# INTERNAL RATE OF RETURN

# Introduction

- You put money in a bank account and expect to get a return 1 percent
- You can think of investment/business/project in the same way
- ***Every investment/business/project has their own return, however choose the largest return***

# Internal Rate Of Return Analysis

- IRR (internal rate of return): produce rate of return while **NPV equals to zero**
- The value of **the interest rate (return), i *, can be calculated by applying present worth analysis or annual worth analysis or future worth analysis**

# Equation

- **NPV = 0**

  **Pw** inflow – PW outflow = 0

- **Equation**

  PWinflow = PWoutflow

  AW inflow = AWoutflow

  FW inflow = Fwoutflow

- **You can use “trial error” to find rate of return by applying interpolation**

# Single Alternative

- You may have to estimate rate of return (i) first then select the decision
- The value of “I” will be compared to MARR value
- What is MARR?

# Suppose you inherited Rp 500Million

# Assume you have 2 alternatives

- **leave the money in the savings account to earn 6% interest over 10 years→ this will be your opportunity cost rate or minimum return required (MARR) for any investment.**

- **Opening steak restaurant will earn 20% return over 5 years**

# Summary

- This business will bring in a **20 % rate of return** on investment.
- This business will result in a **net surplus Rp. 100.000.000** in NPW.

# Decision Criterion

- If $i^* \geq MARR$
  - *The alternative deserves to be* ***selected***

# Example

- Baker co has planed to purchase a machine worth to Rp.**39.000.000**. The annual saving will be estimated at Rp.**7.000.000**. It has **7 years of useful life** and at the end of its useful life the company will sold and approximately worth to Rp.**8.000.000**. if Baker Co has chosen 8 % as MARR, does the Baker co' s decision of buying a machine profitable?

# Using Present Worth Analysis

| PW inflow | = | PW outflow |
|---|---|---|
| 8.000.000(P/F,i*,7) + | | |
| 7.000.000(P/A,i*,7) | = | 39.000.000 |

- if **i*= 9%, then**

  → 8.000.000(0,54703) + 7.000.000(5,03295) = 39.606.890

- if **i*= 10%, then**

  → 8.000.000(0,51316) + 7.000.000(4,86842) = 38.184.220

| i* | PW |
| --- | --- |
| 9 % | 39.606.890 |
| X % | 39.000.000 |
| 10 % | 38.184.220 |

- i* $= 9 + \dfrac{\{39.000.000 - 39.606.890\}}{\{38.184.220 - 39.606.890\}} \times (10 - 9)$

  $= 9 + 0{,}426585 = 9{,}43\%$

- Since i* ≥ MARR, then the decision is favorable

# Using Annual Worth

| AW inflow | = | AW outflow |
|---|---|---|
| 8.000.000(A/F,i*,7) + 7.000.000 | = | 39.000.000(A/P,i*,7) |

**8.000.000(A/F,i*,7) - 39.000.000(A/P,i*,7) = 7.000.000**

- if **i*= 9%**

→ 8.000.000(0,10869) – 39.000.000 (0,19869) = -6.159.390

- if **i*= 10%**

→ 8.000.000(0,10541) – 39.000.000 (0,20541) = -7.167.710

| i* | AW |
|---|---|
| 9 % | -6.159.390 |
| X % | -7.000.000 |
| 10 % | -7.167.710 |

- $i^* = 9 + \dfrac{\{-7.000.000 - (-6.159.390)\}}{\{-7.167.710 - (-6.159.390\}} \times (10 - 9)$

  $= 9 + 0{,}833674 = 9{,}83\%$

- Since $i^* \geq$ MARR, then the decision is favorable

# Using Future Worth

FW Inflow = FW outflow

8.000.000 +

7.000.000 (F/A,i*,7) = 39.000.000(F/P,i*,7)

39.000.000(F/P,i*,7) - 7.000.000 (F/A,i*,7) = 8.000.000

- if i*= 9%

  → 39.000.000 (1,82804) – 7.000.000(9,20043) = 6.890.550

- if i*= 10%

  → 39.000.000 (1,94872) – 7.000.000(9,48717) = 9.589.890

| i* | FW |
|---|---|
| 9 % | 6.890.550 |
| X % | 8.000.000 |
| 10 % | 9.589.890 |

