

Construction Equipment and Plant Management



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Chapter One
Introduction

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1.1 Construction Industry

- A construction is a process of ***constructing something by man for one purpose or another***. It may be a road, bridge, a dam, a dwelling place, an airport, a commercial building, etc.
- In planning for the various types of construction, the methods of procuring professional service, awarding construction contracts, and financing the constructed facility can be quite different.
- Construction is ***the ultimate objective of a design, and the transformation of a design*** by construction into a useful structure.

1.1 Construction Industry

- CI is an industry which is involved in ***the planning, execution and evaluation*** of all types of civil works.
- It can be categorized into ***three major sectors:***
  - ***i. Transport and Communication Sector -*** *Road, Railway, Airway, and Telecommunication related physical works.*
  - ***ii. Water and Energy Works*** *– Hydropower development, transmission lines, wind power, irrigation projects and*
  - ***iii. Buildings and Other Physical Infrastructures.***

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- The broad spectrum of constructed facilities may be classified into ***four major*** categories, each with its own characteristics:
  - **Residential Housing Construction**
    - ✓ *Includes single-family houses, multi-family dwellings, and high rise apartments.*
  - **Institutional and Commercial Building Construction**
    - ✓ *schools and universities, medical clinics and hospitals, recreational facilities and sport stadiums, retail chain stores and large shopping centers, warehouses and light manufacturing plants, and skyscrapers for office and hotels.*
  - **Specialized Industrial construction**
    - ✓ *Involves very large scale projects with a high degree of technological complexity, such as oil refineries, steel mills, chemical processing plants and nuclear plants.*
  - **Infrastructure and heavy construction**
    - ✓ *Includes projects such as highways, mass transit systems, tunnels, bridges, pipelines, drainage systems and sewage treatment plants.*

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- Some of the major challenges faced in the Ethiopian construction industry are:
  - ✓ ***Lack of equipment and material***
  - ✓ ***Obstacles posed by government regulations***
  - ✓ ***Scarcity of finance***
  - ✓ ***Big projects off-limits to domestic firms***
  - ✓ ***Inefficient custom and clearance***
  - ✓ ***Lack of skilled labor***
- Construction project delays: Delays are endemic to construction projects in Ethiopia.

1.2. Construction Equipment Management

What is construction equipment management?

- **Construction equipment management:** means getting the ***most out of the equipment*** for the ***least amount of money***, for the ***longest amount of time***, so that the amount of money spent on the equipment is justified by how much money it generated. This is achieved ***through effective construction*** equipment management

- **Construction Equipment Management is the processes of Planning, Utilization and Monitoring of construction equipments to arrive at:**
  - ✓**Selecting** the appropriate machinery to the **scope of work** and **other constraints** (time, cost, other resources, etc);
  - ✓Best alternatives of **acquiring (accessing)** the **most efficient resource** and **deploying** it on site
  - ✓Once on site, achieve **best productivity** (reduce downtime, increase working hours, improve life time, etc)
  - ✓Have **best fleet and maintenance** management schemes so that machine's downtime is reduced and resource usage is optimized;
  - ✓Harmonize, standardize and enhance quality of **final output (or construction processes)**

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- ***Equipment costs***, in addition to ***the costs of operation***, constitute ***the most expenses*** for a construction company.
- For the most part, equipment is the single most costly aspect of any construction project. It is costlier than even wages and materials.
- This makes effective construction equipment management even ***more important*** to earn more ***profit in a certain project.***
- Total ***owning and operating cost of all equipment's*** must be ***very minimal to give the construction company a competitive advantage***

Construction Equipment Management

- The cost of equipment in a project varies from 10 to 30% of the total cost of the project, depending upon the extent of mechanization.
- In modern fully mechanized projects the cost of equipment goes up to 30%.
- Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for the successful completion of the project.
- Equipment manager’s main task is to reduce downtime , achieve optimum equipment utilization and increase production at minimum cost.

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- Equipment engineer should coordinate with various wings of the organization in discharging his job of:
  - ✓ ***Equipment planning, Balancing,***
  - ✓ ***Selection of equipment and its utilization,***
  - ✓ ***Personnel selection and training,***
  - ✓ ***Financial planning,***
  - ✓ ***Preventive maintenance and***
  - ✓ ***General supervision.***

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Thus equipment management integrates and continuously interacts with human, technical, financial and production system in order to achieve top efficiency and cost effectiveness.

