

- **Course Title:** Engineering Cost Analysis & Economy (ENGR 222)
- **Session:** Fall 2024
- **Instructor:** Sudipta Chowdhury
(chowdhurys@marshall.edu)
- **Class Time:** TR 9.30 AM-10.45 AM
- **Office hours:** TR 11.00 AM-12.30 PM



Rate of Return Analysis: Multiple Alternatives

Six-Step Procedure for Mutually Exclusive Alternatives

- (1) Order alternatives from *smallest to largest initial investment*
- (2) For revenue alts, calculate i^* (vs. DN) and *eliminate all with $i^* < MARR$* ; remaining alternative with lowest cost is **defender**. For cost alternatives, go to step (3)
- (3) Determine incremental CF between **defender** and **next lowest-cost** alternative (known as the *challenger*). Set up ROR relation
- (4) Calculate Δi^* on incremental CF between *two alternatives from step (3)*
- (5) If $\Delta i^* \geq MARR$, *eliminate defender* and *challenger becomes new defender* against next alternative on list
- (6) Repeat steps (3) through (5) *until only one alternative* remains. **Select it.**

For Independent Projects

Compare each alternative vs. DN and select *all with $ROR \geq MARR$*

Example 1. Caterpillar Corporation wants to build a spare parts storage facility in the Phoenix, Arizona, vicinity. A plant engineer has identified four different location options. Initial cost of earthwork and prefab building, and annual net cash flow estimates are detailed in Table 8-5. The annual net cash flow series vary due to differences in maintenance, labor costs, transportation charges, etc. If the MARR is 10%, use incremental ROR analysis to select the one economically best location.

TABLE 8-5 Estimates for Four Alternative Building Locations, Example 8.6				
	A	B	C	D
Initial cost, \$	−200,000	−275,000	−190,000	−350,000
Annual cash flow, \$	+22,000	+35,000	+19,500	+42,000
Life, years	30	30	30	30

Example 2.

A small manufacturing company expects to expand its operation by adding new product lines. Any or all of four new lines can be added. If the company uses a MARR of 15% per year and a 5-year project period, which products, if any, should the company manufacture? Monetary terms are in \$1000.

	Product			
	1	2	3	4
Initial cost, \$	-340	-500	-570	-620
Annual cost, \$/year	-70	-64	-48	-40
Annual savings, \$/year	180	190	220	205

Example 3.

You are considering five projects, all of which can be considered to last indefinitely. If the company's MARR is 15% per year, determine which should be selected if they are (a) independent projects, and (b) mutually exclusive alternatives.

Alternative	First Cost, \$	Net Annual Income, \$	ROR, %
A	-20,000	+3,000	15.0
B	-10,000	+2,000	20.0
C	-15,000	+2,800	18.7
D	-70,000	+10,000	14.3
E	-50,000	+6,000	12.0

Example 4. The four alternatives described below are being evaluated by the rate of return method.

- a) If the proposals are independent, which should be selected at a MARR of 16% per year?
- b) If the proposals are mutually exclusive, which one should be selected at a MARR of 9% per year?

Alternative	Initial Investment, \$	$i^*\%$	$\Delta i^*\%$, When Compared with Alternative		
			A	B	C
A	−40,000	29	−	−	−
B	−75,000	15	1	−	−
C	−100,000	16	7	20	−
D	−200,000	14	10	13	12

- Selection from multiple, mutually exclusive alternatives with unequal lives using ROR values requires the incremental cash flows be evaluated over the LCM of the two alternatives being compared
- Due to multiple round of calculations, it often times becomes very complex to carry out by hand (definitely doable)
- Excel can provide a very useful quick tool

Example 4. Constant improvements for in-flight texting and Internet connections provided at airline passenger seats are an expected service by many customers. Cathay Pacific Airlines knows it will have to replace 15,000 to 24,000 units in the next few years on its Boeing 777, 787, and its Airbus A300 and A380 aircraft. Four optional data handling features that build upon one another are available from the manufacturer, but at an added cost per unit. Besides costing more, the higher-end options (e.g., satellite-based plug-in video service) are estimated to have longer lives before the next replacement is forced by new, advanced features expected by flyers. All four options are expected to boost annual revenues by varying amounts. The Table includes all the estimates for the four options. (a) Using $MARR = 15\%$, perform ROR evaluation using Excel to select the one level of options that is the most promising economically.

Alternative	A	B	C	D
Initial cost	-6000	-7000	-9000	-17000
Annual cash flow	2000	3000	3000	3500
Salvage value	0	200	300	1000
life., years	3	4	6	12

QUESTIONS?