

CALCULATION OF THE PAYBACK PERIOD

Payback Period

Payback period is the time in which the initial outlay of an investment is expected to be recovered through the cash inflows generated by the investment. It is one of the simplest investment appraisal techniques. Since cash flow estimates are quite accurate for periods in the near future and relatively inaccurate for periods in distant future due to economic and operational uncertainties, payback period is an indicator of risk inherent in a project because it takes initial inflows into account and ignores the cash flows after the point at which the initial investment is recovered.

Projects having larger cash inflows in the earlier periods are generally ranked higher when appraised with payback period, compared to similar projects having larger cash inflows in the later periods.

Formula

The formula to calculate the payback period of an investment depends on whether the periodic cash inflows from the project are even or uneven. If the cash inflows are even (such as for investments in annuities), the formula to calculate payback period is:

$$\text{Payback Period} = \frac{\text{Initial Investment}}{\text{Net Cash Flow per Period}}$$

When cash inflows are uneven, we need to calculate the cumulative net cash flow for each period and then use the following formula:

$$\text{Payback Period} = A + \frac{B}{C}$$

Where,

A is the last period number with a negative cumulative cash flow;

B is the absolute value (i.e. value without negative sign) of cumulative net cash flow at the end of the period A; and

C is the total cash inflow during the period following period A

Cumulative net cash flow is the sum of inflows to date, minus the initial outflow.

Both of the above situations are explained through examples given below.

Examples

Example 1: Even Cash Flows

Company C is planning to undertake a project requiring initial investment of \$105 million. The project is expected to generate \$25 million per year in net cash flows for 7 years. Calculate the payback period of the project.

Solution

Payback Period

= Initial Investment ÷ Annual Cash Flow

= \$105M ÷ \$25M

= 4.2 years

Example 2:

The Delta company is planning to purchase a machine known as machine X. Machine X would cost \$25,000 and would have a useful life of 10 years with zero salvage value. The expected annual cash inflow of the machine is \$10,000.

Required: Compute payback period of machine X and conclude whether or not the machine would be purchased if the maximum desired payback period of Delta company is 3 years.

Solution:

Since the annual cash inflow is even in this project, we can simply divide the initial investment by the annual cash inflow to compute the payback period. It is shown below:

Payback period = \$25,000/\$10,000 = 2.5 years

According to payback period analysis, the purchase of machine X is desirable because its payback period is 2.5 years which is shorter than the maximum payback period of the company.

Example 3:

Due to increased demand, the management of Rani Beverage Company is considering to purchase a new equipment to increase the production and revenues. The useful life of the equipment is 10 years and the company's maximum desired payback period is 4 years. The inflow and outflow of cash associated with the new equipment is given below:

Initial cost of equipment: \$37,500

Annual cash inflows: Sales: \$75,000

Annual cash Outflows:

Cost of ingredients: \$45,000

Salaries expenses: \$13,500

Maintenance expenses: \$1,500

Non cash expenses: Depreciation expense: \$5,000

Required: Should Rani Beverage Company purchase the new equipment? Use payback method for your answer.

Solution:

Step 1: In order to compute the payback period of the equipment, we need to work out the net annual cash inflow by deducting the total of cash outflow from the total of cash inflow associated with the equipment.

Computation of net annual cash inflow:

$$\$75,000 - (\$45,000 + \$13,500 + \$1,500) = \$15,000$$

Step 2: Now, the amount of investment required to purchase the equipment would be divided by the amount of net annual cash inflow (computed in step 1) to find the payback period of the equipment.

$$= \$37,500 / \$15,000 = 2.5 \text{ years}$$

Depreciation is a non-cash expense and has therefore been ignored while calculating the payback period of the project.

According to payback method, the equipment should be purchased because the payback period of the equipment is 2.5 years which is shorter than the maximum desired payback period of 4 years.

Comparison of two or more alternatives – choosing from several alternative projects:

Where funds are limited and several alternative projects are being considered, the project with the shortest payback period is preferred. It is explained with the help of the following example:

Example 4:

The management of Health Supplement Inc. wants to reduce its labor cost by installing a new machine. Two types of machines are available in the market – machine X and machine Y. Machine X would cost \$18,000 where as machine Y would cost \$15,000. Both the machines can reduce annual labor cost by \$3,000.

