

PROJECT PLANNING AND MANAGEMENT

PROJECT CASH FLOWS AND INVESTMENT CRITERIA

CHAPTER

7

Dr. Abenet Yohannes, Ph.D.

Chapter Introduction

Investment appraisal determines whether a proposed project is expected to create sufficient value to justify the resources committed to it.

The analysis focuses on:

- Incremental project cash flows
- Timing of cash flows
- Risk and required return
- Recovery of investment
- Value creation
- Comparison of alternatives

CENTRAL INVESTMENT QUESTION

Do the project's expected future cash flows provide an adequate return on the initial and continuing investment?

Learning Objectives

By the end of this chapter, students will be able to:

- Explain the principles of project cash-flow estimation
- Distinguish cash flow from accounting profit
- Identify relevant and irrelevant project cash flows
- Estimate initial, operating and terminal cash flows
- Incorporate working-capital changes
- Apply the time value of money
- Calculate the payback period
- Calculate the discounted payback period
- Calculate the Accounting Rate of Return
- Calculate Net Present Value
- Calculate Internal Rate of Return
- Calculate the Profitability Index
- Compare investment criteria
- Evaluate mutually exclusive projects
- Apply capital-rationing techniques
- Make an investment recommendation

Chapter Roadmap

This chapter covers:

1. Project cash-flow principles
2. Initial investment outlay
3. Operating cash flows
4. Terminal cash flow
5. Time value of money
6. Payback period
7. Discounted payback period
8. Accounting Rate of Return
9. Net Present Value
10. Internal Rate of Return
11. Profitability Index
12. Comparison of investment criteria
13. Mutually exclusive projects
14. Capital rationing
15. Investment decision rules

Opening Reflection

Discussion Question

A proposed project reports:

- High accounting profit
- Low initial cash generation
- Significant credit sales
- Large inventory requirements
- Heavy loan repayments

Can accounting profit alone confirm that the project is financially attractive?

SECTION 1

PROJECT CASH-FLOW PRINCIPLES

01

What Is Project Cash Flow?

Project cash flow represents the actual or expected movement of cash caused by undertaking a project.

Cash flows may be:

- Inflows
- Outflows
- Initial
- Operating
- Terminal
- Incremental

Why Use Cash Flow?

Investment decisions should be based mainly on cash flow because cash is required to:

- Acquire assets
- Pay employees
- Purchase inputs
- Repay loans
- Pay taxes
- Distribute returns
- Finance future operations

Cash Flow versus Accounting Profit

Accounting Profit

Recognizes revenue and expenses using accrual-accounting principles.

Cash Flow

Records the actual timing of cash receipts and cash payments.

Profit-Cash Differences

Profit and cash may differ because of:

- Credit sales
- Accounts receivable
- Inventory changes
- Accounts payable
- Depreciation
- Capital expenditure
- Loan principal repayments

Investment-Appraisal Perspective

A project should be assessed based on:

Cash Flow WITH Project – Cash Flow WITHOUT Project

This is called incremental cash flow.

Incremental Cash Flow

Incremental Cash Flow =
Cash Flow WITH Project – Cash Flow WITHOUT Project

Only cash flows caused by the project are relevant.

Relevant Cash Flows

Relevant cash flows should be:

- Incremental
- Future-oriented
- After tax
- Based on opportunity cost
- Consistent with the financing and discount-rate approach

Irrelevant Cash Flows

Generally irrelevant items include:

- Sunk costs
- Allocated overhead not changed by the project
- Nonincremental corporate expenses
- Financing costs already reflected in the discount rate
- Accounting entries with no cash effect

Sunk Cost

A sunk cost is a past expenditure that cannot be recovered regardless of whether the project proceeds.

Examples:

- Completed feasibility study
- Past market research
- Previous design expenditure

Sunk-Cost Example

A company spent ETB 2 million on a market study.

The expenditure has already occurred. Whether the project is accepted or rejected, the ETB 2 million cannot be recovered.

It should not influence the current investment decision.

Opportunity Cost

Opportunity cost is the benefit forgone by using a resource for the project rather than its best alternative use.

Opportunity-Cost Example

A company owns land that could be sold for ETB 20 million.

If the land is used for the project, the relevant cost is the ETB 20 million forgone, even if no new cash payment is made.

Side Effects

A new project may affect existing operations. Possible effects include:

- Increased sales of existing products
- Reduced sales of existing products
- Shared distribution
- Shared marketing
- Shared production resources

Cannibalization

Cannibalization occurs when a new product reduces sales of an existing product.
The lost contribution should be treated as a project cost.

Synergy

Synergy occurs when the project improves other business activities. Examples:

- Cross-selling
- Shared distribution
- Better capacity utilization
- Reduced overhead
- Stronger brand

Incremental synergy benefits should be included.

Allocated Overhead

Allocated corporate overhead is relevant only when the project causes the total overhead cost to increase.

