usually, the project managers use this method for simplifying the project execution. In WBS, much larger tasks are broken down to manageable chunks of work. These chunks can be easily supervised and estimated. WBS is not restricted to a specific field when it comes to application. This methodology can be used for any type of project management.

Following are a few reasons for creating a WBS in a project:

- Accurate and readable project organization.
- Accurate assignment of responsibilities to the project team.
- Indicates the project milestones and control points.
- Helps to estimate the cost, time and risk.
- Illustrate the project scope, so the stakeholders can have a better understanding of the same.

Construction of a WBS

Identifying the main deliverables of a project is the starting point for deriving a work breakdown structure.

This important step is usually done by the project managers and the subject matter experts (SMEs) involved in the project. Once this step is completed, the subject matter experts start breaking down the high-level tasks into smaller chunks of work.

In the process of breaking down the tasks, one can break them down into different levels of detail. One can detail a high-level task into ten sub-tasks while another can detail the same high-level task into 20 sub-tasks.

Therefore, there is no hard and fast rule on how you should breakdown a task in WBS. Rather, the level of breakdown is a matter of the project type and the management style followed for the project.

In general, there are a few "rules" used for determining the smallest task chunk. In "two weeks" rule, nothing is broken down smaller than two weeks worth of work.

This means, the smallest task of the WBS is at least two-week long. 8/80 is another rule used when creating a WBS. This rule implies that no task should be smaller than 8 hours of work and should not be larger than 80 hours of work.

One can use many forms to display their WBS. Some use tree structure to illustrate the WBS, while others use lists and tables. Outlining is one of the easiest ways of representing a WBS.

Following example is an outlined WBS:

Project Name			
	Task 1		
		Subtask 1.1	Work Package 1.1.1 Work Package 1.1.2
		Subtask 1.2	Workpackage 1.2.1 Workpackage 1.2.2
	Task 2		
		Subtask 2.1	Workpackage 2.1.1 Workpackage 2.1.2

There are many design goals for WBS. Some important goals are as follows:

- Giving visibility to important work efforts.
- Giving visibility to risky work efforts.
- Illustrate the correlation between the activities and deliverables.
- Show clear ownership by task leaders.

WBS Diagram

In a WBS diagram, the project scope is graphically expressed. Usually the diagram starts with a graphic object or a box at the top, which represents the entire project. Then, there are sub-components under the box.

These boxes represent the deliverables of the project. Under each deliverable, there are sub-elements listed. These sub-elements are the activities that should be performed in order to achieve the deliverables.

Although most of the WBS diagrams are designed based on the deliveries, some WBS are created based on the project phases. Usually, information technology projects are perfectly fit into WBS model.

Therefore, almost all information technology projects make use of WBS. In addition to the general use of WBS, there is specific objective for deriving a WBS as well. WBS is the input for Gantt charts, a tool that is used for project management purpose.

Gantt chart is used for tracking the progression of the tasks derived by WBS.

Following is a sample WBS diagram:

Unit 3: Network Analysis

37. Select the correct equation for calculating total float for an activity.

- Total Float = LFT – EST
- Total Float = EFT – EST
- Total Float = LFT – EFT
- Total Float = LST – EFT

Answer: C

38. What is the term for an activity that cannot be deferred without affecting the project completion date or another activity's start date?

- a. Standard float
- b. Intermediate float
- c. Free float
- d. Zero float

Answer: C

39. PERT stands for:

- a. Programme evaluation and review technique
- b. Project estimation and review technique
- c. Programme estimation and renew technology
- d. None of these

Answer: A

40. Activities which have zero float are called:

- a. Critical Activities
- b. Dummy activities
- c. Non-critical activities
- d. None of these

Answer: B

41. The time by which activity completion time can be delayed without affecting the start of succeeding activities, is known as

- a. duration
- b. total flat
- c. free float
- d. interfering float

Answer: C

42. The artificial activity which indicates that an activity following it, cannot be started unless the preceding activity is complete, is known as

- a. event
- b. free float
- c. dummy
- d. constant

Answer: C

43. The estimated time required to perform an activity, is known as

- a. Event
- b. Dummy
- c. Duration
- d. Float

Answer: C

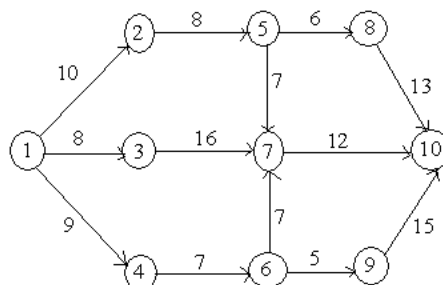
44. Explain various differences between PERT and CPM.

Answer:

Key Differences Between PERT and CPM:

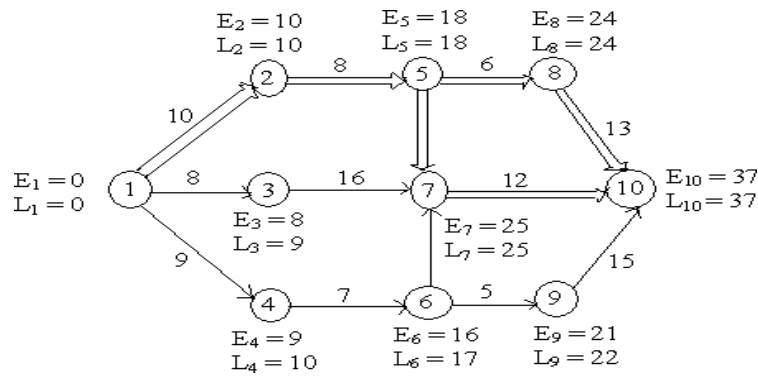
1. PERT is a project management technique, whereby planning, scheduling, organising, coordinating and controlling uncertain activities are done. CPM is a statistical technique of project management in which planning, scheduling, organising, coordination and control of well-defined activities take place.
2. PERT is a technique of planning and control of time. Unlike CPM, which is a method to control costs and time.
3. While PERT is evolved as a research and development project, CPM evolved as a construction project.
4. PERT is set according to events while CPM is aligned towards activities.
5. A deterministic model is used in CPM. Conversely, PERT uses a probabilistic model.
6. There are three times estimates in PERT, i.e. optimistic time (t_o), most likely time t_m , pessimistic time (t_p). On the other hand, there is only one estimate in CPM.
7. PERT technique is best suited for a high precision time estimate, whereas CPM is appropriate for a reasonable time estimate.
8. PERT deals with unpredictable activities, but CPM deals with predictable activities.
9. PERT is used where the nature of the job is non-repetitive. In contrast to, CPM involves the job of repetitive nature.
10. There is a demarcation between critical and non-critical activities in CPM, which is not in the case of PERT.
11. PERT is best for research and development projects, but CPM is for non-research projects like construction projects.
12. Crashing is a compression technique applied to CPM, to shorten the project duration, along with the least additional cost. The crashing concept is not applicable to PERT.

45. Determine the early start and late start in respect of all node points and identify critical path for the following network.



Solution:

Calculation of E and L for each node is shown in the network



Activity(i, j)	Normal Time (D _{ij})	Earliest Time		Latest Time		Float Time (L _i - D _{ij}) - E _i
		Start (E _i)	Finish (E _i + D _{ij})	Start (L _i - D _{ij})	Finish (L _i)	
(1, 2)	10	0	10	0	10	0
(1, 3)	8	0	8	1	9	1
(1, 4)	9	0	9	1	10	1
(2, 5)	8	10	18	10	18	0
(4, 6)	7	9	16	10	17	1
(3, 7)	16	8	24	9	25	1
(5, 7)	7	18	25	18	25	0
(6, 7)	7	16	23	18	25	2
(5, 8)	6	18	24	18	24	0
(6, 9)	5	16	21	17	22	1
(7, 10)	12	25	37	25	37	0
(8, 10)	13	24	37	24	37	0
(9, 10)	15	21	36	22	37	1

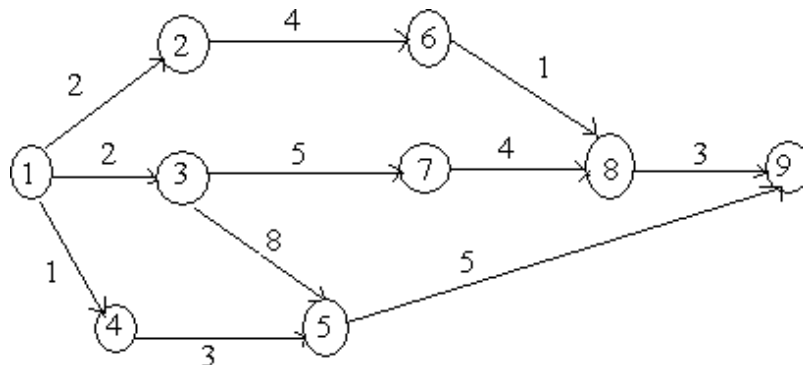
Network Analysis Table

From the table, the critical nodes are (1, 2), (2, 5), (5, 7), (5, 8), (7, 10) and (8, 10)

