Chapter 5
Financial Methods

The hardest part of financial analysis is not the calculations, but deciding what factors should be taken into account and estimating the costs, revenues and risks.

Abstract The aim of this chapter is to introduce the concepts of discounted cash flow in the context of asset management decisions to see how these are applied in establishing asset investment criteria. Asset managers need to have a working knowledge of business finance so they can provide input to business decisions. *Outcomes* After reading this chapter you will know about:

- Interest rates
- The time value of money
- Present value(PV) and net present value(NPV)
- The discount factor
- Cash flow diagrams
- Equivalent annual cost and equivalent unit cost
- The use of Excel financial functions
- The annuity factor and the capital recovery factor
- Asset investment criteria
- Payback period
- Internal rate of return
- Minimum acceptable rate of return

5.1 Introduction[1]

Asset management decisions involve the application of a combination of technical and financial knowledge. Asset managers play a key role in ensuring that the physical facts and the financial and cost data which are used in making asset management decisions

[1] ISO 55002 Clause 6.2 'Asset management objectives and planning to achieve them,' and sub-clause 6.2.1.3, indicate a requirement for consideration of financial analysis methods including net PV and return on investment.

N.A.J. Hastings, *Physical Asset Management*,
DOI 10.1007/978-3-319-14777-2_5

are sufficiently accurate and sufficiently well aligned so that sound decisions can be made. To carry out these functions successfully, asset managers need to be familiar with the language and methods of accounting and financial analysis.[2]

In this chapter, we shall introduce a range of methods of financial analysis and shall illustrate them by asset-related examples. In practice, these methods are used to assess whether particular projects are financially worthwhile, and if so, to support the business case for the projects. By adopting standard methods of financial analysis, we can evaluate and compare projects in a consistent manner. These standard financial analysis methods also provide the basis for good communication between asset managers and financial analysts. Financial methods are developed further in later chapters.

5.2 Discounted Cash Flow

Fixed assets such as buildings, infrastructure, and plant have lives extending over many years. Discounted cash flow analysis is a method of analyzing cash flows over a period of years, which takes account of the time value of money. The topic involves the concepts of interest rate, discount factor, present value (PV), cash flow diagrams, and equivalent annual cost (EAC). We shall study these concepts in an asset management context and also use Excel spreadsheet functions to calculate discounted cash flow quantities.

An example of the application of discounted cash flow that we encounter in everyday life is the repayment of a loan for a motor vehicle purchase. This involves borrowing money and then repaying the initial capital and also the interest on the outstanding loan, so that ultimately both capital and interest costs are covered. Another similar example is the repayment of a mortgage.

5.2.1 Interest Rate

The interest rate is the cost or return per year of either borrowing or lending money, expressed as either a decimal fraction or a percentage of the amount borrowed or lent. The interest rate on borrowing is higher than on lending, the difference being the bank's margin or source of income.

An industrial project will only be worthwhile if the return on it exceeds the return which we could get on a safe investment such as a bank deposit or government bonds. The return must also be high enough to cover the cost involved in carrying out the project, the risk that all may not go according to plan and to provide a profit in return for the effort involved. For information on the interest rate applicable to particular asset-related calculations, it is advisable to consult your finance personnel. For calculation purposes it is easy to change an interest rate in a spreadsheet and to assess the sensitivity of a calculation to different interest rates.

[2] ISO 55001 Clause 7.5 Information Requirements: "The organization shall determine the requirements for alignment with financial… terminology…"
"The organization shall ensure there is consistency…between financial and technical data…".

5.2.2 *Present Value (PV)*

The PV of an amount of money V_n received in n years time is the amount of money available now which will attain the value V_n if invested at interest over the intervening years. For an interest rate r, the present value, PV, of an amount V_1 received in 1 year's time is given by the equation:

$$\text{PV} = V_1 \big/ (1 + r) \tag{5.1}$$

Thus, with an interest rate of 10 %, the PV of $100 received in 1 year's time is:

$$\text{PV} = 100/(1 + 0.1) = \$90.91 \tag{5.2}$$

For an amount V_n received in n years time, the PV is given by:

$$\text{PV} = V_n \big/ (1 + r)^n \tag{5.3}$$

5.2.2.1 Why Consider Present Value?

The reason why we need to consider PV is that asset investments often only pay off over a period of years. We need to take account of this delay factor in making asset management decisions.

5.2.3 *Discount Factor*

The multiplier $1/(1 + r)$ which occurs in Eqs. 5.1–5.3, arises frequently in discounted cash flow analysis and is known as the discount factor. The discount factor is the proportion by which an amount is reduced to give its equivalent value 1 year earlier. We shall denote the discount factor by the symbol p. Then:

$$p = 1 \big/ (1 + r) \tag{5.4}$$

Using the discount factor, p, the PV of an amount V_n received in n years time is given by:

$$\text{PV} = p^n * V_n \tag{5.5}$$

Example: Calculate the PV of $100 received in 2 years time, with an interest rate of 10 %.

