

CONSTRUCTION PROJECT MANAGEMENT CIVIL ENGINEERING PROJECT MANAGEMENT AND EIA

4. EQUIPMENT PURCHASING



EQUIPMENT PURCHASING

FACTORS AFFECTING EQUIPMENT SELECTION

Site conditions

- Type of soil/material to be handled
- Physical constraints (site area, layout, topography, etc.)
- Hauling distances

Nature of the work

- Payload/capacity of the equipment
- Total quantity of work
- Construction schedule

Equipment characteristics

- Capacity and versatility
- Costs



EQUIPMENT PURCHASING

RENTING vs PURCHASING

Equipment purchase represents a capital investment

Enough money must be recovered

- to pay the ownership and operating cost
- Make a profit on the investment

Estimates must include the cost of equipment used on the project

It can be rented or purchased

Depending on the amount of time it will be used

- Purchase. Extensive use
- Rent. Limited use



EQUIPMENT PURCHASING

RENTING vs PURCHASING

Advantages of renting:

- No need to maintain
- Continuous access to the newest and most efficient items
- No need for equipment warehouse and storage facilities
- Reduced need to employ maintenance staff and operate facilities
- Equipment cost accounting is simpler



EQUIPMENT PURCHASING

RENTING vs PURCHASING

Equipment purchase when:

- ownership and economics make it more favourable
- Steady use of certain equipment
- Marketing advantage
 - Show more financially stable
 - Asked by some owners for tendering
- Absolute control on the use and disposition of equipment



EQUIPMENT PURCHASING

TIME-VALUE OF MONEY

It depends on the time it is received

Money today is worth more than the same money to be received in the future

- It can be invested

Different analysis

- Single payment
- Uniform series of payment



EQUIPMENT PURCHASING

TIME-VALUE OF MONEY

Single payment

$$F = P \times (1 + i)^n$$

F: Future value

P: Single payment

i: interest

n: number of years



EQUIPMENT PURCHASING

TIME-VALUE OF MONEY

Uniform series of payment

$$F = C \times \left[\frac{(1 + i)^n - 1}{i} \right]$$

F: Future value

C: Uniform annual payment

i: interest

n: number of years



EQUIPMENT PURCHASING

TIME-VALUE OF MONEY

Uniform series of payment

$$P = C \times \left[\frac{(1 + i)^n - 1}{i(1 + i)^n} \right]$$

P: Present value of a future amount of money (F)

C: Uniform annual payment

i: interest

n: number of years



EQUIPMENT PURCHASING

EXERCISE 1

We want to buy a new crane that is 85,000GBP. We invest our money at 12% interest. How much is every annual payment if we want to pay it back in 5 years?

$$P = C \times \left[\frac{(1 + i)^n - 1}{i(1 + i)^n} \right]$$

$$85,000 = C \times \left[\frac{(1 + 0.12)^5 - 1}{0.12 \times (1 + 0.12)^5} \right]$$

$$C = \frac{85,000}{3.6048} = 23,580\text{GBP}$$

Year	Interest	Payed	Debt
1	10,200	13,380	71,620
2	8,594	14,986	56,634
3	6,796	16,784	39,850
4	4,782	18,798	21,052
5	2,526	21,052	0

**EQUIPMENT PURCHASING****EXERCISE 2**

We don't have this money and borrow it at 12%. What happens if we consider monthly payments?

Then we have to change annual interest to monthly interest and consider time in months

$$P = C \times \left[\frac{(1 + i)^n - 1}{i(1 + i)^n} \right] \qquad i = \frac{0.12}{12 \text{ months}} = 0.01$$

$$85,000 = C \times \left[\frac{(1 + 0.01)^{60} - 1}{0.01 \times (1 + 0.01)^{60}} \right] \qquad 5 \text{ years} = 60 \text{ months}$$

$$C = \frac{85,000}{44.9550384} = 1,890.78 \text{ GBP}$$

SEE PAYBACK TABLE



EQUIPMENT PURCHASING

EQUIPMENT COSTS

Operating costs

Only when the equipment is used

They vary with:

- Type and size of equipment
- Conditions under which it is operated

Ownership costs

Always, whether or not the equipment is used



EQUIPMENT PURCHASING

EQUIPMENT COSTS

Ownership costs include:

- Initial cost
- Financing costs
- Depreciation
- Taxes and insurance costs

Operating costs include:

- Maintenance and repair costs
- Other costs (fuel, lubricating oil, rubber tires, etc.)



