ISE 307: Engineering Economic Analysis

Lecture 12: Project Screening — Payback and Net Present Worth (Ch 5)

Term 253 (Summer)

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Lecture 12

Project Cash Flows, Payback Period,
and the Net Present Worth Criterion

Lecture 12 Objectives

1. Distinguish **loan** cash flows from **project** cash flows; define **MARR**
2. Understand the **conventional payback period**
3. Compute the **discounted payback period (DPP)**
4. Apply the **net present worth (NPW)** criterion

From Loans to Projects

- **Loan**: receive money now, pay it later (the rate is the *cost* of money)
- **Project**: pay money now, receive returns later (the rate is the *earning* of money)

MARR (minimum attractive rate of return):
the lowest rate of return a firm accepts on a new project

In this course the MARR is **given** in each problem; setting it is a management decision (cost of capital, risk, opportunity cost).

Ch 3–4 connection: the MARR plays the role the loan rate played in Ch 3; and it is a *market* rate, so with flows in actual money the Ch 4 **pairing rule** is already satisfied.

Conventional Payback Period (PP)

Phosphate-plant inspection robot: invest **45,000 SAR**, labor and downtime saved **12,000 SAR/yr**:

$$\text{Payback Period (PP)} = \frac{45{,}000}{12{,}000} = \boxed{3.75 \text{ years}}$$

With **uneven** flows: accumulate the cash flows year by year until the running total turns nonnegative.

Quick, intuitive, and widely used as a first filter — many firms set a benchmark like "payback ≤ 3 years" before any deeper analysis.

Payback Period's Flaws

1. **Ignores the time value of money** — a year-4 amount counts the same as a year-1 amount
2. **Ignores all cash flows after payback** — a project with large late profits scores no better than one that ends at payback

PP measures **liquidity** (how fast money returns), **not profitability**. It is a *screening* tool, but not a decision criterion on its own.

Discounted Payback Period (DPP)

Same project, but accumulate **discounted** flows at $i = 10\%$:

n	0	1	2	3	4	5
Discounted flow	$-45{,}000$	10,909	9,917	9,016	8,196	7,451
Cumulative	$-45{,}000$	$-34{,}091$	$-24{,}174$	$-15{,}158$	$-6{,}962$	$+489$

$$\text{DPP} = 4 + \frac{6{,}962}{7{,}451} = \boxed{4.93 \text{ years}} \quad \text{(vs. 3.75 undiscounted)}$$

DPP $>$ PP. **Flaw #2 remains:** flows after the DPP are still ignored, so DPP is still a screening tool.

The Net Present Worth (PW)

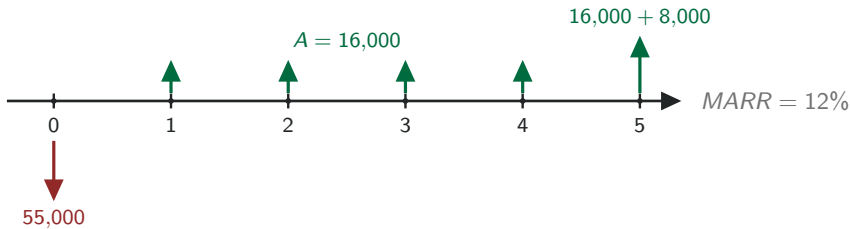
$$\mathrm{PW}(i) = \sum_{n=0}^{N} A_n\,(1+i)^{-n} \quad \text{evaluated at } i = \mathrm{MARR}$$

Single project: **accept if PW** > 0; **reject** if $\mathrm{PW} < 0$; **indifferent** if $\mathrm{PW} = 0$.

- Discount **every** cash flow to time 0 at $i = \mathrm{MARR}$
- $\mathrm{PW} > 0$ means the project does **more** than repay its capital at the MARR
- **Nothing new mechanically:** this is Ch 2 equivalence — (P/F) for singles, (P/A) for series — at $i = \mathrm{MARR}$. The *new* part is the **decision rule**.

NPW in Action: A Haul-Truck Autonomy Retrofit

A mine upgrades one haul truck to run autonomously: invest **55,000 SAR**; receive net savings of **16,000 SAR** per year for 5 years; sell the automation kit at the end for **8,000 SAR**; MARR = 12%:



$$\begin{aligned} \text{PW}(12\%) &= -55{,}000 + 16{,}000\,(P/A,\,12\%,\,5) + 8{,}000\,(P/F,\,12\%,\,5) \\ &= -55{,}000 + 16{,}000\,(3.6048) + 8{,}000\,(0.5674) \\ &= \boxed{+7{,}216 \text{ SAR}} \;\Rightarrow\; \textbf{accept} \end{aligned}$$

What the +7,216 Actually Means

A positive PW says the project does **three** jobs at once:

1. **Repays** the 55,000 SAR investment in full
2. **Pays 12% interest** on every SAR while it is tied up in the retrofit
3. **Leaves a surplus** of 7,216 SAR, measured in today's money

PW $= 0$ does **not** mean "no profit" — it means the project earns *exactly* the MARR.

Practice Problem 1

A flotation-cell control upgrade costs **30,000 SAR** and saves **9,000 SAR/yr** for 5 years (no salvage). MARR = 10%. Find the **payback period** and the **NPW**, and state the decision.

Payback (even flows):

$$\text{Payback} = \frac{30{,}000}{9{,}000} = \boxed{3.33 \text{ years}}$$

NPW at the MARR:

$$\begin{aligned} \text{PW}(10\%) &= -30{,}000 + 9{,}000\,(P/A,\, 10\%,\, 5) \\ &= -30{,}000 + 9{,}000\,(3.7908) = \boxed{+4{,}117 \text{ SAR}} \;\Rightarrow\; \textbf{accept} \end{aligned}$$

Quick Check

A project's **PW at the MARR is exactly 0**. Which statement is correct?

(A) The project loses money and must be rejected

(B) The project earns exactly the MARR on the invested capital

(C) The project has no cash flows after payback

(D) The payback period equals the project life

Answer: (B). PW $= 0$ means the returns repay the capital *and* pay interest at exactly the MARR — no surplus, no shortfall.

Summary

- **MARR** = the hurdle rate; a project must beat what capital earns elsewhere
- **Payback** = liquidity screen; ignores TVM *and* all post-payback flows
- **DPP** fixes the TVM flaw only; flows after the DPP are still ignored
- **NPW at the MARR**: accept a single project iff PW > 0
- PW > 0 = repay capital + pay MARR interest + surplus in today's money

Before Class

To do before our class meeting:

1. **Read Sections 5.1–5.3** (pp. 194–209: payback is §5.2; NPW criterion is §5.3.1)
2. Complete the **Lecture 12 pre-class quiz** on Blackboard before class
3. Try this: invest **30,000 SAR**; receive **9,000/yr** for 5 yrs; MARR 8% — payback and PW?

In class (ICA-12): the conflicting-verdicts case — payback prefers project A, NPW prefers project B; your team must rule and justify.