- $i^* = 9 + \frac{\{8.000.000 - 6.890.550\}}{\{9.589.890 - 6.890.550\}} \times (10 - 9)$

  $= 9 + 0{,}411008 = 9{,}41\%$

- Since i* ≥ MARR, then the decision is favorable

# The different results

- When we applied *present worth, annual worth, atau future worth* to select the decision**, the probability of having different results still exists and can influence to final decision**

- To eliminate this problem, you may calculate using **incremental analysis**

# Incremental Analysis

1. Order the alternatives ascendingly
2. Estimate the first "I"
   - ✓ *You have to compare the first alternative with d nothing – DN) in first iteration*
   - ✓ *If the estimation produces $i^* < MARR$, then DN is acceptable*
   - ✓ *If the estimation produces $i^* \geq MARR$, the first alternative will change DN position as acceptable decision,*
   - ✓ *The later alternative or may be second alternative (challenger) will be benchmarked to first alternative*

3. Calculate incremental cash flow from both alternative at a certain period using this formula
   - *Incremental cash flow=second alternative's cash flow– first alternative's cash flow*

4. Calculate i* dari from incremental cash flow, you may apply linear interpolation

5. If i* < MARR, the first alternative is till acceptable, however if i* ≥MARR, the second alternative will replace former acceptable decision and next alternative will be challenger alternative

6. Repeat step 3 to 5 until all alternatives has been benchmarked one by one. The last acceptable result will be final and chosen alternative

# Problem :

- Baker co has planed to purchase a machine to increase the productivity rate. 2 alternatives has rise up with 10 yeas useful life
- If annual MARR 9%, which machine should be invested?

| Mesin | Initial investment (Rp.) | Annual profit (Rp.) | Salvage value (Rp.) |
|---|---|---|---|
| X | 4.000.000 | 1.000.000 | 2.500.000 |
| Y | 12.000.000 | 3.000.000 | 3.000.000 |

# First step 1 (sorting the alternatives)

- The alternatives should be sorted ascendingly
    1. DN alternatives (investment = 0)
    2. first alternative – machine X

       (initial value of machine X = 4.000.000)
    3. second alternative– machine Y

       (Initial value of machine Y = 12.000.000)

# Step 2
# Estimate first "I"

| Tahun | ALternatif DN<br>(1) | Alternatif Mesin X<br>(2) | Inkremental<br>(3) = (2) – (1) |
|---|---|---|---|
| 0 | 0 | - 4.000.000 | - 4.000.000 |
| 1 - 9 | 0 | 1.000.000 | 1.000.000 |
| 10 | 0 | 3.500.000 | 3.500.000 |

## Step 3
## (calculate incremental cash flow)

# Step 4
# (calculate i* form incremental cash flow)

1.000.000(P/A,i*,9) + 3.500.000 (P/F,i*,10) = **4.000.000**

- if i*= 20%

  → 1.000.000 (4,03097) + 3.500.000(0,16151) = 4.596.255

- if i*= 25%

  → 1.000.000 (3,46313) + 3.500.000(0,10737) = 3.838.925

- Using linear interpolation for 4.000.000 can gain internal rate of return :
- **i***

$$= 20 + \frac{\{4.000.000 - 4.596.255\}}{\{3.838.925 - 4.596.255\}} \times (25 - 20)$$

$$= 24\%$$

**(Step 5→ feasibility analysis)**

since i* ≥ MARR , then purchasing machine x is acceptable

**(Step 6)**

**→ purchase machine X deserves to be selected the second alternative will be challenger alternative**

# Repeat step 3 to 6

| Tahun | Mesin X<br><br>(1) | Mesin Y<br><br>(2) | Inkremental<br><br>(3) = (2) – (1) |
|---|---|---|---|
| 0 | - 4.000.000 | - 12.000.000 | - 8.000.000 |
| 1 - 9 | 1.000.000 | 3.000.000 | 2.000.000 |
| 10 | 3.500.000 | 6.000.000 | 2.500.000 |

Step 3
(calculate incremental cash flow)