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Initial cost

Total cost required to purchase a piece of equipment

Basis for determining other costs related

It is made up of:

- Price at the factory or used equipment price
- Extra options and accessories
- Sales tax
- Freight
- Assembly or setup charges



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Financing cost

Charge of an interest rate for the borrowed money

$$\text{Annual cost of finance} = \underbrace{\left[P \left(\frac{i(1+i)^n}{(1+i)^n - 1} \right) - \frac{P}{n} \right]}_{\text{Annual payment}} - \underbrace{\left[F \left(\frac{i}{(1+i)^n - 1} \right) - \frac{F}{n} \right]}_{\text{Salvage}}$$

Annual
average
payback

This is an average calculation. If you want to be more accurate you have to calculate a payback table and subtract the salvage



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Decrease of an asset in market value

- Wearing out (performs not as well as if it was new)
- Obsolescence (the work can be performed in a better way)



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Initial value. Purchase price of an asset

Salvage. Expected price at the end of useful life

Book value. Current value in the accounting systems

Book value = initial value – depreciation costs till given time

Always calculated at the end of each year

Market value. Value if it is sold in the free market

Book value not necessarily equals the market value



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Methods to calculate depreciation

Straight-line method

A constant depreciation charge is made

$$D_n = \frac{P - F}{N}$$

D_n : Annual depreciation charge

P: initial value

F: salvage value

N: useful life in years



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Methods to calculate depreciation

Straight-line method

Exercise 3

The purchase price of an equipment is 100,000GBP and its salvage value after 10 years is 8,000GBP. Calculate the annual depreciation and the book value of the equipment each year.

$$D_n = \frac{P - F}{N}$$

$$D_n = \frac{100,000 - 8,000}{10} = 9,200$$

Year	Depreciation	Book value
0	0	100,000
1	9,200	90,800
2	9,200	81,600
3	9,200	72,400
4	9,200	63,200
5	9,200	54,000
6	9,200	44,800
7	9,200	35,600
8	9,200	26,400
9	9,200	17,200
10	9,200	8,000



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Methods to calculate depreciation

Sum-of-years digits method

Faster depreciation at the early life of an asset. The depreciation charge for each year is computed as the remaining useful life at the beginning of the year divided by the sum of the years digits for the total useful life. This ratio is multiplied by the total amount of depreciation (P-F).

$$D_n = \left[\frac{N - n + 1}{N(N + 1)/2} \right] \times (P - F)$$

D_n : Annual depreciation charge

P: initial value

F: salvage value

N: useful life in years

n: year calculated



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Methods to calculate depreciation

Sum-of-years digits= $10(10+1)/2$
= 55 years

Sum-of-years digits method

Exercise 4

The purchase price of an equipment is 100,000GBP and its salvage value after 10 years is 8,000GBP. Calculate the annual depreciation and the book value of the equipment each year.

$$D_n = \left[\frac{N - n + 1}{N(N + 1)/2} \right] \times (P - F)$$

Year	Sum-of-years	Depreciation	Book value
0	0	0	100,000
1	10/55	16,727	83,273
2	9/55	15,055	68,218
3	8/55	13,382	54,836
4	7/55	11,709	43,127
5	6/55	10,036	33,091
6	5/55	8,364	24,727
7	4/55	6,691	18,036
8	3/55	5,018	13,018
9	2/55	3,346	9,672
10	1/55	1,672	8,000



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Methods to calculate depreciation

Sinking fund method

An imaginary sinking fund is developed at a given interest rate. The accumulated sum at the end of life will equal the value of the asset depreciated ($P - F$).

$$C = \left[\frac{i}{(1+i)^n - 1} \right] \times (P - F)$$

$$D_n = C \times (1+i)^{n-1}$$

D_n : Annual depreciation charge

P : initial value

F : salvage value

N : useful life in years

n : year calculated

i : interest



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OWNERSHIP COSTS

Depreciation

Methods to calculate depreciation

Sum-of-years digits method

Exercise 5

Solve previous exercise.