From the table, there are two possible critical paths

- i. 1 → 2 → 5 → 8 → 10
- ii. 1 → 2 → 5 → 7 → 10

46. Find the critical path and calculate the slack time for the following network

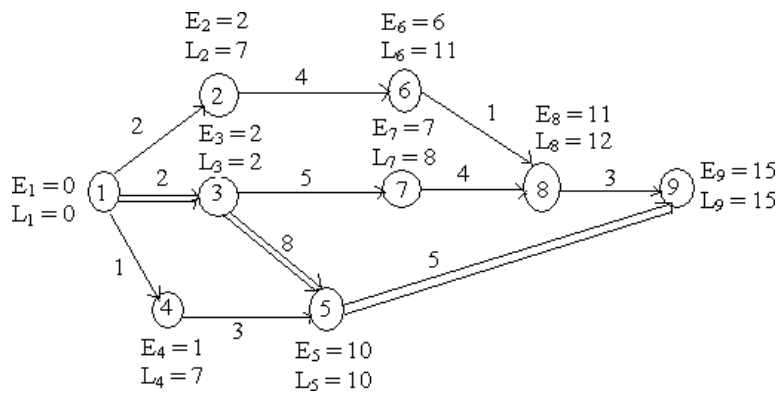


Solution

The earliest time and the latest time are obtained below

Activity(i, j)	Normal Time (D _{ij})	Earliest Time		Latest Time		Float Time (L _i - D _{ij}) - E _i
		Start (E _i)	Finish (E _i + D _{ij})	Start (L _i - D _{ij})	Finish (L _i)	
(1, 2)	2	0	2	5	7	5
(1, 3)	2	0	2	0	2	0
(1, 4)	1	0	1	6	7	6
(2, 6)	4	2	6	7	11	5
(3, 7)	5	2	7	3	8	1
(3, 5)	8	2	10	2	10	0
(4, 5)	3	1	4	7	10	6
(5, 9)	5	10	15	10	15	0
(6, 8)	1	6	7	11	12	5
(7, 8)	4	7	11	8	12	1
(8, 9)	3	11	14	12	15	1

From the above table, the critical nodes are the activities (1, 3), (3, 5) and (5, 9)



The critical path is 1 → 3 → 5 → 9

47. A project has the following times schedule

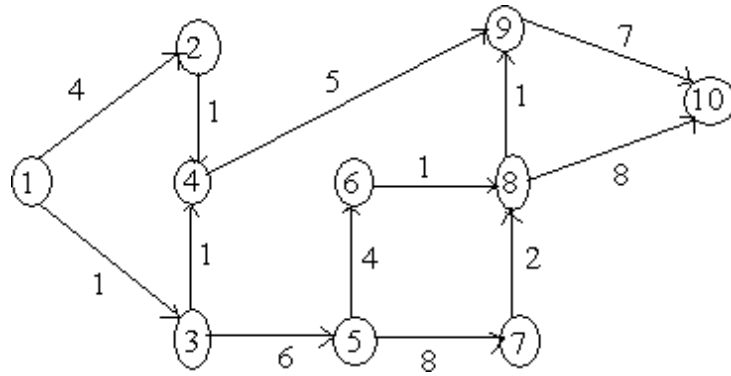
Activity	Time (weeks)	Activity	Time (weeks)	Activity	Time (weeks)
(1 - 2)	4	(4 - 9)	5	(8 - 9)	1
(1 - 3)	1	(5 - 6)	4	(8 - 10)	8
(2 - 4)	1	(5 - 7)	8	(9 - 10)	7
(3 - 4)	1	(6 - 8)	1		

Construct the network and compute

1. T_E and T_L for each event
2. Float for each activity
3. Critical path and its duration

Solution:

The network is

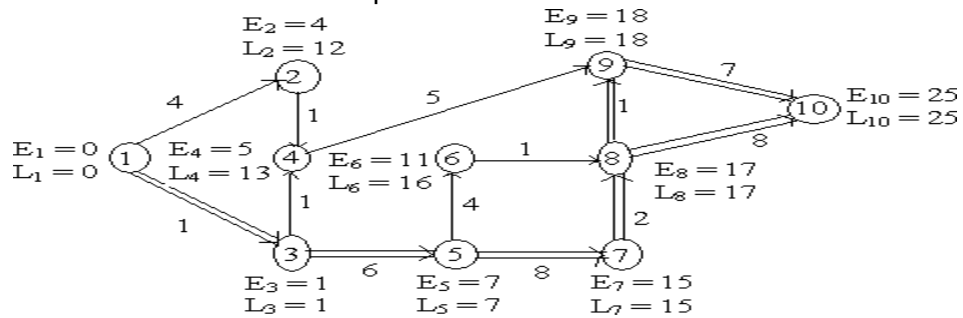


Event No.:	1	2	3	4	5	6	7	8	9	10
T_E :	0	4	1	5	7	11	15	17	18	25
T_L :	0	12	1	13	7	16	15	17	18	25

Float = T_L (Head event) – T_E (Tail event) – Duration

Activity	Duration	T_E (Tail event)	T_L (Head event)	Float
(1 – 2)	4	0	12	8
(1 – 3)	1	0	1	0
(2 – 4)	1	4	13	8
(3 – 4)	1	1	13	11
(3 – 5)	6	1	7	0
(4 – 9)	5	5	18	8
(5 – 6)	4	7	16	5
(5 – 7)	8	7	15	0
(6 – 8)	1	11	17	5
(7 – 8)	2	15	17	0
(8 – 9)	1	17	18	0
(8 – 10)	8	17	25	0
(9 – 10)	7	18	25	0

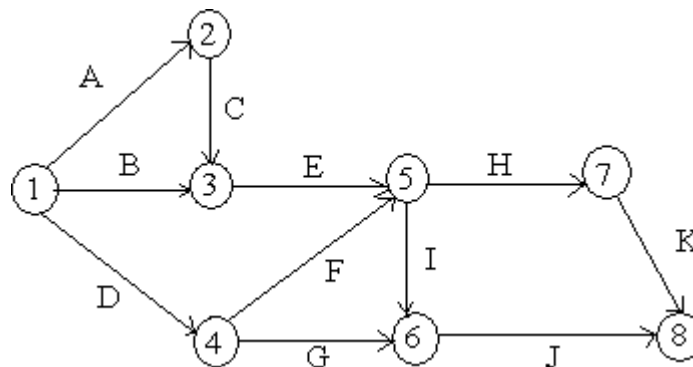
The resultant network shows the critical path



The two critical paths are

- i. $1 \rightarrow 3 \rightarrow 5 \rightarrow 7 \rightarrow 8 \rightarrow 9 \rightarrow 10$
- ii. $1 \rightarrow 3 \rightarrow 5 \rightarrow 7 \rightarrow 8 \rightarrow 10$

48. For the project



Task:	A	B	C	D	E	F	G	H	I	J	K
Least time:	4	5	8	2	4	6	8	5	3	5	6
Greatest time:	8	10	12	7	10	15	16	9	7	11	13
Most likely time:	5	7	11	3	7	9	12	6	5	8	9

Find the earliest and latest expected time to each event and also critical path in the network.

Solution

Task	Least time (t_0)	Greatest time (t_p)	Most likely time (t_m)	Expected time $(t_0 + t_p + 4t_m)/6$
A	4	8	5	5.33
B	5	10	7	7.17
C	8	12	11	10.67
D	2	7	3	3.5
E	4	10	7	7

F	6	15	9	9.5
G	8	16	12	12
H	5	9	6	6.33
I	3	7	5	5
J	5	11	8	8
K	6	13	9	9.17

Task	Expected time (t_e)	Start		Finish		Total float
		Earliest	Latest	Earliest	Latest	
A	5.33	0	0	5.33	5.33	0
B	7.17	0	8.83	7.17	16	8.83
C	10.67	5.33	5.33	16	16	0
D	3.5	0	10	3.5	13.5	10
E	7	16	16	23	23	0
F	9.5	3.5	13.5	13	23	10
G	12	3.5	18.5	15.5	30.5	15
H	6.33	23	23	29.33	29.33	0
I	5	23	25.5	28	30.5	2.5
J	8	28	30.5	36	38.5	2.5
K	9.17	29.33	29.33	31.5	38.5	0

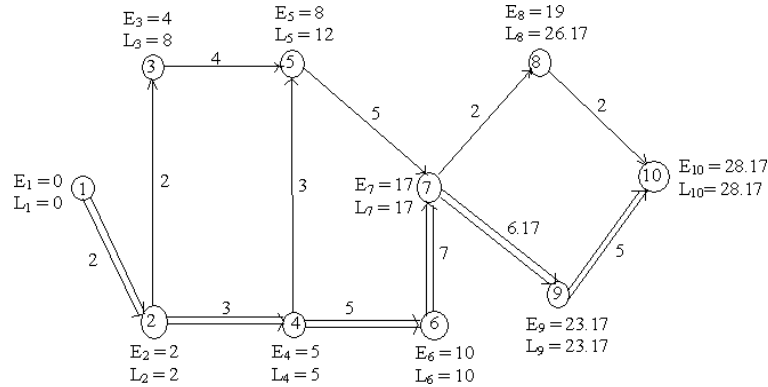
The network is

The critical path is $A \rightarrow C \rightarrow E \rightarrow H \rightarrow K$

49. A project has the following characteristics

Activity	Most optimistic time (a)	Most pessimistic time (b)	Most likely time (m)
(1 – 2)	1	5	1.5
(2 – 3)	1	3	2
(2 – 4)	1	5	3
(3 – 5)	3	5	4
(4 – 5)	2	4	3
(4 – 6)	3	7	5
(5 – 7)	4	6	5
(6 – 7)	6	8	7
(7 – 8)	2	6	4
(7 – 9)	5	8	6

(8 - 10)	1	3	2
(9 - 10)	3	7	5



Construct a PERT network. Find the critical path and variance for each event.