A purely accounting allocation is not an incremental cash flow.

Financing Costs

When project cash flows are discounted using the weighted average cost of capital:

- Do not deduct interest from project operating cash flows
- Financing cost is reflected in the discount rate

This prevents double counting.

After-Tax Cash Flow

Investment appraisal should generally use after-tax cash flows because taxes represent real project cash outflows.

Nominal and Real Cash Flows

Nominal Cash Flows

Include inflation.

Real Cash Flows

Exclude general inflation and use constant purchasing power.

Consistency Rule

Use:

- Nominal cash flows with a nominal discount rate
- Real cash flows with a real discount rate

Mixing the two produces misleading results.

SECTION 2

PROJECT CASH-FLOW STRUCTURE 02

Main Cash-Flow Components

Project cash flows are normally divided into:

1. Initial investment outlay
2. Operating cash flows
3. Terminal cash flow

Cash-Flow Timeline

Year 0

Initial investment outlay.

Years 1 to n

Operating cash flows.

Final Year

Operating cash flow plus terminal cash flow.

Basic Project Timeline

CF_0 , CF_1 , CF_2 , CF_3 , ... , CF_n

- CF_0 is usually negative
- CF_1 to CF_n may be positive or negative

SECTION 3

INITIAL INVESTMENT OUTLAY

03

What Is Initial Investment?

The initial investment is the net cash outflow required to establish the project and make it ready for operation.

Initial-Outlay Components

Initial investment may include:

- Asset purchase price
- Freight
- Installation
- Site preparation
- Building cost
- Training
- Initial working capital
- Opportunity cost
- Less proceeds from assets replaced
- Tax effects of disposal

Initial-Outlay Formula

$$\begin{aligned} I_0 = & \text{Cost of New Assets} + \text{Installation} \\ & + \text{Initial Working Capital} + \text{Opportunity Costs} \\ & - \text{After-Tax Proceeds from Old Assets} \end{aligned}$$

Equipment-Cost Example

Purchase price

ETB 50 million

Installation

ETB 5 million

Initial working capital

ETB 8 million

$$I_0 = 50 + 5 + 8 = \text{ETB } 63 \text{ million}$$

Replacement Project

For a replacement project, the initial outlay should consider:

- New equipment cost
- Installation
- Sale of old equipment
- Tax on gain or saving on loss
- Change in working capital

Book Value of Old Asset

$$\text{Book Value} = \text{Original Cost} - \text{Accumulated Depreciation}$$

Taxable Gain on Disposal

$$\text{Taxable Gain} = \text{Sale Price} - \text{Book Value}$$

When the sale price exceeds book value, the gain may create a tax payment.

Tax Saving on Disposal Loss

If:

$$\text{Sale Price} < \text{Book Value}$$

the loss may create a tax saving, subject to applicable tax rules.

After-Tax Sale Proceeds

After-Tax Proceeds = Sale Price – Tax on Gain

or plus the tax saving on a deductible loss.

Initial Working Capital

Initial working capital may include:

- Raw materials
- Finished goods
- Receivables
- Minimum cash
- Less spontaneous operating liabilities

Working Capital as Cash Flow

An increase in net working capital

Is a cash outflow.

A reduction or recovery of working capital

Is a cash inflow.

SECTION 4

04

OPERATING CASH FLOWS

What Is Operating Cash Flow?

Operating cash flow is the after-tax cash generated by the project's normal operations during each year.

Operating Cash-Flow Components

Operating cash flow depends on:

- Sales revenue
- Cash operating costs
- Depreciation
- Tax
- Changes in working capital
- Incremental side effects

Direct Operating Cash Flow

A direct formulation is:

$$\text{OCF} = \text{Cash Revenue} - \text{Cash Operating Costs} - \text{Taxes}$$

Indirect Operating Cash Flow

A common formulation is:

$$\text{OCF} = \text{Net Operating Profit After Tax} + \text{Depreciation}$$

before adjusting for working-capital changes.

EBIT-Based Formula

$$OCF = EBIT(1 - T) + D$$

- EBIT = earnings before interest and tax
- T = tax rate
- D = depreciation

Expanded Formula

$$OCF = (S - C - D)(1 - T) + D$$

- S = sales
- C = cash operating costs
- D = depreciation

Equivalent Formula

$$OCF = (S - C)(1 - T) + DT$$

The term DT represents the depreciation tax shield.

Depreciation Tax Shield

$$\text{Depreciation Tax Shield} = \text{Depreciation} \times \text{Tax Rate}$$

Tax-Shield Example

Annual depreciation

ETB 10 million

Tax rate

30%

Tax Shield = $10 \times 30\%$ = ETB 3 million

Operating-Cash-Flow Example

Sales

ETB 100 million

Cash operating costs

ETB 60 million

Depreciation

ETB 10 million

Tax rate

30%

These figures are used in the following calculations.