(imaginary interest 10%)

$$C = \left[\frac{i}{(1+i)^n - 1} \right] \times (P - F)$$

$$C = \left[\frac{0.1}{(1+0.1)^{10} - 1} \right] \times (100,000 - 8,000)$$

$$C = 5,773$$

Year	Depreciation	Book value
0	0	100,000
1	5,773	94,227
2	6,350	87,877
3	6,985	80,892
4	7,684	73,208
5	8,451	64,757
6	9,297	55,460
7	10,226	45,234
8	11,249	33,985
9	12,374	21,611
10	13,611	8,000



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OPERATING COSTS

Maintenance and repair costs

- Replacement parts
- Labour required to keep the equipment in good condition

Historical cost records

Manufacturers provide information

Often expressed as:

- A percentage of purchase prices
- A percentage of the straight-line depreciation costs



EQUIPMENT PURCHASING

EQUIPMENT COSTS. OPERATING COSTS

Fuel consumption

Operating under standard conditions

- Gasoline engine. 0.06 gallon/horsepower-hour
- Diesel engine. 0.04 gallon/horsepower-hour

Lubricating oil consumption

It varies with the engine size, capacity, equipment condition and number of hours between oil changes

Rubber tires



EQUIPMENT PURCHASING

EXERCISE 6

Calculate the ownership costs and operating costs per hour for an excavator powered by a 250-hp engine.

Data:

Purchase price (P)	= 350,000GBP
Salvage value (F)	= 150,000GBP
Insurance	= 3,000GBP
Operation factor	= 50%
Useful life (N)	= 8 years
Working hours	= 200 days/year, 8 hr/day
Maintenance/repair costs	= 110% of annual depreciation
Diesel fuel price	= 3.8GBP/gallon
Fuel consumption	= 0.04 gallon/hp/hr
Lube oil cost	= 10% of fuel
Interest rate	= 12%

**EQUIPMENT PURCHASING****EXERCISE 6**

Depreciation (assume straight-line)

$$D_n = \frac{350,000 - 150,000}{8} = 25,000 \text{ GBP/year}$$

Annual investment cost

$$\left[350,000 \left(\frac{0.12(1.12)^8}{(1.12)^8 - 1} \right) - \frac{350,000}{8} \right] - \left[150,000 \left(\frac{0.12}{(1.12)^8 - 1} \right) - \frac{150,000}{8} \right]$$

$$[70,456.00 - 43,750] - [12,195.43 - 18,750] = 33,260.57 \text{ GBP/year}$$

**EQUIPMENT PURCHASING****EXERCISE 6****Total ownership costs**

$$25,000 + 33,260.57 + 3,000 = 61,260.57 \text{ GBP/year}$$

$$\text{Total working hours per year} = 200 \text{ days} \times \frac{8 \text{ hr}}{\text{day}} = 1,600 \text{ hr/year}$$

$$\text{Ownership costs} = \frac{61,260.57}{1,600} = 38.29 \text{ GBP/hr}$$



EQUIPMENT PURCHASING

EXERCISE 6

Maintenance and repair costs

$$Total = 1.1 \times 25,000 = 27,500 \text{ GBP/year}$$

$$\frac{27,500}{1,600} = 17.19 \text{ GBP/hr}$$

Fuel and lubricate oil costs

$$Fuel \text{ consumption} = 250 \times 0.04 \times 0.5 = 5 \text{ gallon/hr}$$

$$Fuel \text{ cost} = 5 \times 3.8 = 19 \text{ GBP/hr}$$

$$Lubricate \text{ oil cost} = 19 \times 0.1 = 1.9 \text{ GBP/hr}$$



EQUIPMENT PURCHASING

EXERCISE 6

Total operating costs

$$17.19 + 19.00 + 1.90 = 38.09 \text{ GBP/hr}$$

Total cost per hour

$$38.29 + 38.09 = 76.38 \text{ GBP/hr}$$