Required: Which is the best machine to purchase according to payback method?

Solution:

Payback period of machine X: $\$18,000 / \$3,000 = 6 \text{ years}$

Payback period of machine Y: $\$15,000 / \$3,000 = 5 \text{ years}$

According to payback method, machine Y is more desirable than machine X because it has a shorter payback period than machine X.

Payback method with uneven cash flow:

In the above examples we have assumed that the projects generate even cash inflow but many projects usually generate uneven cash flow. When projects generate inconsistent or uneven

cash inflow (different cash inflow in different periods), the simple formula given above cannot be used to compute payback period. In such situations, we need to compute the cumulative cash inflow and then apply the following formula:

$$\text{Payback period} = \text{Years before full recovery} + \frac{\text{Unrecovered cost at start of the year}}{\text{Cash flow during the year}}$$

Example 5:

An investment of \$200,000 is expected to generate the following cash inflows in six years:

Year 1: \$70,000 **Year 2:** \$60,000 **Year 3:** \$55,000
Year 4: \$40,000 **Year 5:** \$30,000 **Year 6:** \$25,000

Required: Compute payback period of the investment. Should the investment be made if management wants to recover the initial investment in 3 years or less?

Solution:

(1). Because the cash inflow is uneven, the payback period formula cannot be used to compute the payback period. We can compute the payback period by computing the cumulative net cash flow as follows:

Initial investment: \$200,000		
Year	Cash inflow	Cumulative cash inflow
1	\$ 70,000	\$ 70,000
2	60,000	130,000
3	55,000	185,000
4	40,000	225,000
5	30,000	255,000
6	25,000	280,000

$$\text{Payback period} = 3 + (15,000*/40,000) = 3 + 0.375 = 3.375 \text{ Years}$$

*Unrecovered investment at start of 4th year:
 = Initial cost – Cumulative cash inflow at the end of 3rd year
 = \$200,000 – \$185,000 = \$15,000

The payback period for this project is 3.375 years which is longer than the maximum desired payback period of the management (3 years). The investment in this project is therefore not desirable.

Example 6

Company XYZ is considering an investment of \$100,000. The useful life of the project is 10 years. The cutoff period is three (3) years. The board of directors has identified two alternatives A and B. The expected annual cash flows are as follows:

Cost or Cash Flow	Alternative A	Alternative B
Initial cost	(\$100,000)	(\$100,000)
Cash flow year 1	35,000	35,000
Cash flow year 2	28,000	35,000
Cash flow year 3	32,000	35,000
Cash flow year 4	40,000	35,000

The payback period for Alternative A is calculated as follows:

1. $\$35,000 + \$28,000 + \$32,000 = \$95,000$. In 3 years the company expects to recover \$95,000 of the initial \$100,000 invested. After 3 years the company will need to recover \$5,000 more of the original investment.
2. In year 4, the company expects to recover the remaining \$5,000, and the annual cash flow that year is \$40,000. Assuming the cash flow is uniform throughout the year, we can divide \$5,000 by \$40,000 to get 0.125 (or 1.5 months).
3. The payback period for Alternative A is 3.125 years (i.e., 3 years plus 1.5 months).

The payback period for Alternative B is calculated as follows:

1. Divide the initial investment by the annuity: $\$100,000 \div \$35,000 = 2.86$ (or 10.32 months).
2. The payback period for Alternative B is 2.86 years (i.e., 2 years plus 10.32 months).

As mentioned earlier, Company XYZ's cutoff period is 3 years. Since Alternative B recovers the investment within the cutoff period (i.e., 2.86 is less than 3), Alternative B can be accepted.

This payback method of evaluating two investment alternatives has its limitation: the time value of money is not considered. To incorporate the time value of money concept, the discounted payback period method can be used.

Example 7

Osman Service Center just purchased an automobile hoist for \$33,700. The hoist has an 8-year life and an estimated salvage value of \$3,640. Installation costs and freight charges were \$3,550 and \$820, respectively. Osman uses straight-line depreciation.