Calculate EBIT

$$\text{EBIT} = 100 - 60 - 10 = \text{ETB } 30 \text{ million}$$

Calculate Tax

$$\text{Tax} = 30 \times 30\% = \text{ETB } 9 \text{ million}$$

Calculate Operating Cash Flow

$$\begin{aligned}\text{OCF} &= 30(1 - 0.30) + 10 \\ \text{OCF} &= 21 + 10 = \text{ETB } 31 \text{ million}\end{aligned}$$

Working-Capital Adjustment

Free project cash flow is:

$$\text{Project Cash Flow} = \text{OCF} - \text{Capital Expenditure} - \Delta\text{NWC}$$

Increase in Working Capital

Operating cash flow

ETB 31 million

Working capital increases by

ETB 5 million

Net project cash flow = $31 - 5 =$ ETB 26 million

Depreciation Is Not Cash Revenue

Depreciation is added back because:

- It reduced taxable profit
- It did not require a current cash payment
- The asset cash outflow occurred when the asset was acquired

Capital Expenditure

Capital expenditure during operations may include:

- Replacement machinery
- Expansion
- Major repairs capitalized
- Additional vehicles
- New information systems

These are project cash outflows.

SECTION 5

05

TERMINAL CASH FLOW

What Is Terminal Cash Flow?

Terminal cash flow is the net cash flow arising at the end of the project's evaluation period.

Terminal-Cash-Flow Components

Terminal cash flow may include:

- Final operating cash flow
- Asset-sale proceeds
- Tax on disposal gain or tax saving on loss
- Recovery of working capital
- Closure and restoration costs

Terminal-Cash-Flow Formula

$$\begin{aligned} \text{TCF} = & \text{After-Tax Salvage Value} \\ & + \text{Working-Capital Recovery} \\ & - \text{Closure Costs} \end{aligned}$$

Salvage Value

Salvage value is the expected proceeds from selling or disposing of project assets at the end of the evaluation period.

After-Tax Salvage Value

$$\text{After-Tax Salvage} = \text{Sale Price} - T(\text{Sale Price} - \text{Book Value})$$

when the difference is taxable.

Salvage Example

Sale price

ETB 12 million

Book value

ETB 8 million

Tax rate

30%

$$\text{Tax on gain} = (12 - 8) \times 30\% = \text{ETB } 1.2 \text{ million}$$

$$\text{After-tax salvage} = 12 - 1.2 = \text{ETB } 10.8 \text{ million}$$

Working-Capital Recovery

At project termination, working capital may be recovered through:

- Inventory sale
- Collection of receivables
- Release of minimum cash
- Settlement of payables

Terminal-Cash-Flow Example

After-tax salvage value

ETB 10.8 million

Working-capital recovery

ETB 8 million

Closure cost

ETB 2 million

$$\text{TCF} = 10.8 + 8 - 2 = \text{ETB } 16.8 \text{ million}$$

SECTION 6

06

COMPLETE PROJECT CASH-FLOW ESTIMATE

Integrated Cash-Flow Structure

Year	Initial Outlay	Operating CF	Capital Exp.	Working Capital	Terminal Flow	Net Cash Flow
0	(100)	—	—	(10)	—	(110)
1	—	30	—	(2)	—	28
2	—	35	—	(3)	—	32
3	—	40	(5)	—	20	55

Cash-Flow Estimation Checklist

Ensure that:

- Cash flows are incremental
- Sunk costs are excluded
- Opportunity costs are included
- Side effects are considered
- Taxes are included
- Depreciation tax effects are recognized
- Working capital is included
- Terminal values are included

SECTION 7

TIME VALUE OF MONEY

07

Why Timing Matters

A dollar received today is worth more than the same dollar received in the future because it can be:

- Invested
- Used productively
- Protected from uncertainty
- Used to meet current obligations

Future Value

$$FV_n = PV(1 + r)^n$$

- PV = present value
- r = interest rate
- n = number of periods

Present Value

$$PV = FV_n / (1 + r)^n$$

Present Value of Project Cash Flow

$$PV(CF_t) = CF_t / (1 + r)^t$$

Discount Factor

$$DF_t = 1 / (1 + r)^t$$

Discounting Example

Future cash flow

ETB 100,000

Discount rate

10%

Period

2 years

$$PV = 100,000 / (1.10)^2 = \text{ETB } 82,645$$

Required Rate of Return

The discount rate reflects:

- Time value of money
- Project risk
- Financing cost
- Opportunity cost of capital
- Investor-return requirements

SECTION 8

PAYBACK PERIOD

08

What Is the Payback Period?

The payback period is the time required for cumulative project cash inflows to recover the initial investment.

Equal-Cash-Flow Payback

When annual cash inflows are equal:

$$\text{Payback Period} = \text{Initial Investment} / \text{Annual Cash Inflow}$$

Equal-Cash-Flow Example

Initial investment

ETB 100 million

Annual cash inflow

ETB 25 million

$$\text{Payback} = 100 / 25 = 4 \text{ years}$$

Unequal Cash Flows

When cash flows differ, calculate cumulative cash flows until the investment is recovered.