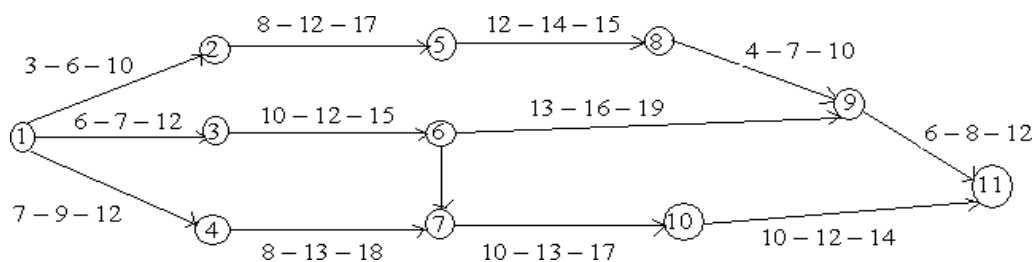
Solution:

Activity	(a)	(b)	(m)	(4m)	t_e (a + b + 4m)/6	V [(b - a) / 6] ²
(1 - 2)	1	5	1.5	6	2	4/9
(2 - 3)	1	3	2	8	2	1/9
(2 - 4)	1	5	3	12	3	4/9
(3 - 5)	3	5	4	16	4	1/9
(4 - 5)	2	4	3	12	3	1/9
(4 - 6)	3	7	5	20	5	4/9
(5 - 7)	4	6	5	20	5	1/9
(6 - 7)	6	8	7	28	7	1/9
(7 - 8)	2	6	4	16	4	4/9
(7 - 9)	5	8	6	24	6.17	1/4
(8 - 10)	1	3	2	8	2	1/9
(9 - 10)	3	7	5	20	5	4/9

The network is constructed as shown below

The critical path = 1 → 2 → 4 → 6 → 7 → 9 → 10

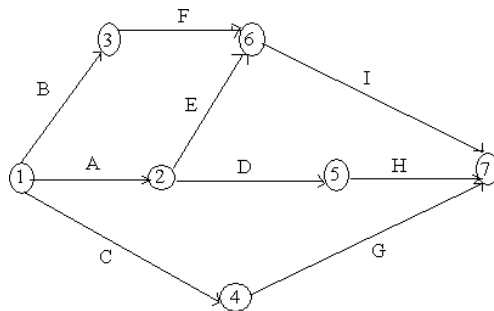
50. Calculate the variance and the expected time for each activity



Solution:

Activity	(t_o)	(t_m)	(t_p)	$t_e = (t_o + t_p + 4t_m)/6$	$V = [(t_p - t_o) / 6]^2$
(1 - 2)	3	6	10	6.2	1.36
(1 - 3)	6	7	12	7.7	1.00
(1 - 4)	7	9	12	9.2	0.69
(2 - 3)	0	0	0	0.0	0.00
(2 - 5)	8	12	17	12.2	2.25
(3 - 6)	10	12	15	12.2	0.69
(4 - 7)	8	13	19	13.2	3.36
(5 - 8)	12	14	15	13.9	0.25
(6 - 7)	8	9	10	9.0	0.11
(6 - 9)	13	16	19	16.0	1.00
(8 - 9)	4	7	10	7.0	1.00
(7 - 10)	10	13	17	13.2	1.36
(9 - 11)	6	8	12	8.4	1.00
(10 - 11)	10	12	14	12.0	0.66

51. A project is represented by the network as shown below and has the following data



Task:	A	B	C	D	E	F	G	H	I
Least time:	5	18	26	16	15	6	7	7	3
Greatest time:	10	22	40	20	25	12	12	9	5
Most likely time:	15	20	33	18	20	9	10	8	4

Determine the following

- Expected task time and their variance
- Earliest and latest time

Solution

a.

Activity	Least time (t_0)	Greatest time (t_p)	Most likely time (t_m)	Expected time $(t_0 + t_p + 4t_m)/6$	Variance (σ^2)
(1-2)	5	10	8	7.8	0.69
(1-3)	18	22	20	20.0	0.44
(1-4)	26	40	33	33.0	5.43
(2-5)	16	20	18	18.0	0.44
(2-6)	15	25	20	20.0	2.78
(3-6)	6	12	9	9.0	1.00
(4-7)	7	12	10	9.8	0.69
(5-7)	7	9	8	8.0	0.11
(6-7)	3	5	4	4.0	0.11

b.

Earliest time

$$E_1 = 0$$

$$E_2 = 0 + 7.8 = 7.8$$

$$E_3 = 0 + 20 = 20$$

$$E_4 = 0 + 33 = 33$$

$$E_5 = 7.8 + 18 = 25.8$$

$$E_6 = \max [7.8 + 20, 20 + 9] = 29$$

$$E_7 = \max [33 + 9.8, 25.8 + 8, 29 + 4] = 42.8$$

Latest time

$$L_7 = 42.8$$

$$L_6 = 42.8 - 4 = 38.8$$

$$L_5 = 42.8 - 8 = 34.3$$

$$L_4 = 42.8 - 9.8 = 33$$

$$L_3 = 38.8 - 9 = 29.8$$

$$L_2 = \min [34.3 - 18, 38.8 - 20] = 16.8$$

$$L_1 = \min [16.8 - 7.8, 29.8 - 20, 33 - 33] = 0$$

52. Which of the following has no effect on replacement decision?

- Defender's sunk cost
- Defender's salvage value
- Defender's operating cost
- Challenger's first cost

Answer: a

53. A sunk cost is the difference between

- First cost and salvage value
- Present market value and salvage value
- First cost and present market value
- Book value and present market value

Answer: c

54. When asset's annual operating and maintenance are always increasing while salvage values remain constant (over the life of asset), the economic life of the asset is

- a. Shortest possible life
- b. Longest possible life
- c. Zero
- d. Can't be said

Answer: a

55. The unused capital cost of an investment alternative at some point in time prior to the end of its expected life is known as

- a. Salvage value
- b. Implied salvage value
- c. Book value
- d. Depreciation charges

Answer: b

56. After two years of service rendered, the capacity of a bulldozer to move soil has reduced. If the bulldozer is considered for replacement, the reason will be

- a. Physical deterioration
- b. Obsolescence
- c. Lack of technological upgradation
- d. None of the above

Answer: a

57. The value of the defender in study of replacement is

- a. What it cost when originally purchased
- b. The sunk cost
- c. The salvage value at the end of its life
- d. Its worth at present time

Answer: d

Unit 4: Site Organization

58. Discuss objectives of construction management and Explain Planning, Scheduling and Controlling as a Function of Construction Management.

Answer:

Objectives of Construction Management: If one is going to practice management within an industry, it is a good idea to define the arena in which the management techniques will be applied. We really need to know just what business we are in to evaluate our present goals, find out where we have been, and where we hope to go from here.

- Prepare and negotiate cost estimates, budgets, and work timetables
- Select appropriate construction methods and strategies
- Interpret and explain contracts and technical information to workers and other professionals
- Report on work progress and budget matters to clients
- Collaborate with architects, engineers, and other construction and building specialists
- Instruct and supervise construction personnel and activities onsite
- Respond to work delays and other problems and emergencies
- Select, hire, and instruct laborers and subcontractors
- Comply with legal requirements, building and safety codes, and other regulations

Planning

Planning in the context of a project involves providing a roadmap for the proper execution of the project. The planning process involves defining the project, including the proposed outcome of the project. The planning process also involves clearly defining the goals and objectives of the project, the specifications of the quality, the budget and time estimates and control parameters. In short, the planning stage is a stage to review and reaffirm the project objectives and guidelines and resolve any undermining issues. Contingency approaches are also designed during the planning process to avoid pitfalls. Ideally, the planning process should involve all the team members.

Scheduling

Scheduling projects involves breaking down the project to clearly defined simpler tasks. This is also known as the “work breakdown structure”. This structure allows the team members to understand a complex project in terms of simple achievable tasks. Scheduling also involves assigning these tasks to the relevant personnel and establishing the time, money and other resource constraints for each task. For example, if the project is to organize a convention, then the work breakdown structure would involve tasks such as booking a hall or printing brochures. Specific people are assigned to each task with time, money and quality constraints.