The new hoist will be used to replace mufflers and tires on automobiles. Osman estimates that the new hoist will enable his mechanics to replace 6 extra mufflers per week. Each muffler sells for \$72 installed. The cost of a muffler is \$39, and the labor cost to install a muffler is \$13.

- a. Compute the cash payback period for the new hoist.
- b. Compute the annual rate of return for the new hoist.

Payback Period:

The payback period is the total time in which the project or asset will generate enough cash inflow that will cover the initial cost. Project with shortest payback period is selected.

Answer and Explanation:

Data:

Automobile purchase cost = \$33,700 , Life = 8 years, Salvage value = \$3,640 , Installation cost = \$3,550, Freight cost = \$820, Extra mufflers = 6, Selling price = \$72,

Cost of muffler = \$39 , Labor cost = \$13 , No. of week in year = 52 weeks

Solving:

a.

Annual savings = (No. of week in year * Extra mufflers) * (Selling price - Cost of muffler - Labor cost)

$$\text{Annual savings} = (52 * 6) * (72 - 39 - 13)$$

$$\text{Annual savings} = 312 * 20$$

$$\text{Annual savings} = \$6,240$$

Payback period = $\frac{\text{Automobile purchase cost} + \text{Installation cost} + \text{Freight cost}}{\text{Annual savings}}$
 Payback period = $\frac{33,700 + 3,550 + 820}{6,240}$
 Payback period = 6.10 years

b.

Depreciation expense = $\frac{\text{Automobile purchase cost} - \text{Salvage value}}{\text{Life}}$
 Depreciation expense = $\frac{33,700 - 3,640}{8}$
 Depreciation expense = \$3,757.50

Annual net income = Annual savings - Depreciation expense

$$\text{Annual net income} = 6,240 - 3,757.50$$

$$\text{Annual net income} = \$2,482.50$$

Annual rate of return = $\frac{\text{Annual net income}}{\text{Automobile purchase cost} + \text{Installation cost} + \text{Freight cost}}$
 Annual rate of return = $\frac{2,482.50}{33,700 + 3,550 + 820}$
 Annual rate of return = 0.065 or 6.5%

Example 8

Comparing Payback Period and Discounted Payback Period – Neilsen Incorporated is switching from Payback Period to Discounted Payback Period for small dollar projects. The cut-off period will remain at 3 years. Given the following four projects cash flows and using a 10% discount rate, which projects that would have been accepted under Payback Period will now be rejected under Discounted Payback Period?

Cash Flows	Project One	Project Two	Project Three	Project Four
Initial cost	\$10,000	\$15,000	\$8,000	\$18,000
Year One	\$4,000	\$7,000	\$3,000	\$10,000
Year Two	\$4,000	\$5,500	\$3,500	\$11,000
Year Three	\$4,000	\$4,000	\$4,000	\$0

Solution

Calculate the Discounted Payback Periods of each project at 10% discount rate:

Project One

Present Value of cash flow year one = $\$4,000 / 1.10 = \$3,636.36$

Present Value of cash flow year two = $\$4,000 / 1.10^2 = \$3,305.78$

Present Value of cash flow year three = $\$4,000 / 1.10^3 = \$3,005.26$

Discounted Payback Period = $-\$10,000 + \$3,636.36 + \$3,305.78 + \$3,005.26$
= $-\$52.60$ so the discount payback period is over 3 years and the project is a no-go!

Project Two

Present Value of cash flow year one = $\$7,000 / 1.10 = \$6,363.64$

Present Value of cash flow year two = $\$5,500 / 1.10^2 = \$4,505.21$

Present Value of cash flow year three = $\$4,000 / 1.10^3 = \$3,005.26$

Discounted Payback Period = $-\$15,000 + \$6,363.64 + \$4,505.21 + \$3,005.26$
= $-\$1,125.89$ so the discount payback period is over 3 years and the project is a no-go!