Unequal-Cash-Flow Example

Year	Cash Flow	Cumulative Cash Flow
0	(100m)	(100m)
1	30m	(70m)
2	35m	(35m)
3	40m	5m

Fractional Payback

At the start of Year 3, ETB 35 million remains unrecovered; Year 3 cash flow is ETB 40 million.

$$\text{Fraction} = 35 / 40 = 0.875$$

$$\text{Payback} = 2.875 \text{ years}$$

Payback Decision Rule

Accept the project when:

$$\text{Payback Period} \leq \text{Maximum Acceptable Payback}$$

Advantages of Payback

- Easy to calculate
- Easy to understand
- Emphasizes liquidity
- Useful under high uncertainty
- Highlights early cash recovery

Limitations of Payback

- Ignores time value of money
- Ignores cash flows after payback
- Does not directly measure value creation
- Uses an arbitrary cutoff
- May reject profitable long-term projects

SECTION 9

DISCOUNTED PAYBACK PERIOD

09

What Is Discounted Payback?

The discounted payback period is the time required for discounted cash inflows to recover the initial investment.

Difference from Simple Payback

Simple Payback

Uses undiscounted cash flows.

Discounted Payback

Uses present values of cash flows.

Discounted-Payback Example

Initial investment: ETB 100 million · Discount rate: 10%

Year	Cash Flow	Discounted Cash Flow
1	40m	36.36m
2	40m	33.06m
3	40m	30.05m
4	40m	27.32m

Discounted-Payback Result

Cumulative after Year 3 = $36.36 + 33.06 + 30.05 = \text{ETB } 99.47 \text{ million}$

The project recovers the remaining amount early in Year 4.

Advantages and Limitations

Advantage

Recognizes time value of money.

Limitations

Ignores cash flows after recovery; does not directly measure total value; still requires an arbitrary cutoff.

SECTION 10

ACCOUNTING RATE OF RETURN

10

What Is Accounting Rate of Return?

Accounting Rate of Return measures expected accounting profit as a percentage of investment.

ARR Formula

One common formula is:

$$\text{ARR} = (\text{Average Annual Accounting Profit} / \text{Average Investment}) \times 100$$

Average Investment

For a fully depreciable asset with residual value:

$$\text{Average Investment} = (\text{Initial Investment} + \text{Residual Value}) / 2$$

ARR Example

Initial investment

ETB 100 million

Residual value

ETB 10 million

Average annual profit

ETB 16.5 million

Calculate Average Investment

Average Investment = $(100 + 10) / 2 = \text{ETB } 55 \text{ million}$

Calculate ARR

$$\text{ARR} = (16.5 / 55) \times 100 = 30\%$$

ARR Decision Rule

Accept if:

$$\text{ARR} \geq \text{Required Accounting Return}$$

Advantages of ARR

- Uses familiar accounting information
- Easy to calculate
- Considers profitability over project life
- Useful for performance reporting

Limitations of ARR

- Uses accounting profit rather than cash flow
- Ignores time value of money
- Formula definitions may differ
- May be affected by accounting policies
- Does not directly measure value creation

SECTION 11

NET PRESENT VALUE

11

What Is Net Present Value?

Net Present Value is the difference between the present value of project cash inflows and the present value of project cash outflows.

NPV Formula

$$\text{NPV} = \sum CF_t / (1 + r)^t$$

- summed over $t = 0$ to n
- CF_0 is usually negative

Alternative NPV Formula

$$\text{NPV} = \sum CF_t / (1 + r)^t - I_0$$

- summed over $t = 1$ to n

NPV Decision Rule

- Accept if $NPV > 0$
- Reject if $NPV < 0$
- Indifferent if $NPV = 0$

Meaning of Positive NPV

A positive NPV indicates that the project is expected to:

- Recover the investment
- Provide the required return
- Create additional value

NPV Example Data

Initial investment

ETB 100 million

Discount rate

10%

Year 1 inflow

ETB 40 million

Year 2 inflow

ETB 45 million

Year 3 inflow

ETB 50 million

Present Value of Year 1

$$PV_1 = 40 / 1.10 = \text{ETB } 36.36 \text{ million}$$

Present Value of Year 2

$$PV_2 = 45 / (1.10)^2 = \text{ETB } 37.19 \text{ million}$$

Present Value of Year 3

$$PV_3 = 50 / (1.10)^3 = \text{ETB } 37.57 \text{ million}$$

Calculate NPV

$$\begin{aligned}\text{NPV} &= 36.36 + 37.19 + 37.57 - 100 \\ \text{NPV} &= \text{ETB } 11.12 \text{ million}\end{aligned}$$

The project is financially acceptable at a 10% required return.