Control

Execution of the project involves dealing with unexpected events. While establishing a clear plan and scheduling process minimizes ambiguities, careful control has to be exercised by the project manager in order to maintain the time, quality and budget requirements. Two elements of project control involve establishing and achieving clearly defined project milestones and maintaining clear lines of communication. Milestones help in monitoring progress, and communication helps in oversight and improving team effort.

59. Explain the concept of time value of money.

Answer:

The time value of money (TVM) is the concept that money you have now is worth more than the identical sum in the future due to its potential earning capacity. This core principle of finance holds that provided money can earn interest, any amount of money is worth more the sooner it is received. TVM is also sometimes referred to as present discounted value.

KEY TAKEAWAYS

- Time value of money is based on the idea that people would rather have money today than in the future.
- Given that money can earn compound interest, it is more valuable in the present rather than the future.
- The formula for computing time value of money considers the payment now, the future value, the interest rate, and the time frame.
- The number of compounding periods during each time frame is an important determinant in the time value of money formula as well.

60. Explain the importance of organization in construction projects. Discuss the superiority of line and staff organisation over the other systems.

Answer:

Organizations are systems created to achieve common goals through people-to-people and people-to-work relationships. They are essentially social entities that are goal-directed, deliberately structured for coordinated activity systems, and is linked to the external environment. Organizations are made up of people and their relationships with one another. Managers deliberately structure and coordinate organizational resources to achieve the organization's purpose. Each organization has its own external and internal environments that define the nature of the relationships according to its specific needs. Organizing is the function that managers undertake to design, structure, and arrange the components of an organization's internal environment to facilitate attainment of organizational goals. Organizing creates the framework needed to reach a company's objectives and goals. Organizing is the process of defining and grouping activities, and establishing authority relationships among them to attain organizational objectives.

Importance of Organizing

A comprehensive approach to organizing helps the management in many ways. Organizing aligns the various resources towards a common mission.

Efficient Administration

It brings together various departments by grouping similar and related jobs under a single specialization. This establishes coordination between different departments, which leads to unification of effort and harmony in work.

It governs the working of the various departments by defining activities and their authority relationships in the organizational structure. It creates the mechanism for management to direct and control the various activities in the enterprise.

Resource Optimization

Organizing ensures effective role-job-fit for every employee in the organization. It helps in avoiding confusion and delays, as well as duplication of work and overlapping of effort.

Benefits Specialization

It is the process of organizing groups and sub-divide the various activities and jobs based on the concept of division of labor. This helps in the completion of maximum work in minimum time ensuring the benefit of specialization.

Promotes Effective Communication

Organizing is an important means of creating coordination and communication among the various departments of the organization. Different jobs and positions are interrelated by structural relationship. It specifies the channel and mode of communication among different members.

Creates Transparency

The jobs and activities performed by the employees are clearly defined on the written document called job description which details out what exactly has to be done in every job. Organizing fixes the authority-responsibility among employees. This brings in clarity and transparency in the organization.

Expansion and Growth

When resources are optimally utilized and there exists a proper division of work among departments and employees, management can multiply its strength and undertake more activities. Organizations can easily meet the challenges and can expand their activities in a planned manner.

Advantages of Line and Staff Organisation over other:

1. Specialization:

Line and staff organisation introduces specialization in a systematic manner. Persons with specialized knowledge are appointed to help line officers. The planning part is generally undertaken by staff personnel and line officers are able to devote much time for execution.

2. Better Discipline:

The unity of command is maintained in this type of organisation. The staff personnel do not interfere with the executive work of line officers. The workers get command from line personnel and are accountable directly to them for their performance. This creates better understanding and discipline among employees.

3. Balanced and Prompt Decisions:

The functional managers have the advantage of expert advice when taking important decisions. The staff can also be used to investigate and advise on inter-departmental relationships. The line officers can take balanced and quick decisions.

4. Growth and Expansion:

The line and staff organisation is quite suitable for growth and expansion. The burden of line staff is eased by the appointment of specialists. Line officers will be able to devote much time for future planning. The present staff will enable the expansion and growth of unit. Some assistants can be appointed to cope with the work if needed.

5. Development of Employees:

This organisation provides scope for advancement of career to able and dedicated employees. There are more openings for those who have capabilities of going up. The separation of functions of 'planning' and 'doing' also helps in creating more and more job opportunities. Promotional chances increase for deserving persons.

6. Lesser Burden on Line Officers:

With the appointment of staff officers the burden of the officers is greatly reduced. The specialists help line officers in deciding things regarding their lines of specialization. The line officers are left with routine administrative work. They will be able to devote their time in supervising the implementation of various plans and policies.

61. Discuss resource scheduling and resource smoothing.

Answer:

Resource Leveling

You use resource leveling when you have limited resources and you may extend the schedule.

Resource leveling is used when:

- A critical resource may not be available for a certain duration;
- A critical resource may not be available at a certain point of time;
- You have to share a resource with another project;
- The demand for a resource exceeds the supply.

You also use this technique when you must keep some resource usage at a constant level.

In resource leveling, you are asked to optimize the limited resources given to you. Here the schedule is not fixed.

Resource leveling answers the question of when you will be able to complete the project with the given resources.

Resource leveling is sometimes called resource constrained scheduling (RCS). If resources are not available, the project duration may change.

Resource Smoothing

You use resource smoothing when you have to optimize the resources and you cannot extend the schedule.

Since you cannot extend the schedule, the project completion date and the critical path will stay the same. Here the activities cannot be delayed more than their total and free float.

Using float in this technique will cause you to lose some flexibility from your path; however, the schedule will be optimized, efficient and cost effective.

In resource smoothing, you must be careful to avoid any delay in activity as it may affect your critical path.

Time is the main constraint here. You have a fixed schedule and are asked to optimize resources.

Resource smoothing is also known as time constrained scheduling (TCS). The project end date cannot be changed, and you have to optimize resources within the float.

Difference Between Resource Leveling and Resource Smoothing

The following are a few differences between resource leveling and resource smoothing:

- In resource leveling the project end date may change while in smoothing it does not change.
- In resource leveling the critical path changes (generally increases) while in resource smoothing it does not, and activities can be delayed within their float.
- Generally resource smoothing is usually performed after the resource leveling.
- In resource leveling resources are the main constraint while in resource smoothing project end date is a constraint.
- Resource leveling is used when resources are under or over allocated. Resource smoothing is used when resources are unevenly allocated.
- Resource leveling can be applied to activities on the critical path while in resource smoothing you do not touch activities on the critical path.

Similarities Between Resource Leveling and Resource Smoothing

The following are a few similarities between these two techniques:

- They both help you optimize resource utilization
- They both help you in scheduling network analysis

Resource leveling and resource smoothing are different techniques and they are used under different situations. It is not always necessary to use both techniques; in this blog post I mentioned that resource smoothing usually happens after resource leveling.

62. Describe decision making under uncertainty.

Answer:

A decision problem, where a decision-maker is aware of various possible states of nature but has insufficient information to assign any probabilities of occurrence to them, is termed as decision-making under uncertainty. A decision under uncertainty is when there are many unknowns and no possibility of knowing what could occur in the future to alter the outcome of a decision.

We feel uncertainty about a situation when we can't predict with complete confidence what the outcomes of our actions will be. We experience uncertainty about a specific question when we can't give a single answer with complete confidence.

Launching a new product, a major change in marketing strategy or opening your first branch could be influenced by such factors as the reaction of competitors, new competitors, technological changes, changes in customer demand, economic shifts, government legislation and a host of conditions beyond your control. These are the type of decisions facing the senior executives of large corporations who must commit huge resources.

The small business manager faces, relatively, the same type of conditions which could cause decisions that result in a disaster from which he or she may not be able to recover. A situation of uncertainty arises when there can be more than one possible consequences of selecting any course of action. In terms of the payoff matrix, if the decision-maker selects A_1 , his payoff can be X_{11} , X_{12} , X_{13} , etc., depending upon which state of nature S_1 , S_2 , S_3 , etc., is going to occur.

63. Related to construction injuries, define frequency rate, severity rate and incidence rate.

Answer:

Frequency Rate- The frequency rate shall be calculated both for lost time injury and reportable lost time injury as follows:

$$F_A = \frac{\text{Number of lost time injury} \times 1\,000\,000}{\text{Man-hours worked}}$$

$$F_B = \frac{\text{Number of reportable lost time injury} \times 1\,000\,000}{\text{Man-hours worked}}$$

Severity Rate – The severity rate shall be calculated from man days lost both of lost time injury and reportable lost time injury as follows:

$$S_A = \frac{\text{Man-days lost due to lost time injury} \times 1\,000\,000}{\text{Man-hours worked}}$$

$$S_B = \frac{\text{Man-days lost due to reportable lost time injury} \times 1\,000\,000}{\text{Man-hours worked}}$$

Incidence Rates – Ratio of the number of injuries to the number of persons during the period under review. It is expressed as the number of injuries per 1 000 persons employed.

$$\text{Lost-time injury incidence rate} = \frac{\text{Number of lost-time injuries} \times 1\,000}{\text{Average number of persons employed}}$$

$$\text{Reportable lost-time injury incidence rate} = \frac{\text{Number of reportable lost-time injuries} \times 1\,000}{\text{Average number of persons employed}}$$

64. What is the importance of a job lay-out and sketch a typical job layout for RCC framed building construction?

The sequence of work to be followed in the construction of a building is the at most important procedures of construction. The major sequences of construction are marking, excavation, concreting, brick masonry, roof laying, flooring and finishing.