Project Three

Present Value of cash flow year one = $\$2,500 / 1.10 = \$2,272.73$

Present Value of cash flow year two = $\$3,000 / 1.10^2 = \$2,479.34$

Present Value of cash flow year three = $\$3,500 / 1.10^3 = \$2,629.60$

Discounted Payback Period = $-\$8,000 + \$2,272.73 + \$2,479.34 + \$2,629.20 = -\$618.33$ so the discount payback period is over 3 years and the project is a no-go!

Project Four

Present Value of cash flow year one = $\$10,000 / 1.10 = \$9,090.91$

Present Value of cash flow year two = $\$11,000 / 1.10^2 = \$9,090.91$

Present Value of cash flow year three = $\$0 / 1.10^3 = \0

Discounted Payback Period = $-\$18,000 + \$9,090.91 + \$9,090.91 + \$0 = \$181.82$ so the discount payback period is 3 years and the project is a go!

Projects one and three will now be rejected using discounted payback period with a discount rate of 10%.

Advantages and disadvantages of payback method:

Some advantages and disadvantages of payback method are given below:

Advantages:

1. An investment project with a short payback period promises the quick inflow of cash. It is therefore, a useful capital budgeting method for cash poor firms.
2. A project with short payback period can improve the liquidity position of the business quickly. The payback period is important for the firms for which liquidity is very important.
3. An investment with short payback period makes the funds available soon to invest in another project.
4. A short payback period reduces the risk of loss caused by changing economic conditions and other unavoidable reasons.
5. Payback period is very easy to compute.

Disadvantages:

1. The payback method does not take into account the time value of money.
2. It does not consider the useful life of the assets and inflow of cash after payback period. For example, If two projects, project A and project B require an initial investment of \$5,000. Project A generates an annual cash inflow of \$1,000 for 5 years whereas project B generates a cash inflow of \$1,000 for 7 years. It is clear that the project B is more profitable than project A. But according to payback method, both the projects are equally desirable because both have a payback period of 5 years ($\$5,000/\$1,000$).

Exercise (IN YOUR GROUPS ANSWER Q 1,2, 3&4 COMPULSORY AND ANY OTHER 4 QUESTIONS) THE WORK SHOULD BE SUMITTED BY ENDMONTH

1. Muchelule Corporation is considering purchasing a new delivery truck. The truck has many advantages over the company's current truck (not the least of which is that it runs). The new truck would cost \$56,100. Because of the increased capacity, reduced maintenance costs, and increased fuel economy, the new truck is expected to generate cost savings of \$8,200. At the end of 8 years, the company will sell the truck for an estimated \$28,500. Traditionally the company has used a rule of thumb that a proposal should not be accepted unless it has a payback period that is less than 50% of the asset's estimated useful life. Larry Newton, a new manager, has suggested that the company should not rely solely on the payback approach, but should also employ the net present value method when evaluating new projects. The company's cost of capital is 8%. Compute the cash payback period and the net present value of the proposed investment.
2. Discounted Payback Period – Given the following four projects and their cash flows, calculate the discounted payback period with a 5% discount rate, 10% discount rate, and 20% discount rate. What do you notice about the payback period as the discount rate rises? Explain this relationship.

Projects	A	B	C	D
Cost	\$10,000	\$25,000	\$45,000	\$100,000
Cash Flow Year One	\$4,000	\$2,000	\$10,000	\$40,000
Cash Flow Year Two	\$4,000	\$8,000	\$15,000	\$30,000
Cash Flow Year Three	\$4,000	\$14,000	\$20,000	\$20,000
Cash Flow Year Four	\$4,000	\$20,000	\$20,000	\$10,000

3. Draw the network diagram and determine the CPM, PERT a

Activity	Description	Predecessors	Optimistic Duration (To)	Pessimistic Duration (Tp)	Most likely Duration (Tm)	Expected Duration $(To + 4Tm + Tp)/6$
O	Start Milestone	-	0	0	0	0
A	Select Technical Staff	O	12	18	15	15
B	Site Survey	O	6	12	9	9
C	Select Equipments	A	9	15	12	12
D	Prepare Designs	B	6	18	9	10
E	Bring Utilities to the Site.	B	18	36	30	29
F	Interview Applicants and Fill Positions	A	9	15	12	12
G	Purchase the Equipment.	C	36	42	36	37
H	Construct the Power Plant	D	42	54	48	48
I	Develop an Information System.	A	6	18	12	12
J	Install the Equipment.	H,G,E	3	9	6	6
K	Train the Staff to Run the System	F,J,I	3	9	6	6