NPV and Shareholder Value

NPV is generally considered the strongest investment criterion because it measures expected value creation in monetary terms.

Advantages of NPV

- Recognizes time value of money
- Uses all project cash flows
- Uses cash flow rather than profit
- Reflects required return
- Measures value creation
- Supports mutually exclusive decisions

Limitations of NPV

- Requires a discount-rate estimate
- Depends on forecast quality
- May appear less intuitive than percentage returns
- Absolute values may favor larger projects

SECTION 12

INTERNAL RATE OF RETURN

12

What Is Internal Rate of Return?

Internal Rate of Return is the discount rate that makes the project's NPV equal to zero.

IRR Equation

$$0 = \sum CF_t / (1 + IRR)^t$$

- summed over $t = 0$ to n

IRR Decision Rule

- Accept if $IRR > \text{required return}$
- Reject if $IRR < \text{required return}$
- Indifferent if they are equal

IRR Interpretation

An IRR of 18% means the project is expected to generate a return equivalent to approximately 18% on the invested capital under the IRR assumptions.

IRR Estimation by Interpolation

When NPV is positive at one discount rate and negative at another:

$$\text{IRR} = r_l + \left[\text{NPV}_l / (\text{NPV}_l - \text{NPV}_h) \right] \times (r_h - r_l)$$

- L = lower discount rate
- H = higher discount rate

IRR Example

Suppose NPV at 15% = ETB 5 million and NPV at 20% = ETB -2 million:

$$\text{IRR} = 15 + \left[5 / (5 - (-2)) \right] \times (20 - 15)$$

IRR Solution

$$\begin{aligned}\text{IRR} &= 15 + (5 / 7) \times 5 \\ \text{IRR} &\approx 18.57\%\end{aligned}$$

Advantages of IRR

- Recognizes time value of money
- Uses all project cash flows
- Expressed as an intuitive percentage
- Easy to compare with required return
- Widely used in business practice

Limitations of IRR

- May produce multiple rates
- May produce no meaningful rate
- Can conflict with NPV
- Assumes reinvestment at the IRR
- May favor smaller high-percentage projects

Multiple IRRs

A project may have multiple IRRs when cash flows change signs more than once. Example:

- , + , - , +

This is called a nonconventional cash-flow pattern.

No Meaningful IRR

Some cash-flow patterns may not produce a meaningful positive IRR.

In such cases, NPV should be used.

Reinvestment Assumption

NPV

Assumes intermediate cash flows can be reinvested at the required return.

IRR

Traditionally assumes reinvestment at the IRR.

The NPV assumption is generally more realistic.

SECTION 13

13

MODIFIED INTERNAL RATE OF RETURN

What Is MIRR?

Modified Internal Rate of Return addresses some limitations of IRR by using:

- A financing rate for negative cash flows
- A reinvestment rate for positive cash flows

MIRR Formula

$$\text{MIRR} = (\text{Terminal Value of Positive CF} / \text{PV of Negative CF})^{(1/n)} - 1$$

Advantages of MIRR

- Produces one meaningful rate
- Uses realistic reinvestment assumptions
- Handles nonconventional cash flows better
- Improves comparison with the cost of capital

SECTION 14

PROFITABILITY INDEX

14

What Is Profitability Index?

Profitability Index measures the present value of future cash inflows per unit of initial investment.

PI Formula

PI = Present Value of Future Cash Inflows / Initial Investment

PI Decision Rule

- Accept if $PI > 1$
- Reject if $PI < 1$
- Indifferent if $PI = 1$

PI Example

Present value of future inflows

ETB 120 million

Initial investment

ETB 100 million

$$\text{PI} = 120 / 100 = 1.20$$

Relationship between NPV and PI

$$PI = 1 + (NPV / I_0)$$

for a conventional project with a single initial investment.

Advantages of PI

- Recognizes time value of money
- Uses cash flows
- Indicates value per unit invested
- Useful under capital rationing

Limitations of PI

- May conflict with NPV for mutually exclusive projects
- Can favor smaller projects
- Depends on the discount rate
- Does not show total monetary value created

SECTION 15

15

COMPARISON OF INVESTMENT CRITERIA

Criteria Comparison

Criterion	Time Value	Uses Cash Flow	All Cash Flows	Measures Value
Payback	No	Yes	No	No
Discounted Payback	Yes	Yes	No	No
ARR	No	No	Yes	No
NPV	Yes	Yes	Yes	Yes
IRR	Yes	Yes	Yes	Indirectly
PI	Yes	Yes	Yes	Relative value

Preferred Criterion

For value-maximizing decisions, NPV is generally preferred because it:

- Measures absolute value creation
- Uses all cash flows
- Recognizes the required return
- Produces consistent additive decisions

Supporting Criteria

Other criteria may support NPV:

- Payback for liquidity
- IRR for percentage return
- PI for capital efficiency
- ARR for accounting performance
- DSCR for lender assessment

SECTION 16

16

NPV-IRR CONFLICT

When Can NPV and IRR Conflict?