1. Paper Work

Construction of residential building required paper work before the start of actual construction. The paper works are preparation of drawings, estimation of material cost, labor cost & contingencies, approval of drawings from City Development Authority.

2. Marking of Layout

The approved plan boundaries are marked in the ground first and the ground inside and outside the layout is cleaned. Later the complete layout is marked on the ground with accurate dimension and orientation.



Fig : Marking of Layout

3. Excavation

Generally excavation is carried out for the construction of wall foundations. Excavation should be carried out as per the drawings defined lengths & widths. Suitable machines are used to excavate the the earth for the making of foundation.

4. Foundation Work

Foundation work consists of many sub works which are as follows,

1. Compacting the ground

The excavation pits are trimmed and dressed as per the requirement and the bottom is compacted using hand compactors.

2. PCC

To form a solid base on which the reinforcement can be tied and footing can be placed. Plain cement concrete of the mix 1:4:8 or 1:3:6 is laid on the compacted soil in varying depth as required.

3. Footing Reinforcement

Reinforcement steel bars are tied together and placed on the PCC to form a skeleton in which the concrete is poured and the column rods are taken from them.

4. Shuttering

To achieve proper shaped concrete, shuttering is done as per the dimensions mentioned in the drawing. It is also done so that the concrete doesn't come in contact with the soil.

5. Footing Concrete

It is very necessary to check the levels of foundation before concrete work. There are patches where excavated depth slightly exceeds and vice versa. Concrete is poured as per drawing specs.

Depth of foundation varies from 9" to 18" and normally for most of the cases it is considered as 12" depth. The foundation width is kept equal to its depth.

5. Column Casting

Casting of columns is made by fixing the shuttering framework and concrete is poured in the formwork. The shuttering is usually removed after 24hr of casting and curing is done.

6. Construction of Walls

Walls are constructed using many materials such as brick, wooden, precast concrete and many other. Before starting the wall construction the base of wall is constructed first using concrete or size stone masonry. The height of the walls depends upon the floor height. Necessary openings are given for doors, windows and ventilators.

7. Lintel

Masonry work of buildings is carried out in one go till roof. Openings for windows & doors are left during masonry works. Reinforced cement concrete beams are laid down on the top of openings. So, those loads of structure above openings not directly come on to the door frames.

8. Roofing

Roof slab of building is poured after completion of masonry works. Now a days, roofing is of reinforced cement concrete slab. Slab thickness & reinforcement details should be according to approved drawings.

9. Plastering Work

Form work is removed after 14 days of slab pouring. Now plaster work begins. Mortar for plaster work is generally of 1:3 or 1:4 is used. Thickness of plaster layer should not be more than 0.75inch. Cure the surface about 7 days. So that, plaster gain proper strength.

Generally, internal walls of buildings are covered with plastered layer and external walls with pointing. It is better plaster the external walls rather than pointing.

10. Fixing of Doors and Windows

Traditionally, doors and windows of woods are used. But, steel & aluminum is also not a bad choice. In case of wooden doors & windows, frames are fixed in walls during masonry work. Panels are then fixed with hinges after plaster work. Steel and aluminum doors are fixed after completion of paint works.

11. Fixing of Electrical and Plumbing Works

The necessary electrical and plumbing works are carried out before the final finishing works such as painting and tiles laying is done so as to reduce the damage.

12. Tiles Laying

Majorly tiles are laid in the bathrooms and kitchen area. First the wall tiles are fixed after which the floor tiles are fixed. For flooring works, granite, marble, tiles , epoxy are also used.

13. Painting

Painting consists of different sequences depending upon the type of finished required. 1 coat of primer and 2 coat of water based paint is also done or 2 coat of putty and 2 coats of painting is done for the smooth finish. It defers for outside and inside works.

14. Miscellaneous Works

Other than all these above mentioned works, there are other works that are carried as per the requirement of the consumer and design engineer.

- Terrace water proofing
- landscaping works
- False Ceiling
- Installation of Furniture

65. What criteria would you suggest for evaluating the effectiveness of a management team?

Answer:

To assist in this process, the Harvard Business Review has published five components of emotional intelligence that can be extremely helpful when estimating how good potential management candidates might be. Similarly, these criteria can help you to effectively judge your management's potential at any step along the way.

The five criteria are:

- 1) Self-Awareness – Your managers' ability to recognize their own moods
- 2) Self-Regulation – Their ability to separate personal mood from job performance
- 3) Motivation – The level of passion for the job that goes beyond salary
- 4) Empathy – Their ability to actually "connect" with employees, clients and customers
- 5) Social Skills – Their ability to "gel" with employees and other managers, as well as the ability to clearly communicate ideas and concepts

66. Discuss the methods of project monitoring.

Answer:

Project monitoring methods are the different methods and means by which the ongoing success of a project is measured. Regular project monitoring is essential, because it allows the project team and the Project Manager to evaluate whether:

- the project is proceeding as planned (within cost budgets and according to the schedule)

- the team is working effectively, with resources being efficiently used
- the project is staying within the expected project boundaries.

Regular monitoring allows managers to identify anything not 'going to plan' early. They can then take remedial action quickly, before the problem (and any consequent time, cost or scope blow-outs) develops further. Lack of monitoring has the converse effect: problems can build and accelerate so that they become very difficult to control or to reverse without adverse consequences for the project.

Project stakeholders may also use various project monitoring methods to stay informed about current project progress. This external project monitoring, however, is normally agreed in advance.

Qualitative and quantitative methods

In general, monitoring is either quantitative or qualitative:

- Quantitative methods use numerical data to evaluate the project. These methods may include financial auditing, auditing of resources and analysis of person-hours spent on the project.
- Qualitative methods monitor non-numerical aspects of the project. Methods may include holding certain meetings, providing certain reports, interviewing team members and analysing project documentation.

The type(s) of project monitoring methods chosen may depend on what phase the project is currently in, or what particular information is sought.

Project monitoring methods are usually decided upon during the project planning phase, so that team members know when the monitoring will take place and what format it will take.

67. Outline and explain the factors to be considered for site layout development.

Answer:

A proper site selection is one of the most important steps before beginning construction works. The contractor or civil engineer should consider key factors affecting when selecting a site. Site selection of a building should be done based upon some surveys of various aspects of the site such as the development of the site, cost, the stability of the proposed structure, and type of construction project, for example industrial, commercial or residential building.

Three main categories of factors provide influence to the site selection and layout process.

1. Natural Factors
2. Man-made Factors or Cultural Factors
3. Aesthetic Factors

Following general factors must be taken account while selecting a site for any type of building construction.

1. Purpose of Building
2. Government Laws

3. Shape & Size
4. Terrain Condition
5. Type of Ground Soil
6. Natural Light & Air
7. Environmental Condition
8. Legal & Financial Aspects

Unit 5: Maintenance Management

68. Discuss the importance of safety in construction project management.

Answer:

Health and safety is one of the most important considerations you should take before any construction project gets underway. You should always make sure that all aspects of health and safety have been considered before you step foot on the construction site. Health and safety in construction are particularly important because the industry is prone to hazardous situations and can be dangerous at times. Statistics show that 3% of all construction workers in the UK sustain a work related injury and around 4% are suffering from work related illness. This can lead to a huge loss in working hours and also mean that workers are unhappy within their job roles. There are some major reasons why health and safety is important in the workplace.

Injuries in Construction

Over the last year, there were 43 workers fatally injured in the construction sector, which is still an alarmingly large number. A large portion of accidents on the construction site were caused by slips, trips and falls, as reported by employers in 2015/16. But many people were also injured during lifting and handling or falling from a height on the construction site. This emphasises the magnitude of safety in construction and there are 2 ways that you can help to prevent these accidents from happening.

- Training – many accidents occur on the construction site because workers have not had the proper training before starting on a project. Effective training will make sure your employees are aware of the risks on the construction site.
- Tools – the right safety tools can also make a huge difference in the workplace and help to avoid any unnecessary accidents. Safety products such as fall arrest harnesses and safety clothing can help to reduce the risk in the workplace.

Businesses are Responsible

If you don't have the correct health and safety procedures in place then you will most likely be breaking the law. This means that your business could be fined, sued or even banned from operating depending on the level of risk. If the HSE find that the construction site has not met health and safety regulations, they have the power to take action against your business. If an employee feels they have not received the proper health and safety training, they can inform the HSE who will investigate the issues. You may also face the problem of compensation if a worker is seriously injured on the construction site, and the project might even need to be halted for investigation.