Equipment planning

- ❖ Modern construction projects are complex in nature and success of a project depends greatly on proper and scientific planning.
- ❖ Before starting every project its planning is done with great care, as the efficiency of the whole project largely depends upon its planning.
- ❖ While planning a project we must very carefully decide about the extent of use of construction equipment's.

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Forecasting equipment requirement

Following are the main points planner has to decide in equipment planning.

1. **Working Shifts:**

By increasing the number of shifts we can reduce the number of equipment required, as the same equipment can be used in second and third shift.

2. Number and Size of Equipment's:

For deciding the number and size of the equipment's following factors should be considered.

- Quantum of work,
- Working days available for completion of project.
- Number of shifts planned.

3. Matching Units:

The number and size of the matching equipment's should be planned for each activity, keeping in view that complete matching set must be utilized at the maximum and combination must be optimum.

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4.Procurement Scheduling:

Procurement scheduling is done considering procurement time required and time when equipment is required.

5. Workshop and Stores Planning:

While planning for the purchase of equipment's, it is necessary to plan for the workshop and stores for carrying out the repair and maintenance.

6. Man power planning:

Planning for manpower in order to operate the equipment and to carry out the repair and maintenance is also necessarily be done sufficiently in advance.

7. Site Conditions:

The type of equipment selected mainly depends upon soil available, and valley conditions, surface and strata where work is to be carried out.

Modern construction projects are complex in nature and success of a project depends greatly on proper and scientific planning.

1.3. Relevance of Construction Equipment / Plant Management

- One can state ***many reasons why construction equipment or plant management is relevant for the successful completion*** of a construction project or in this specific case for the profession construction technology and management.
- These reasons can generally fall into four major themes called
  - ✓***Resources,***
  - ✓***Productivity / Efficiency,***
  - ✓***Quality and***
  - ✓***Development demand related issues.***

Resources

- ***Materials, Money, Manpower and Machineries (the 4 M's)*** are usual resources recognized in most situations of those construction industries.
- Efficient and effective implementation of construction projects require good knowledge of relationships for and among resource like;-
  - ✓ ***Human*** (Capacity and Capability),
  - ✓ ***Financial***
  - ✓ ***Physical*** (Material, Equipment and Plant)
  - ✓ ***Institutional***(Management and Production Systems), and
  - ✓ ***Information***(Access and Availability)resources together with the concepts of availability and utilization of Time and Space could best describe these categories.

The Major Resources in Construction

- **Institutional** (reputation, O. culture, O. capability, management style & experience, etc.)
  - ✓ Need to be cultivated, nurtured and exploited to gain a competitive edge
- **Finance (Money):** the ***most liquid resource*** of a firm
  - ✓ The major resource used to secure other resources
- **Human** (capacity and capability):
  - ✓ Is the resources that actually **does** the job
- **Physical** (Material, Equipment & Plant):
  - ✓ The major resources **used** to do the job
- **Information (Network)** (Availability &access)
  - ✓ As the saying goes “Information is power!”
- **Time and space**
  - ✓ Managing the time and the space available for any action is importance for its success

Construction execution strategy

- The focus of resources management in construction works depends on the execution strategy adopted.

Work by own resource (Force accounts) ✓ Available and under utilized own resources/expertise; ✓ Work can be done more effectively (better, faster, more economical) by own force; ✓ No available sub-contractor to take on the job; etc. ✓ Mainly a resource management issue	**Work by outsourcing:** ✓ Own force is tied on other jobs; ✓ No available resource or expertise; ✓ Subcontractors do the job more effectively (specialized); etc. ✓ Mainly a procurement & contract management issue

Productivity / Efficiency in Construction Equipment

- Equipment or Plants are designed to replace human resources where repeated activities are mostly applicable to increase productivity or efficiency.
- Productivity or efficiency can be defined as the ratio of output to input. In addition, time could be saved to decrease the production time where time value of money can contribute to the benefit of a completed project.