4. Draw a network for a project of erection of steel works for a shed. The various elements of the project are as under:

Activity code	Description	Prerequisites
A	Erect site workshop	None
B	Fence site	None
C	Bend reinforcement	A
D	Dig foundation	B
E	Fabricate steel works	A, C
F	Install concrete plant	B
G	Place reinforcement	C, D
H	Concrete foundation	G, F
I	Paint steel works	E
J	Erect steel work	H, I
K	Give finishing touch	J

5. A system project has the following activities and other characteristics A project has the following characteristics

Activity	Preceding activity	Time estimates in weeks		
		Most optimistic	Most likely	Most pessimistic
A	None	4	6	8
B	None	2	4	6
C	A	3	5	7
D	B	6	9	12
E	C	2	3	4
F	D	3	4	5
G	E,F	6	7	8
H	F	5	5	5
I	G,H	6	7	8

J	I	4	5	6
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Required:

- i. Draw the PERT network diagram and determine its critical path method.
 - ii. Find Z if the project is to be completed within 31 weeks.
6. An initial investment of \$10,320 thousand on plant and machinery is expected to generate cash inflows of \$8,400 thousand, \$7,000 thousand, \$6,224 thousand and \$4,065 thousand at the end of first, second, third and fourth year respectively. At the end of the fourth year, the machinery will be sold for \$1000 thousand. Calculate the net present value of the investment if the discount rate is 12%. A project has the following characteristics

Activity	Preceding activity	Time estimates in weeks			Expected duration $T_e = (a+4m+b)/6$	standard deviation $sd(T_e) = (b-a)/6$	variance $var = (sd(T_e))^2$
		Most optimistic (a)	Most likely (m)	Most pessimistic (b)			
A	None	3	7	11			
B	None	2	2.5	6			
C	A	2	3	4			
D	A	6	7	14			
E	A	2	3	4			
F	C	2.5	3	3.5			
G	D	2.5	4	5.5			
H	B, E	4.5	5.5	9.5			
I	H	1	2	3			
J	F, G, I	1	2	3			
		standard deviation					
		variance = sum of variance of the critical activities					

Required:

- i. Draw the PERT network diagram.
 - ii. Identify the critical path.
 - iii. Determine the mean project completion time.
 - iv. Find the probability that the project is completed in 20 weeks.
7. A system project has the following activities and other characteristics A project has the following characteristics

Activity	Preceding activity	Time estimates in weeks			Expected duration $T_e = (a+4m+b)/6$	standard deviation $sd(T_e) = (b-a)/6$	variance $var = (sd(T_e))^2$
		Most optimistic (a)	Most likely (m)	Most pessimistic (b)			

A	None	7	6	8			
B	None	2	4	6			
C	A	3	5	7			
D	B	7	5	10			
E	C	2	3	4			
F	D	3	4	5			
G	E,F	6	7	8			
H	F	5	5	7			
I	G,H	6	7	9			
J	I	5	5	6			
		VARIANCE					
		STANDARD DEVIATION					

Required:

- iii. Draw the PERT network diagram and determine its critical path method. Find Z if the project is to be completed within 29 weeks.

8. Discounted Payback Period – Graham Incorporated uses discounted payback period for projects under \$25,000 and has a cut off period of 4 years for these small value projects. Two projects, R and S are under consideration. The anticipated cash flows for these two projects are listed below. If Graham Incorporated uses an 8% discount rate on these projects are they accepted or rejected? If they use 12% discount rate? If they use a 16% discount rate? Why is it necessary to only look at the first four years of the projects' cash flows?