Your Business Can Benefit

Not only is health and safety important to avoid injury, there are also plenty of other long term benefits that your business stands to gain. By implementing the right health and safety procedures, your employees are much more likely to be happier in their roles. If your

workers have the right knowledge and tools, it can boost morale on the construction site and lead to better productivity. With less illness and injury you can also gain more productive working hours, which can lead to better profitability. In the long term you can also build a good reputation for your business and it will help to retain staff.

If you are looking for health and safety equipment then take a look at our range of products online. We provide a comprehensive range of health and safety products to make sure that you have the correct equipment and our team can advise you on the most suitable products and specifications for your business. We offer same day emergency delivery in London and next day delivery on our products nationwide.

69. Discuss different elements of Risk cost management.

Answer:

The key elements of a risk management program include:

- a. Process
- b. Integration
- c. Culture
- d. Infrastructure.

These elements of a risk management program are flexible. They have to be, because strategies, organizational structures, operating philosophies and risk profiles vary in complexity across industries and firms.

Step One: Identify Risk

An enterprise risk assessment process identifies and prioritizes a company's risks, providing quality inputs to decision makers to help them formulate effective risk responses, including information about the current state of capabilities around managing the priority risks.

Risk assessment spans the entire organization, including critical business units and functional areas. Effectively applied using business strategy as a context, risk assessment considers attributes such as:

1. Impact
2. Likelihood
3. Velocity
4. Persistence

Step Two: Source Risk

Once priority risks are identified, they are traced to their root causes. If management understands the drivers of risk, it is easier to design risk metrics and proactive risk responses at the source. Will this step present challenges? Almost certainly. Overcoming them is key to success.

Step Three: Measure Risk

There is an old adage that says, "If you can't measure something, you can't manage it." Because not all risks are quantifiable, increasing transparency by developing quantitative and qualitative risk measures is common practice.

Measurement methodologies may be simple and basic. Here are some examples of how to measure risk:

1. Risk rating or scoring
2. Claims exposure and cost analysis
3. Sensitivity analysis

4. Stress testing
5. Tracking key variables relating to an identified exposure

More complex methodologies for companies with more advanced capabilities could differ — and might be more complicated. But remember: ignoring risk won't make it go away. Other risk management methodologies might include analyzing these complex factors:

1. Earnings at risk
2. Rigorous analytics that are proprietary to the company
3. Risk-adjusted performance measurement
4. Examining value at risk

Step 4: Evaluate Risk

Based on the priority risks identified, their drivers or root causes and their susceptibility to measurement, the next step requires that management choose the appropriate risk response.

There are four categories of risk responses:

1. Avoid
2. Accept
3. Reduce
4. Share

These responses can be applied to groups of related risks consisting of natural families of risks that share fundamental characteristics (like common drivers, positive or negative correlations, etc.) consistent with a portfolio view.

The organization first decides whether to accept or reject a risk based on an assessment of whether the risk is desirable or undesirable. A desirable risk is one that is inherent in the entity's business model or normal future operations and that the company believes it can monitor and manage effectively. An undesirable risk is one that is off-strategy, offers unattractive rewards or cannot be monitored or managed effectively.

If an entity chooses to accept a risk, it can accept it at its present level, reduce its severity and/or its likelihood of occurrence (typically through internal controls), or share it with a financially capable, independent party (typically through insurance or a hedging arrangement).

Step 5: Mitigate Risk

Depending on the risk response selected, management identifies any gaps in risk management capabilities and improves those capabilities as necessary to implement the risk response. Over time, the effectiveness of risk mitigation activities should be monitored.

Step 6: Monitor Risk

Models, risk analytics and web-enabled technologies make it possible to aggregate information about risks using common data elements to support the creation of a risk management dashboard or scorecard for use by risk owners, unit managers and executive management.

Dashboard and scorecard reporting should be flexible enough to enable the design of reports to address specific needs, including reporting to the board of directors. Examples of

dashboard reporting, which often features “heat maps” or “traffic light” indicators, are provided in the Application Techniques of the COSO Enterprise Risk Management Integrated Framework. Monitoring also includes activities of an internal audit function.

The purpose of the risk management process varies from company to company, e.g., reduce risk or performance variability to an acceptable level, prevent unwanted surprises, facilitate taking more risk in the pursuit of value creation opportunities, etc. Regardless of purpose, the good news is that a large body of knowledge on the risk management process is readily available so that companies can adopt a process view that best fits their circumstances.

70. Discuss the important aspects of project planning.

The important aspect is to deal with it. The project manager needs to strike a balance between the three constraints so that quality of the project will not be compromised.

To overcome the constraints, the project managers have several methods to keep the project going. Some of these will be based on preventing stakeholders from changing the scope and maintaining limits on both financial and human resources.

A project manager's role is evolved around responsibility. A project manager needs to supervise and control the project from the beginning to the closure.

The following factors will outline a project manager's role:

- The project manager needs to define the project and split the tasks amongst team members. The project manager also needs to obtain key resources and build teamwork.
- The project manager needs to set the objectives required for the project and work towards meeting these objectives.
- The most important activity of a project manager is to keep stakeholders informed on the progress of the project.
- The project manager needs to assess and carefully monitor risks of the project.

Skills Required for a Project Manager

In order to overcome the challenges related to project triangle and meet the project objectives, the project manager needs to have a range of skills, which includes:

- Leadership
- Managing people
- Negotiation
- Time management
- Effective communication
- Planning
- Controlling
- Conflict resolution
- Problem solving

Therefore, software project management is essential to incorporate user requirements along with budget and time constraints.

71. Explain the role of decision in Project Management.

Answer:

A project manager is a person who has the overall responsibility for the successful initiation, planning, design, execution, monitoring, controlling and closure of a project. Construction, petrochemical, architecture, information technology and many different industries that produce products and services use this job title.

The project manager must have a combination of skills including an ability to ask penetrating questions, detect unstated assumptions and resolve conflicts, as well as more general management skills.

Key among a project manager's duties is the recognition that risk directly impacts the likelihood of success and that this risk must be both formally and informally measured throughout the lifetime of a project.

Risks arise from uncertainty, and the successful project manager is the one who focuses on this as their primary concern. Most of the issues that impact a project result in one way or another from risk. A good project manager can lessen risk significantly, often by adhering to a policy of open communication, ensuring every significant participant has an opportunity to express opinions and concerns.

A project manager is a person who is responsible for making decisions, both large and small. The project manager should make sure they control risk and minimise uncertainty. Every decision the project manager makes must directly benefit their project.

Project managers use project management software, such as Microsoft Project, to organise their tasks and workforce. These software packages allow project managers to produce reports and charts in a few minutes, compared with the several hours it can take if they do it by hand.

Roles and Responsibilities

The role of the project manager encompasses many activities including:

- Planning and Defining Scope
- Activity Planning and Sequencing
- Resource Planning
- Developing Schedules
- Time Estimating
- Cost Estimating
- Developing a Budget
- Documentation
- Creating Charts and Schedules
- Risk Analysis
- Managing Risks and Issues

- Monitoring and Reporting Progress
- Team Leadership
- Strategic Influencing
- Business Partnering
- Working with Vendors
- Scalability, Interoperability and Portability Analysis
- Controlling Quality
- Benefits Realisation

Finally, senior management must give a project manager support and authority if he or she is going to be successful.

72. What is a Gantt Bar chart? Explain, with the help of a suitable example, the method of preparing a bar chart.

Answer:

A Gantt chart is a graphical depiction of a project schedule. It's is a type of bar chart that shows the start and finish dates of several elements of a project that include resources, milestones, tasks, and dependencies. Henry Gantt, an American mechanical engineer, designed the Gantt chart.

The Gantt chart is the most widely used chart in project management. These charts are useful in planning a project and defining the sequence of tasks that require completion. In most instances, the chart is displayed as a horizontal bar chart.

Horizontal bars of different lengths represent the project timeline, which can include task sequences, duration, and the start and end dates for each task. The horizontal bar also shows how much of a task requires completion.

A Gantt chart is constructed with a horizontal axis representing the total time span of the project, broken down into increments (for example, days, weeks, or months) and a vertical axis representing the tasks that make up the project (for example, if the project is outfitting your computer with new software, the major tasks involved might be: conduct research, choose software, install software). Horizontal bars of varying lengths represent the sequences, timing, and time span for each task. Using the same example, you would put "conduct research" at the top of the vertical axis and draw a bar on the graph that represents the amount of time you expect to spend on the research, and then enter the other tasks below the first one and representative bars at the points in time when you expect to undertake them. The bar spans may overlap, as, for example, you may conduct research and choose software during the same time span. As the project progresses, secondary bars, arrowheads, or darkened bars may be added to indicate completed tasks, or the portions of tasks that have been completed. A vertical line is used to represent the report date.