Equipment Quality in Construction Projects

- Use of Construction equipments and plants often give a harmonized and standardized output against variations of quality that could be achieved among different skilled manpower.
- Besides, technological advancement has brought an enhancement of quality products using such equipments and plants. Therefore, use of equipment and plants increased the quality of materials, components and the whole product of a construction process.

Equipment Mechanization On a Project

- The introduction of new mechanized equipment in construction has had a profound effect on the cost and productivity of construction as well as the methods used for construction itself. An exciting example of innovation in this regard is the introduction of computer microprocessors on tools and equipment. As a result, the performance and activity of equipment can be continually monitored and adjusted for improvement. In many cases, automation of at least part of the construction process is possible and desirable.
- For example, wrenches that automatically monitor the elongation of bolts and the applied torque can be programmed to achieve the best bolt tightness. On grading projects, laser controlled scrapers can produce desired cuts faster and more precisely than wholly manual methods.

Equipment Mechanization On a Project

Advantages of Equipment Mechanization:

- ✓ Use of appropriate equipment eliminates human errors and ensures superior quality of work consistently
- ✓ Speedy construction avoids time and cost overruns. Facility available for usage earlier.
- ✓ Certain construction not possible by manual methods

Degree of Mechanization on a Project will depend on:

- ✓ Project size
- ✓ Quality requirements
- ✓ Speed of completion
- ✓ Availability of skilled and unskilled labor
- ✓ Economics

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Extent of mechanization

Extent to which mechanization in a project should be planned depends upon the following main factors:

1. Manpower:

Type of manpower required by the project for its execution, is first decided and whether this type of manual labor is cheaply and sufficiently available round the year.

2. Completion period:

Completion period plays a deciding role about the extent of mechanization, since less the completion period more the mechanization.** wrt hourly cost! If the quantity is large!

3. Nature of work:

Nature of work includes adverse weather, climatic conditions, topography, toughness, handling of large quantities of construction material for long distance.

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4. Availability of money:

Since cost of equipment is too high and to be spent initially, it needs heavy investment in the beginning. Therefore availability of money is a main factor in deciding the extent of mechanization.

5. Availability of Indigenous Equipment:

After sales service, repair facilities are also considered where equipment's manufactured in our own country are not available.

6. Social objects of the project:

Sometimes projects are sanctioned with the object of providing employment opportunities, to improve the economic condition of the masses in addition to the development in the area.

7. Labor Relations:

In certain areas, past experience indicates labor unrests, strikes, absenteeism, uncertainty, unavailability of labor or seasonal fluctuations. In such circumstances machines are preferred being more reliable to complete the project in time.

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8. Overseas Projects:

It is difficult and expensive to send large number of man-power required in adopting the manual means in these projects, therefore only alternative left is to execute the project using construction equipment's only.

9. Quality and Performance:

The work carried out by means of construction equipment's is of high standard of quality and performance. The quality is consistent, execution is fast and work is more durable.

10. Development of Industries:

In countries like Ethiopia where industries are in developing stage, it is the need of time to use construction equipment's for the development of manufacturing industry and faster industrialization of the country.

Equipment's in Construction

- The involvement of equipment's in construction works is dependent of the level of mechanization needed/sought.

- **Low (labor Intensive)**
- **Used in light constructions**
  - ✓ Low rise buildings
  - ✓ Small structures in road constructions
  - ✓ Small irrigation projects, etc.
- **Very useful in creating job opportunities**

- **High (Machine intensive)**
- **Used in heavy constructions like**
  - ✓ High rise buildings
  - ✓ Road projects
  - ✓ Hydropower projects
  - ✓ Mining projects
  - ✓ Mechanized irrigations, etc.
- **Help achieve high quality efficient execution of tasks**