Conflicts may arise for mutually exclusive projects because of differences in:

- Project size
- Timing of cash flows
- Project life
- Reinvestment assumptions

Scale Difference

Project A

Small investment with high percentage return.

Project B

Large investment with lower percentage return but greater total value.

IRR may favor A while NPV favors B.

Timing Difference

One project

May generate large early cash flows.

Another project

May generate larger later cash flows.

The preferred project may change with the discount rate.

Decision Rule in Conflict

When NPV and IRR conflict for mutually exclusive projects, choose the project with the higher NPV at the appropriate required return.

Incremental Cash-Flow Analysis

For mutually exclusive projects, calculate:

$$\text{Incremental Cash Flow} = \text{CF}(\text{larger project}) - \text{CF}(\text{smaller project})$$

Then calculate the incremental NPV or IRR.

SECTION 17

17

MUTUALLY EXCLUSIVE PROJECTS

What Are Mutually Exclusive Projects?

Mutually exclusive projects are alternatives where accepting one prevents acceptance of another.
Examples:

- Two locations
- Two technologies
- Buy versus lease
- Manual versus automated production

Independent Projects

Independent projects do not directly compete.

Each project may be accepted if it independently meets the investment criteria and funds are available.

Unequal Project Lives

Projects with unequal lives may require:

- Replacement-chain analysis
- Equivalent Annual Annuity
- Common planning horizon

Equivalent Annual Annuity

$$\text{EAA} = \text{NPV} / \text{Present Value Annuity Factor}$$

It converts NPV into an equivalent annual value.

EAA Decision Rule

For repeatable projects with unequal lives, choose the alternative with the higher equivalent annual benefit or lower equivalent annual cost.

SECTION 18

CAPITAL RATIONING

18

What Is Capital Rationing?

Capital rationing occurs when available investment funds are insufficient to finance all acceptable projects.

Types of Capital Rationing

Soft Capital Rationing

Internally imposed by management.

Hard Capital Rationing

Caused by external financing constraints.

Capital-Rationing Objective

Select the combination of projects that:

- Fits within the capital limit
- Maximizes total NPV
- Respects strategic and operational constraints

Profitability Index under Rationing

PI can help rank projects according to value created per unit of investment.

However, the combination producing the highest total NPV should be selected.

Capital-Rationing Example

Available capital: ETB 100 million

Project	Investment	NPV	PI
A	50m	15m	1.30
B	60m	16m	1.27
C	40m	10m	1.25

Possible Combinations

- A only: NPV = 15m
- B only: NPV = 16m
- C only: NPV = 10m
- A + C: Investment = 90m; NPV = 25m
- B + C: Investment = 100m; NPV = 26m

Best combination: B + C

Nonfinancial Constraints

Capital-rationing decisions may also consider:

- Management capacity
- Skilled labour
- Project dependencies
- Risk concentration
- Strategic balance
- Regulatory requirements

SECTION 19

19

INFLATION AND CASH FLOWS

Inflation Effects

Inflation may affect:

- Selling prices
- Raw-material costs
- Labour
- Utilities
- Working capital
- Capital expenditure
- Tax

Specific Inflation Rates

Different items may grow at different rates. Example:

- Sales prices: 5%
- Raw materials: 8%
- Salaries: 10%
- Utilities: 12%

Nominal Discount Rate

The nominal discount rate includes expected inflation.

Real and Nominal Relationship

$$1 + r_n = (1 + r_r)(1 + i)$$

- r_n = nominal rate
- r_r = real rate
- i = inflation rate

Approximate Relationship

$$r_n \approx r_r + i$$

This approximation is more accurate at relatively low rates.

SECTION 20

20

TAXES IN PROJECT CASH FLOW

Taxable Operating Profit

$\text{Taxable Profit} = \text{Revenue} - \text{Deductible Costs} - \text{Tax Depreciation}$

Tax Losses

A project may incur tax losses in early years. Treatment depends on:

- Tax-loss carryforward
- Group-tax rules
- Expiry limits
- Tax holidays
- Minimum taxes

Tax Holiday

A tax holiday may reduce tax payments temporarily. The project model should distinguish between:

- Accounting tax
- Actual tax payable
- Deferred tax implications where relevant

Tax Consistency

Tax assumptions should be supported by:

- Applicable tax rate
- Allowable deductions
- Depreciation rules
- Investment incentives
- Loss-carryforward provisions
- Disposal-tax treatment

SECTION 21

PRACTICAL PROJECT APPRAISAL

21

MBA Case Exercise

Proposed Agro-Processing Project

Initial investment

ETB 200 million

Project life

5 years

Required return

15%

Expected Cash Flows

Year	Cash Flow
0	(200m)
1	55m
2	65m
3	75m
4	80m
5	95m

Year 5 includes salvage value and working-capital recovery.