Gantt charts give a clear illustration of project status, but one problem with them is that they don't indicate task dependencies - you cannot tell how one task falling behind schedule affects other tasks. The PERT chart, another popular project management charting method, is designed to do this. Automated Gantt charts store more information about tasks, such as the individuals assigned to specific tasks, and notes about the procedures. They also offer the benefit of being easy to change, which is helpful. Charts may be adjusted frequently to

reflect the actual status of project tasks as, almost inevitably, they diverge from the original plan.

Example of a Gantt Chart

If the project is about installing new software on a server, the project tasks that require completion are conducting research, selecting a software product, testing the software and installing it. A milestone is selecting the software. These tasks appear as vertical lines on the chart. The project duration is 40 days.

Each task takes 10 days to complete, and each task is dependent on the previous task. A critical activity is testing the software in the development and test environments. The task start and end dates, duration, and milestones appear as horizontal bars. The percentage of work completed for each task also is displayed on the horizontal bars.

73. Describe common defects in buildings and their remedial measures.

Webster word reference characterizes building absconds as an inadequacy; an insufficiency intends to be needing, ailing in some quality important for fulfillment. (California jury, 2001) likewise characterizes building deserts as a disappointment of building or any segment to be raised in a sensibly workmanlike way or to play out the way planned by the producer or sensibly expected by the purchaser which roughly makes harm the structure. (Akinsola, 2010 pp. 58) characterizes a building imperfection as any blame in the parts or entire of a building which sterns the execution of the building part in which its happens. A building or development imperfection is a deformity or lack in the outline, development, or materials on a development extend. Extensively, incorporating deserts fall with two (2) classifications: surrenders that influence the execution of the structure, and deformities that influence the presence of the structure. From the lawful point of view, a building imperfection is characterized in fairly extraordinary terms. Lawfully, a building imperfection is an infringement of the relevant construction law, an infringement of the standard of care in the group in which the venture is found, or an infringement of the producer's proposals (Mann, 2007) Defect is the dissention of a part with a standard or determined trademark. Imperfection is utilized some of the time as an equivalent word for "disappointment", yet the favored significance is to demonstrate just a deviation from a few (saw) standard that may, however won't really, result in disappointment (David, 1997)

Causes of Building defects

Building surrenders emerges through improper or poor plan, detail and development and in addition lacking consideration given to building support. It can certainly be said that no building is free from deformities, not even another one, close supervision on quality procedures will diminishes the quantity of imperfections and great review will uncover any undeniable deformity. A deformity alludes to the unmistakable proof of an undesirable condition in progress influencing serviceability, basic condition or appearance. Damaged building development not just adds to the last cost of the item additionally to the cost of support which can be generous. Deficient development incorporates exercises, for example, compaction not done to detail prompting ground subsidence and in the end early crumbling of each segment of the building, this may prompt finish disappointment of a structure with high cost of support on the long run. Deserts bringing about off base development can be maintained a strategic distance from by guaranteeing that appropriate examination instruments are set up. (Adeyeye, 2009) expressed in this respects most nearby working in Nigeria experiences avoidable deformities. As per the National Building Agency (1985), deserts happen either in light of poor plan, or low quality workmanship, or on the grounds that the building was not built by the outline, or on the grounds that it has been liable to elements not took into consideration in the plan. These essential drivers may work separately or in blend and result in imperfections demonstrated by changes in organization

of materials; in the development itself; in the size, shape or weight of materials; or basically in appearances

Category of Building Defects

The defect can be divided into two categories, which are:
a) Structural defect

Basic imperfection implies any deformity in an auxiliary component of a building that is owing to blemished plan, inadequate or flawed workmanship or deficient material and once in a while any blend of these. Building structure incorporates earth holding dividers, sections, bars and level sections. (Northern Territory Consolidated Regulation) According to the Engineering Encyclopedia, basic imperfection can be classified as splits in establishments (Substructure), breaks in floor or pieces (superstructure), and breaks in dividers (superstructure). These imperfections can be caused by shameful soil investigation, improper site determination, and the utilization of deficient materials. The greater part of the auxiliary issue can be stayed away from by inferring the correct and detail of the outline and arranging. Auxiliary deformities in a building can happen after some time because of crumbling, wear and tear, over-burdening, and poor support. They should be repaired to keep up the building's structure and to keep any further disappointments. Consistent investigation is the way to securing the "wellbeing" of a building's structure. Basic deformity that dependably happens are steel consumption, splits, and redirection.

b) Non-structural defect

As per Northern Territory Consolidated Regulation, a non-basic deformity in a private building is depicted as an imperfection in a non-basic component of the working subsequently of blemished private building work. As per the Engineering Encyclopedia, non-auxiliary deformity incorporates imperfection in block work, moistness in old structures, and imperfections in mortar works.

74. What is crashing?

- a. Using more time to complete activities not on the critical path
- b. Using more resources to complete activities on the critical path
- c. Using fewer activities to shorten the overall project duration
- d. Using fewer resources to complete activities on the critical path

Answer: B

75. The technique for establishing and maintaining priorities among the various jobs of a project, is known

- a. Event flow scheduling technique
- b. Critical ratio scheduling
- c. Slotting technique for scheduling
- d. Short interval scheduling.

Answer: B

76. Frederick W. Taylor introduced a system of working known as

- a. line organization
- b. line and staff organization
- c. functional organization

- d. effective organization

Answer: C

77. A Milestone chart

- a. shows the interdependencies of various jobs
- b. depicts the delay of jobs, if any
- c. points outgoing ahead of schedule of jobs, if any
- d. none of these

Answer: D

78. Bar charts are suitable for

- a. minor works
- b. major works
- c. large projects
- d. all the Above

Answer: C

79. Arrange the phases of project management in correct order

- 1. Controlling, 2. Scheduling, 3. Planning**
- a. 1-2-3
 - b. 2-1-3
 - c. 3-1-2
 - d. 3-2-1

Answer: D

80. One of the main disadvantages of the Bar charts in project analysis is that

- a. Progress of the work cannot be monitored
- b. They do not show the interdependencies of the activities
- c. The time schedule is not shown properly
- d. The financial aspect is not show

Answer: D

81. For a given activity, the optimistic time, pessimistic time and the most probable estimates are 5, 17 and 8 days respectively. The expected time is

- a. 8 days
- b. 9 days
- c. 10 days
- d. 15 days

Answer: B

82. The probability distribution taken to represent the completion time in PERT analysis is

- a. Gamma distribution
- b. Normal distribution
- c. Beta distribution
- d. Log normal distribution

Answer: B

83. The area under the Beta-distribution curve is divided into two equal halves by vertical ordinate through

- a. Expected time
- b. Most likely time
- c. Optimistic time
- d. Pessimistic time

Answer: A

84. State the important points to be observed during inspection of the RCC, Masonry, sanitary and water supply services, electrical services.

Answer:

Every operation is connected with the quality of the product. In the case of construction the quality of construction is to be maintained as per project specifications. It is important that quality requirements be satisfied and production schedules are met. The satisfaction of the owner of the project is mainly derived by the quality of the work.

Stiff competition in the national and international level of construction sector demands a high quality oriented attitude of engineers. However, the management is required to achieve the satisfaction of the owner by completing the project within the cost constraints for the project. Both of these things are dependent on properly integrating quality development, quality maintenance and quality improvement in construction. The integration of all these three aspects can be achieved through a sound quality control system.

Inspection means the checking of material or product at various stages of manufacture or construction of an object. It is done with respect to some pre-defined parameters and it tries to detect the faulty nature of the object. When we inspect something, we try to see the past history of construction and try to learn from our past experiences. Faulty objects are sorted out and are rejected. For example, those structural members, whose construction has been faulty, may be dismantled and reconstructed. There may be different aspects which may be followed. For example, the quality of a beam specimen may be faulty because the concrete in that beam may not be of the chosen grade. It may be considered faulty if the detailing of reinforcement (i.e. how the reinforcement is to be placed in the beam) also is faulty. Such beam members would be discarded, dismantled and reconstructed.

Inspection should not be confused with quality control. Inspection is a way or method of maintaining the quality of the object being constructed or produced. Controlling the quality is what is termed as quality control. Quality control is a wide term which involves inspections at various stages of construction. Basically, when we consider the quality control of some object, we always have some future object in mind and we try to find out the ways as to how to control the quality of that object, to be produced in future. This is why, the quality control people are provided with instructions prior to the production or construction of some object or some building.

Inspections give us needed inputs to control quality. If the quality of an object is found to be not as per expectations, we have to take remedial steps. Inspections check the quality of past constructions and quality control norms or specifications are provided for the future constructions. Inspection is an act of checking the objects or items, sorting out and finding out the faulty item. Quality control is a broad term which includes inspection as an activity out of a number of activities carried out for the purpose.

Inspections are carried out using precise equipment and instruments. These devices or tools are used to measure those characteristics which define the quality of an object. Using such devices, we can ascertain the quality of past constructions and judge if those objects, which were constructed, were as per accepted norms and specifications. Inspection is mainly carried out by people who are responsible for it. They must know the norms and specifications, characteristics to be measured and should know how to use different devices

and tools to examine the quality of a construction.