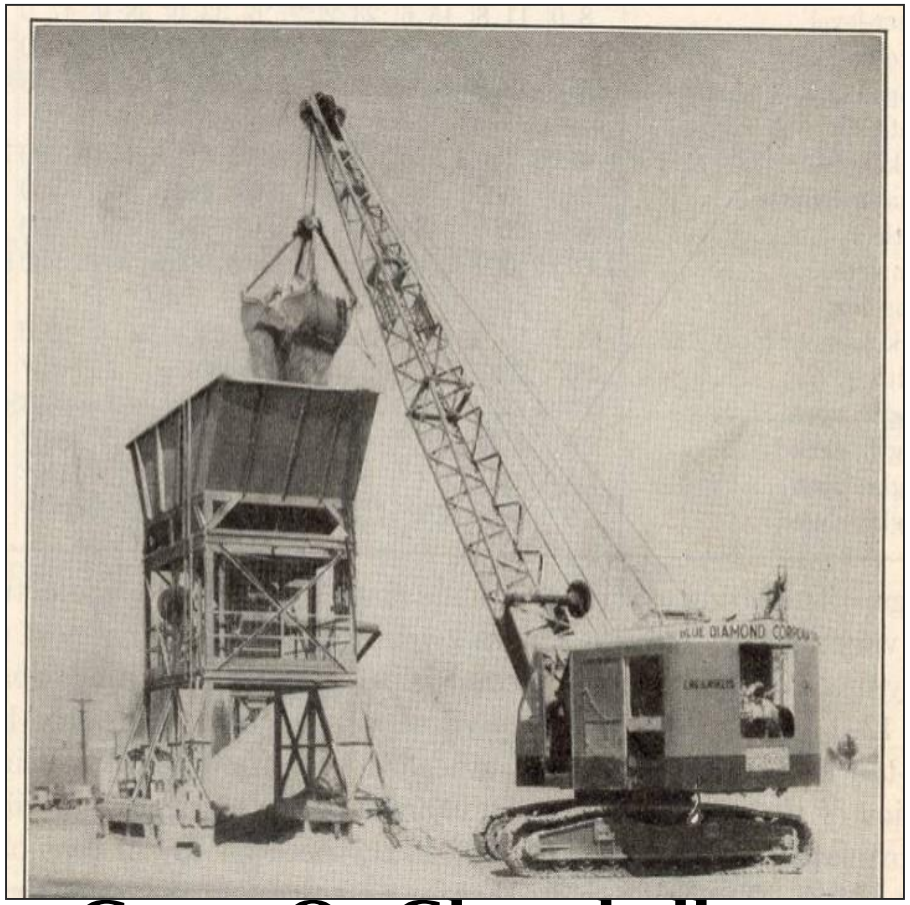
1.4. Classification of Major Equipment

1.Earthwork Equipment

Excavation and lifting equipment



Face Shovels



Grata Or Clamshell



Draglines

Earth cutting and moving equipment







Bulldozers, **Scrapers,** **Front-end Loaders**

Transportation equipment



- – tippers dump truck, scrapers rail wagons and conveyors.

Compacting and finishing equipment





Plate Compactor



Vibratory Compactor





c) Vibratory Rollers



Soil / Course Compactor



Asphalt Compactor

2. Material Hoisting Plant

- ✓ **Mobile cranes:-** crawler mounted, self-propelled rubber-tired, truck mounted.
- ✓ **Tower cranes:-** stationary, travelling and climbing types
- ✓ **Hoists:-** mobile, fixed fork-lifts

3. Concreting Plant and Equipment

- ✓ **Production equipment:-** batching plants, concrete mixers
- ✓ **Transportation equipment:-** truck mixers, concrete dumpers
- ✓ **Placing equipment:-** concrete pumps, concrete buckets, elevators, conveyors, hoists, grouting equipment.
- ✓ **Pre casting special equipment:-** vibrating and tilting tables, battery molds, surface finishes equipment, pre-stressing equipment, GRC equipment, steam curing equipment, shifting equipment.

4.Support and Utility Services Equipment

- ✓ Pumping equipment
- ✓ Sewage treatment equipment
- ✓ Pipeline laying equipment
- ✓ Compressed air equipment

5.Special Purpose Heavy Construction Plant

- ✓ Aggregate production plant & rock blasting equipment
- ✓ Hot mix plant and paving equipment
- ✓ Piles and pile driving equipment
- ✓ Bridge construction equipment
- ✓ Railway construction equipment

Factors influencing equipment selection:-

1. **Site conditions-**primary site condition factors are:-Type of material to be handled, Physical constraints on site and Hauling distance
2. **Nature of work:** nature of work factor are: Payload, Total quantity of work and Construction schedule
3. **Equipment characteristic-**refers to equipment Capacities and cost