Simple Payback

After Year 1 = -145m

After Year 2 = -80m

After Year 3 = -5m

The project recovers the remaining ETB 5 million during Year 4.

Payback Result

Year 4 cash flow = ETB 80 million

Fraction = $5 / 80 = 0.0625$

Payback = 3.06 years

NPV Calculation Table

Year	Cash Flow	DF at 15%	Present Value
0	(200m)	1.000	(200m)
1	55m	0.870	47.83m
2	65m	0.756	49.15m
3	75m	0.658	49.31m
4	80m	0.572	45.75m
5	95m	0.497	47.23m

NPV Result

PV of inflows = $47.83 + 49.15 + 49.31 + 45.75 + 47.23 = \text{ETB } 239.27\text{m}$

NPV = $239.27 - 200 = \text{ETB } 39.27 \text{ million}$

NPV Decision

Because:

$$\text{NPV} = \text{ETB } 39.27 \text{ million} > 0$$

the project is acceptable at a required return of 15%.

Profitability Index

$$PI = 239.27 / 200 = 1.20$$

The project creates approximately ETB 1.20 of present value for each ETB 1 invested.

IRR Interpretation

The IRR is the rate that reduces the ETB 39.27 million NPV to zero. Students may estimate it using:

- Trial-and-error
- Interpolation
- Financial calculator
- Spreadsheet software

Investment Recommendation

The project appears acceptable because:

- Payback is approximately 3.06 years
- NPV is positive
- PI exceeds 1.00
- IRR is expected to exceed 15%

The final decision should also consider risk and financing capacity.

SECTION 22

22

REPLACEMENT-PROJECT EXERCISE

Replacement Decision

A company considers replacing old equipment.

New equipment cost

ETB 80 million

Installation

ETB 5 million

Old equipment can be sold for

ETB 12 million

Old-Asset Information

Old equipment book value

ETB 20 million

Tax rate

30%

Because sale price is below book value, a tax saving may arise.

Tax Saving

Loss on disposal = $20 - 12 = \text{ETB } 8 \text{ million}$

Tax saving = $8 \times 30\% = \text{ETB } 2.4 \text{ million}$

After-Tax Sale Proceeds

$$12 + 2.4 = \text{ETB } 14.4 \text{ million}$$

Net Initial Outlay

Assume additional working capital of ETB 6 million:

$$I_0 = 80 + 5 + 6 - 14.4$$

$$I_0 = \text{ETB } 76.6 \text{ million}$$

SECTION 23

23

INVESTMENT-APPRAISAL RISKS

Main Appraisal Risks

- Forecast sales overstated
- Costs understated
- Working capital omitted
- Project life exaggerated
- Residual value overstated
- Tax assumptions incorrect
- Discount rate too low
- Implementation delay ignored

Optimism Bias

Promoters may unintentionally:

- Overestimate benefits
- Underestimate costs
- Assume rapid market penetration
- Ignore competitor response
- Minimize implementation risk

Independent review can reduce optimism bias.

Sensitivity Testing

The project should be tested for changes in:

- Initial investment
- Selling price
- Sales volume
- Operating cost
- Working capital
- Project life
- Salvage value
- Discount rate

Scenario Testing

Prepare:

Optimistic Scenario

Higher sales and lower costs.

Base Scenario

Most realistic assumptions.

Pessimistic Scenario

Lower sales, higher costs and delayed implementation.

Switching Value

A switching value identifies the change required to make $NPV = 0$. Examples:

- Maximum cost increase
- Minimum selling price
- Minimum sales volume
- Maximum delay

SECTION 24

24

INVESTMENT-DECISION FRAMEWORK

Recommended Decision Hierarchy

1. Verify cash-flow relevance
2. Estimate initial, operating and terminal flows
3. Select a risk-adjusted discount rate
4. Calculate NPV
5. Calculate supporting criteria
6. Conduct sensitivity and scenario analysis
7. Review strategic and operational factors
8. Make the decision

Investment Decision Rules

Accept when the project

Has positive NPV; meets strategic objectives; has manageable risk; can be financed; can be implemented.

Reject or Redesign when the project

Has negative NPV; depends on unrealistic assumptions; exceeds risk tolerance; creates unmanageable financing pressure.

Financial and Strategic Decision

A project with positive NPV may still be rejected because of:

- Regulatory problems
- Environmental harm
- Strategic mismatch
- Management constraints
- Excessive risk
- Capital limitations

Mandatory Projects

Some projects may be necessary for:

- Legal compliance
- Safety
- Environmental protection
- Business continuity

In such cases, appraisal may focus on the least-cost effective alternative rather than whether to invest.