For inspecting the quality of construction, non-destructive test procedures have been established. In such procedures, which are termed as NDT procedures, we can test the quality of construction without deforming a structural element.

To understand the aspect of quality control in construction, it has to appreciate that construction industry is somewhat different from other manufacturing industries. The objects created or constructed in this sector are most of the times unique in the sense that the structures are never the same or the exact replica of one another. Two buildings, two bridges, two roads may be chosen at random and in each case we would find that there are differences or variations.

There are certain considerations which should be kept in mind when we consider quality control in civil engineering construction.

Quality of construction is dependent, to a great extent, on

- The quality of materials which are used in construction
- The expertise of workers
- The technology adopted in construction
- Number, type and quality of inspections
- Quality consciousness of people
- Funds available for construction and quality control
- Time available for quality control procedures
- Existence of norms and guidelines for assessing quality of construction of a particular type
- Experience and expertise of inspectors
- Quality of design
- Nature of the construction project

Unit 6: Introduction to Project Management Software

85. Explain various elements of Project management.

Projects come in all shapes and sizes from small, simple ones to larger and more complex projects. Whatever the size or type of project, there are 5 essential elements that you must get right in order to achieve a successful outcome. Whether your project is about improving an existing product or service, managing change or implementing a new system, the same basic considerations are required when managing projects.

In order to ensure that all your projects reach the required level of success, here are the 5 essential elements that need to be included:

Strategic Planning

The first stage of any project is to understand the need for the project and what it is trying to achieve. SMART (Specific, Measurable, Attainable, Relevant, Timely,) objectives need to be established along with measures of success and key milestones where progress can be reviewed. Working as an internal project manager will require close liaison with key internal stakeholders and departments to establish their specific requirements and set commonly agreed objectives.

Product Development

The variety of activities that are deemed to be projects are wide-ranging and varied, and can

include new products, processes and services. The development of any of these needs to be closely linked to meeting defined business objectives and adding value to the organisation. The benefits of a project should be well articulated at the beginning so there is a clear link to the success of the project and the impact on overall business aims.

Communication

It is vital to sell the benefits of any project to those who will be affected during the project or by the project's final outcome. Implementing a new process requires that end users understand why the project is beneficial and potential buyers need to be convinced by the advantages of new products and services. In essence, communicating the message of why new or different is good will help counteract the typical human reluctance to change.

Resources

It is vital to ensure that adequate resources in terms of people, time, finances and equipment are in place. Internally, this could involve the IT department providing the appropriate hardware/software, Human Resources recruiting the necessary people or the Facilities department providing offices or other relevant support. There also needs to be allocated budgets and finance as well as appropriate timelines for project completion.

People

No project manager works in isolation. There are many stakeholders involved in a project who all have a specific role to play and who all have a vested interest in the project's success. The key stakeholders who drive projects and help make them a success include:

- **Sponsor:** The project sponsor is the person who defines the business objectives that drive the project. The sponsor can be a member of the senior management team or someone from outside of the organisation.
- **Project Manager:** A professional project manager creates the project plan and ensures that it meets the budget, schedule and scope determined by the sponsors. The project manager is also responsible for risk assessment and management.
- **Project Team Members:** These can include subject area experts, members of departments, external professionals and new recruits. Anyone who can offer a positive contribution to the project in terms of their knowledge and capabilities makes a good team member.

Including these elements in a project will ensure that the final outcome is a successful one.

86. Define Project Management Information System (PMIS).

Answer:

Project Management Information System (PMIS) are system tools and techniques used in project management to deliver information. Project managers use the techniques and tools to collect, combine and distribute information through electronic and manual means. Project Management Information System (PMIS) is used by upper and lower management to communicate with each other.

Project Management Information System (PMIS) help plan, execute and close project management goals. During the planning process, project managers use PMIS for budget framework such as estimating costs. The Project Management Information System is also used to create a specific schedule and define the scope baseline. At the execution of the project management goals, the project management team collects information into one database. The PMIS is used to compare the baseline with the actual accomplishment of each activity, manage materials, collect financial data, and keep a record for reporting purposes. During the close of the project, the Project Management Information System is

used to review the goals to check if the tasks were accomplished. Then, it is used to create a final report of the project close.

To conclude, the project management information system (PMIS) is used to plan schedules, budget and execute work to be accomplished in project management.

87. Name some of the popular project management software. Discuss their utility.

Answer:

Popular project management software

Scoro

It is a comprehensive solution that combines all the features you might need in project management software: projects & tasks, contact management, quotes, team collaboration, billing, and reporting.

Top features:

- Projects with sub-tasks and deadlines
- Real-time KPI dashboard
- Shared team calendar & meeting scheduling
- Contact management
- Time tracking and billing for work
- Detailed reports on project progress and finances
- Quoting and invoicing with pre-set templates

Proofhub

It offers a replacement for conventional emailing and a bunch of other tools, integrating multiple project management features under one roof.

Top features:

- Assigned user roles
- Online team discussions and chats
- Task delegating and assignments
- Reporting and tracking project history
- Secure file storage

Basecamp

It is the preferred tool for thousands of project management teams, who enjoy its modern social media-like interface and carefree team collaboration features.

Top features:

- Projects to manage multiple users' work
- Message boards for discussing new projects or ideas
- In-app collaboration with team
- Reporting on project performance
- Separate dashboard for showing to clients
- Email and desktop notifications

Asana

It combines elements of project management, file storage, and collaboration and helps to manage projects across a team without email.

Top features:

- Break your work down into tasks, and assign it to team members
- Organize your tasks into projects for roadmaps and timelines
- Review milestones, and check on your team's progress
- Get notified about projects updates
- Use project dashboards to get a quick overview

Podio

It is a flexible and highly customizable online hub for work and team communication.

Top features:

- Assign tasks, attach files and discuss details within the solution
- Share encrypted & large files
- Automate the sales pipelines, project budget tracking, and more
- Get an overview of the company with visual dashboards
- Automate your workflows

88. Effective software project management focuses on the four P's. What are those four P's?

- A) People, performance, payment, product
- B) People, product, process, project
- C) People, product, performance, project
- D) All of the above.

Answer: B

89. You are working in a company as a project manager. Company wants to develop a project. You are also involved in planning team. What will be your first step in project planning

- A) Establish the objectives and scope of the product.
- B) Determine the project constraints.
- C) Select the team.
- D) None of the above.

Answer: A

90. Which of these software characteristics are used to determine the scope of a software project?

- A) Only performance.
- B) Only context.
- C) Information objectives, function, performance
- D) None of the above.

Answer: C

91. Boehm suggests an approach that addresses project objectives, milestones and schedules, responsibilities, management and technical approaches, and required resources. This principle is called as:

- A) W3HH principle
- B) WHO principle
- C) W5HH principle
- D) None of the above.

Answer: C

92. Which of the following is/are considered stakeholder in the software process?

- A) Customers
- B) End-users
- C) Project managers
- D) All of the above.

Answer: D

93. You are working in a company as a project manager. What you will do to minimize the risk of software failure?

- A) Request a large budget
- B) You will increase the team size
- C) Track progress
- D) None of the above.

Answer: C

94. What are the signs that a software project is in trouble?

- A) The product scope is poorly defined.
- B) Deadlines are unrealistic.
- C) Changes are managed poorly.
- D) All of the above.

Answer: D

95. Completion of an activity on CPM network diagram, is generally known

- A) Event
- B) Node
- C) Connector
- D) All the above.

Answer: D

96. For completion of a project, the critical path of the network represents

- A) Minimum time
- B) Maximum time
- C) Maximum cost
- D) Minimum cost

Answer: A

97. Pick up the correct network for the activities of pouring concrete, erection of form work, removal of form work and curing of concrete from the following :

- A) 1. Pouring of Concrete, 2. Erection of form work, 3. Curing of concrete, 4. Removal of form work
- B) 1. Erection of form work, 2. Pouring of concrete 3. Curing of concrete, 4. Removal of form work
- C) 1. Removal of form work 2. Erection of form work 3. Pouring of concrete, 4. Curing of concrete
- D) 1. Pouring of concrete 2. Curing of concrete 3. Erection of form work 4. Removal of form work.

Answer: B

98. In a certain project an activity C can only be started when activities A and B have been completed, which have no bearing on each other and can be started independently. The correct network for the activities, is

- A) Activities A and B can be started independently
- B) Activity C can be started only on completion of activity A
- C) Activity D can be started only on completion of activity
- D) D. all the above

Answer: D

99. Pick up the incorrect statement from the following :

- A. The activity is the time consuming part of a project
- B. The beginning and end of a job, are called events
- C. The activity which consumes maximum time, is called a node
- D. Logically and sequentially connected activities and events form a network

Answer: C

100. Pick up the correct statement from the following:

- A) CPM analysis is activity oriented
- B) PERT analysis is event oriented
- C) CPM does not make any allowance for the uncertainties in the duration of time
- D) All the above

Answer: D