# Step 4
# (calculate i* form incremental cash flow)

2.000.000(P/A,i*,9) + 2.500.000 (P/F,i*,10) = 8.000.000

- if i*= 20%

→ 2.000.000 (4,03097) + 2.500.000(0,16151) = 8.465.715

- If i*= 25%

→ 2.000.000 (3,46313) + 2.500.000(0,10737) = 7.194.685

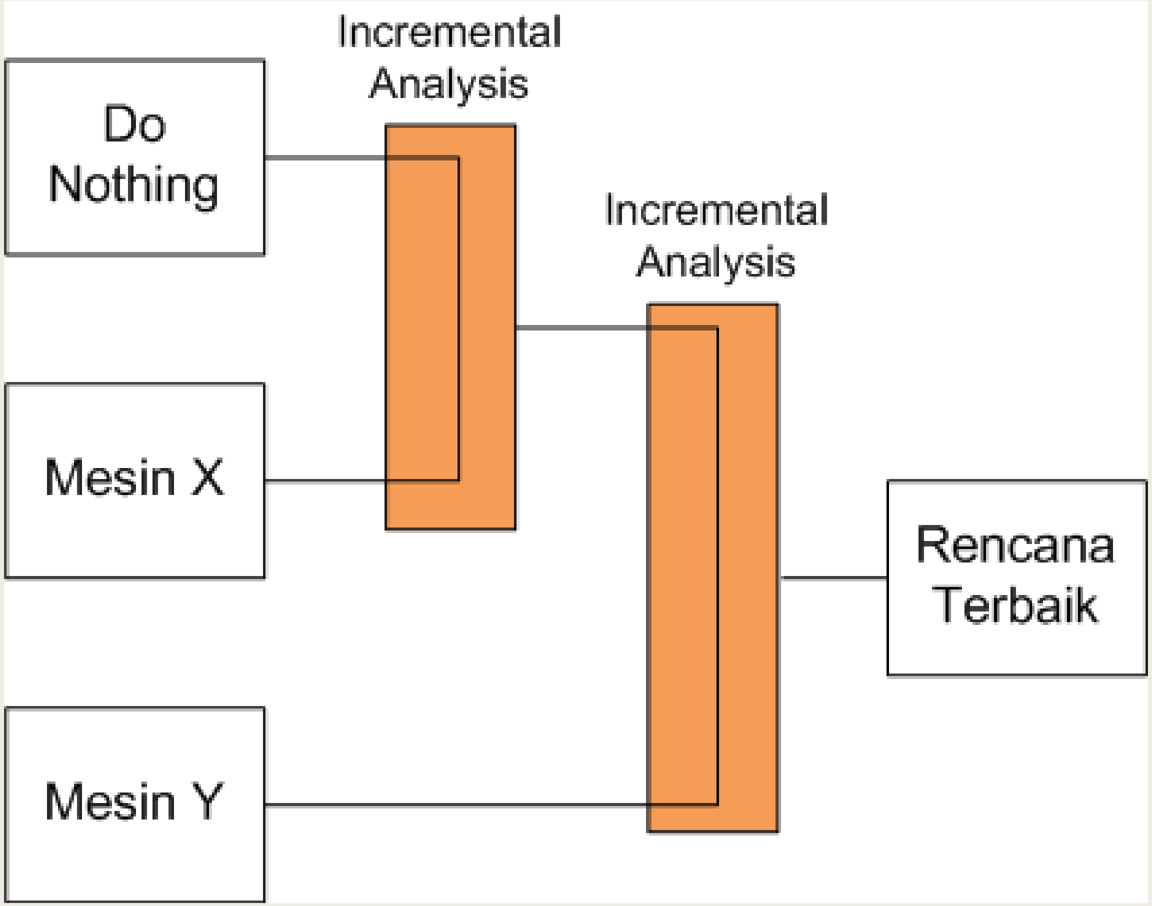
# Step 5 (feasibility test)

Using linear interpolation for 4.000.000 can gain internal rate of return :

$$i^* = 20 + \frac{\{8.000.000 - 8.465.715\}}{\{7.194.685 - 8.465.715\}} \text{ x } (25 - 20)$$

$$= 22\%$$

since i* ≥ MARR , then choose machine Y.


Incremental Analysis
Do Nothing
Incremental Analysis
Mesin X
Rencana Terbaik
Mesin Y