- In excavation for building construction, for examples, factors that could affect the selection of excavators include:
  - Size of the job
  - Availability of equipment
  - Cost of transportation of equipment
  - Type of excavation
  - Soil characteristics
  - Space constraints
  - Characteristics of haul units
  - Location of dumping areas
  - Weather and temperature

Cont…

- **Size of the job:** Larger volumes of excavation will require larger excavators, or smaller excavators in greater number.
- **Availability of equipment:** Productivity of excavation activities will diminish if the equipment used to perform them is available but not the most adequate.
- **Cost of transportation of equipment:** This cost depends on the size of the job, the distance of transportation, and the means of transportation.
- **Space constraints:** The ***performance of equipment*** is influenced by the spatial limitations for the movement of excavators.
- **Characteristics of haul units:** The size of an excavator will depend on the haul units if there is a constraint on the size and/or number of these units.

- **Location of dumping areas:** The distance between the construction site and dumping areas could be relevant not only for selecting the type and number of haulers, but also the type of excavators.
- **Weather and temperature:** Rain, snow and severe temperature conditions affect the job-site productivity of labor and equipment.
- **Type of excavation:** Principal types of excavation in building projects are cut and/or fill, excavation massive, and excavation for the elements of foundation. The most adequate equipment to perform one of these activities is not the most adequate to perform the others.
- **Soil characteristics:** The type and condition of the soil is important when choosing the most adequate equipment since each piece of equipment has different outputs for different soils. Moreover, one excavation pit could have different soils at different stratums.

Proportions of equipment costs in Construction Works

- Varies with:
  - ✓Level of mechanization of execution,
  - ✓Country of work (eg.Ethio = cheap labor),
  - ✓Project characteristics (deep fill/cut road),
  - ✓ Etc
- Generally:



Building sector:

- •Material cost ¡Ö 40% of project cost
- •Labor cost ¡Ö 25-30%
- •Equipment ¡Ö 5- 10%



Civil works construction:

- •Equipment cost ¡Ö 40% of project cost
- •Material cost ¡Ö
- •Labor cost ¡Ö

Wastes in Equipment Utilization

Downtime & its consequences

- ✓ Idleness of equipment
- ✓ Idleness of crews
- ✓ Work Disruption
- ✓ Activity delay
- ✓ Loss of productivity

❖Repair cost/ cost of substitute
❖Idle related resource cost (personnel and/or equipment);
❖Loss of productivity costs (disruption, new learning, moral, etc);
❖Contract related costs: Liquidated damage, escalations due delay, disruption to the work of other contractors (related to the job), etc;
❖Other costs: extended overhead costs, extended overtime, acceleration costs, etc.
❖Etc.

1.5. Tools &Equipment Maintenance

- Tools and equipment used at the construction site undergo rigorous handling.
- Proper maintenance of construction tools and equipment is critical to preserving them for future construction jobs. ‘Failure to maintain the tools properly results in unnecessary expense’

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Instructions

- Clean the construction tools and equipment after each day's work.
- Keep airlines and electrical cords protected from heavy foot-traffic and construction vehicles.
- Lubricate air tools and pneumatic equipment before each day's use.
- Inspect and repair all construction equipment and tools at the completion of each job.

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- ❑ Objectives of Tools &Equipment preventive maintenance.
- ✓ To ensure breakdown free operation and optimum life of equipment
- ✓ To reduce cost by reducing downtime of equipment
- ✓ To keep the machine in proper condition so as to maintain the quality of product
- ✓ To ensure the safety during the work.
- ✓ To keep the plant or machinery at the maximum production efficiency.

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❑ Functions or Elements of Preventive Maintenance

- ❖Inspection or Check Ups
- ❖Servicing
- ❖Planning and Scheduling
- ❖Record and Analysis
- ❖Training of maintenance staff
- ❖Storage of spare parts

❑ Advantages of Preventive maintenance

- ❖Reduction in production downtime
- ❖Lesser number of standby equipment’s
- ❖Less expenditure on repair
- ❖Lesser spare parts needed to remain in store
- ❖Safe operation of equipment’s

Thank You For Your Attention!!!