Cash Flows	Project R	Project S
Initial Cost	\$24,000	\$18,000
Cash flow year one	\$6,000	\$9,000
Cash flow year two	\$8,000	\$6,000
Cash flow year three	\$10,000	\$6,000
Cash flow year four	\$12,000	\$3,000

9. Comparing Payback Period and Discounted Payback Period – Mathew Incorporated is debating using Payback Period versus Discounted Payback Period for small dollar projects. The Information Officer has submitted a new computer project of \$15,000 cost. The cash flows will be \$5,000 each year for the next five years. The cut-off period used by Mathew Incorporated is three years. The Information Officer states it doesn't matter what model the company uses for the decision, it is clearly an acceptable project. Demonstrate for the IO that the selection of the model does matter!

Which project has a better payback period? Project A requires a \$25,000 investment and provides \$5,000 per year for 6 years; Project B requires an \$8,000 project and provides \$4,000 per year for 2 years. Explain the strengths and weaknesses of this approach.

10. Maryanne Company is considering purchasing new equipment for \$450,000. It is expected that the equipment will produce net annual cash flows of \$60,000 over its 10-year useful life. Annual depreciation will be \$45,000. Compute the cash payback period. (Round answer to 1 decimal place, e.g. 10.5.)
11. Company C is planning to undertake another project requiring initial investment of \$50 million and is expected to generate \$10 million net cash flow in Year 1, \$13 million in Year 2, \$16 million in year 3, \$19 million in Year 4 and \$22 million in Year 5. Calculate the payback value of the project.
12. State any six stages of feasibility study
13. Discuss change management processes by kurt lewins
14. Discuss project lifecycle
15. Discuss system development lifecycle
16. Discuss software development models
17. Process of risk management involves several stages. Discuss the stages.
18. Under economic feasibility the cost is broken into three discuss.
19. Configuration management of a software system product involves four closely related activities. Discuss
20. Define a quality plan and state any five components that are included in it.
21. There are three systems change over strategies. Discuss
22. A firm has to choose between two possible projects and the details of each project are as follows. Determine the payback period and the ARR of the projects. Which project would you recommend to the board to accept and why?

Capital cost	\$000
Project A	300
Project B	500
Project C	450

Net cash inflow (\$000)	Project A	Project B	Project C
Year 1	75	100	50
Year 2	125	200	75
Year 3	125	300	250
Year 4	100	300	300
Year 5	75	150	200

23. Payback Period – What are the Payback Periods of Projects E, F, G and H? Assume all cash flows are evenly spread throughout the year. If the cut-off period is three years, which projects do you accept?

Projects	E	F	G	H
Cost	\$40,000	\$250,000	\$75,000	\$100,000
Cash Flow Year One	\$10,000	\$40,000	\$20,000	\$30,000
Cash Flow Year Two	\$10,000	\$120,000	\$35,000	\$30,000
Cash Flow Year Three	\$10,000	\$200,000	\$40,000	\$30,000
Cash Flow Year Four	\$10,000	\$200,000	\$40,000	\$20,000
Cash Flow year Five	\$10,000	\$200,000	\$35,000	\$10,000
Cash Flow Year Six	\$10,000	\$200,000	\$20,000	\$0

24. Eric Mathis is considering refinancing his home mortgage to reduce his house payment by \$75 per month. Closing costs associated with the refinancing will total \$3,750. Eric will finish graduate school in 2 years, at which time he will sell the house and move to another state.
- (a) What is the payback period for refinancing this loan?
 (b) Given Eric's plans, should he refinance his mortgage at this time?
25. Neil Corporation has three projects under consideration. The cash flows for each of them are shown in the following table:

	Project A	Project B	Project C
Initial investment (CF ₀)	\$40,000	\$40,000	\$40,000
Year (t)	Cash inflows (CF _t)		
1	\$16,000	\$4,000	\$28,000
2	\$16,000	\$10,000	\$22,000
3	\$16,000	\$16,000	\$16,000
4	\$16,000	\$22,000	\$10,000
5	\$16,000	\$28,000	\$4,000

The firm has a cost of capital of 15%.

- a. Calculate each project's payback period. Which project is preferred according to this method?
 b. Calculate each project's net present value (NPV). Which project is preferred according to this method?
 c. Comment on you