PRACTICAL APPLICATION

Group Assignment

Each group should prepare:

1. Project cash-flow timeline
2. Initial-investment estimate
3. Operating-cash-flow schedule
4. Working-capital schedule
5. Terminal cash-flow estimate
6. Payback period
7. Discounted payback period
8. Accounting Rate of Return
9. Net Present Value
10. Internal Rate of Return
11. Profitability Index
12. Sensitivity analysis
13. Scenario analysis
14. Final recommendation

Spreadsheet Exercise

Create an editable financial model with:

- Assumption sheet
- Cash-flow schedule
- Discount factors
- NPV calculation
- IRR calculation
- Payback calculation
- Sensitivity table
- Scenario analysis
- Investment dashboard

Decision Memo Exercise

Prepare a one-page investment memo containing:

- Project description
- Investment required
- Expected cash flows
- NPV
- IRR
- Payback
- Main risks
- Recommendation
- Conditions for approval

CHAPTER REVIEW

Common Cash-Flow Mistakes

- Using accounting profit instead of cash flow
- Including sunk costs
- Excluding opportunity costs
- Deducting interest and using WACC
- Forgetting working capital
- Ignoring tax effects
- Omitting terminal cash flow
- Mixing nominal and real values
- Using unrealistic salvage values

Common Investment-Criteria Mistakes

- Using payback as the only decision criterion
- Selecting the highest IRR regardless of scale
- Ignoring NPV–IRR conflicts
- Using one discount rate for projects with different risks
- Ignoring capital constraints
- Comparing projects with unequal lives incorrectly
- Ignoring nonfinancial risks

Project-Appraisal Checklist

Confirm that:

- Cash flows are incremental
- Sunk costs are excluded
- Opportunity costs are included
- Taxes are correct
- Working capital is included
- Salvage value is after tax
- Cash flows and discount rate are consistent
- NPV is calculated
- IRR and PI are used appropriately
- Sensitivity analysis is completed
- Strategic factors are considered

Knowledge Check

1. What is incremental cash flow?
2. Why are sunk costs excluded?
3. What is opportunity cost?
4. What are the three project cash-flow components?
5. How is operating cash flow calculated?
6. What is the depreciation tax shield?
7. What is terminal cash flow?
8. What does the payback period measure?
9. What is NPV?
10. What is IRR?
11. What is Profitability Index?
12. Why is NPV preferred when NPV and IRR conflict?
13. What is capital rationing?

Knowledge Check Answers

1. Cash-flow difference between undertaking and not undertaking the project
2. They have already occurred and cannot be changed
3. Benefit forgone from the best alternative use of a resource
4. Initial, operating and terminal cash flows
5. After-tax operating profit plus depreciation
6. Tax saving created by deductible depreciation
7. Final asset, working-capital and closure cash flows
8. Time required to recover the investment
9. Present value of inflows minus present value of outflows
10. Discount rate that makes NPV equal to zero
11. Present value of inflows per unit of investment
12. NPV measures absolute value creation
13. Selection under limited investment funds

Individual Assignment

Select one proposed project and prepare:

- Relevant-cash-flow analysis
- Initial-outlay estimate
- Five-year operating cash flows
- Working-capital schedule
- Terminal cash-flow calculation
- Payback period
- Discounted payback period
- Accounting Rate of Return
- Net Present Value
- Internal Rate of Return
- Modified Internal Rate of Return
- Profitability Index
- Sensitivity analysis
- Scenario analysis
- Final investment recommendation

Chapter Summary

- Investment appraisal should be based on incremental cash flows.
- Accounting profit differs from cash flow.
- Sunk costs should be excluded.
- Opportunity costs and side effects should be included.
- Cash flows consist of initial, operating and terminal components.
- Depreciation creates a tax shield but is not a cash outflow.
- Working-capital increases reduce cash flow.
- Terminal cash flow includes after-tax salvage and WC recovery.
- Payback measures investment-recovery speed.
- ARR uses accounting profit and ignores time value of money.
- NPV measures expected monetary value creation.
- IRR measures the project's implied percentage return.
- PI measures value per unit invested.
- NPV is generally preferred for mutually exclusive projects.
- Capital rationing maximizes total value within a limit.
- Sensitivity and scenario analysis strengthen the decision.

KEY MESSAGE

A project creates financial value only when the present value of its incremental after-tax cash inflows exceeds the present value of all required cash outflows.

Initial Investment → Operating Cash Flows → Terminal Cash Flow → Discounting → NPV → Risk Testing → Investment Decision

Next Chapter Preview

NEXT CHAPTER — Organizational, Institutional and Management Feasibility

The next chapter will cover:

- Organizational structure
- Governance arrangements
- Legal and institutional framework
- Management capacity
- Human-resource planning
- Roles and responsibilities
- Implementation arrangements
- Financial and procurement systems
- Monitoring and reporting systems
- Institutional sustainability

THANK YOU

Questions and Discussion

Dr. Abenet Yohannes, Ph.D.

MBA-525 — Project Planning and Management

Master of Business Administration · Jigjiga University

Email: abenetyohannes@gmail.com