Solution: For an interest rate of 10 %,

$$p = 1 \big/ (1 + 0.1) = 0.9091 \tag{5.6}$$

$$\text{PV} = p^2 * V_2 = 0.9091^2 \times 100 = \$82.64 \tag{5.7}$$

We see that $100 received in 2 years time only has the same value as $82.64 received now, assuming a 10 % interest rate.

5.2.4 Net Present Value (NPV)

The NPV of a series amounts received or expended over a number of years is the sum of the PV of the amounts. For a series of amounts $\$V_i$ received in i years time, the Net Present Value, NPV, is the amount of money available now which is equal to the value of the series, allowing for the interest rate.

$$\text{NPV} = V_0 + pV_1 + p^2V_2 + \cdots + p^nV_n \tag{5.8}$$

5.2.4.1 Example

As an example, consider receiving \$100 in 1 year's time and then another \$100 in 2 years time. If the interest rate is 10 %, the discount factor will be as given by Eq. 5.6, that is $p = 0.9091$. Using the symbols of Eq. 5.8 we have:

$$V_0 = 0,\ V_1 = 100,\ V_2 = 100,\ p = 0.9091.$$

$$\text{NPV} = 0 + 0.9091 \times 100 + 0.9091^2 \times 100 = \$173.55. \tag{5.9}$$

Thus the NPV of the amounts received is \$173.55. In other words, \$100 received in 1 year's time plus \$100 received in 2 years time has the same value as \$173.55 received right now, if the interest rate is 10 %.

5.2.4.2 Cash Flow

A cash flow is an amount of money that we receive or expend. Money received is a positive cash flow and expenditures are negative cash flows. In the example just given, both cash flows were positive. More generally, in NPV calculations some of the cash flows may be positive and some negative.

5.2.4.3 Why Consider NPV?

The reason why we need to consider NPV is that asset investments often involve a series of expenditures and revenues over a period of years. We need to take account of amounts and timings of these cash flows in making asset management decisions. Use of the NPV allows us to put any series of cash flows onto a common basis.

5.2.5 Cash Flow Diagram

A cash flow diagram is a schematic representation of cash received and expended year by year in the course of an activity. A cash flow diagram is a convenient way of visualizing the income and expenditure in a project. As an example, consider the

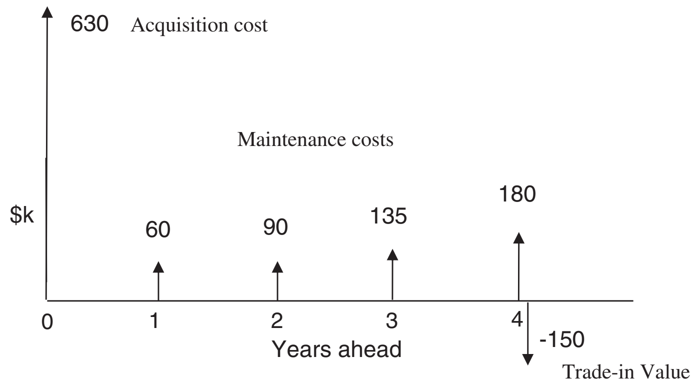


Fig. 5.1 Loader—cash flow diagram ($k)

purchase, maintenance, and disposal of an earth moving machine called a loader. The following costs are incurred over the life cycle of the loader at the times indicated.

Year 1 (beginning) $630 k acquisition cost
Year 1 (end) $60 k maintenance cost
Year 2 (end) $90 k maintenance cost
Year 3 (end) $135 k maintenance cost
Year 4 (end) $180 k maintenance cost
Year 4 (end) −$150 k trade-in value.

We have assumed that the maintenance costs are end-of-year costs. This is not strictly accurate but adjusting for part year timings is usually not considered justified in this type of calculation. The cash flows can be represented as shown in Fig. 5.1.

The NPV of the cash flows in Fig. 5.1 can be calculated using Eq. 5.8. Prior to the widespread availability of spreadsheets, PV calculations were facilitated by the use of tables which give values of the n year discount factor, p^n, for various values of interest rate and numbers of years. Appendix shows an example of such a table. However, in current practice we are likely to use a spreadsheet such as Excel for this type of calculation so we shall illustrate the use of the Excel NPV function.

5.2.6 Excel Function NPV

In Fig. 5.2 the Excel function NPV is used to calculate the NPV of the life cycle costs for the loader. The costs are as shown in Fig. 5.1. In the spreadsheet, Fig. 5.2, cells B3−F3 show the acquisition and maintenance costs of the loader. Note that the net cost in year 4 was entered, that is the maintenance cost minus the trade-in value. The interest rate in this case was 9 % and this value is shown at cell B1.

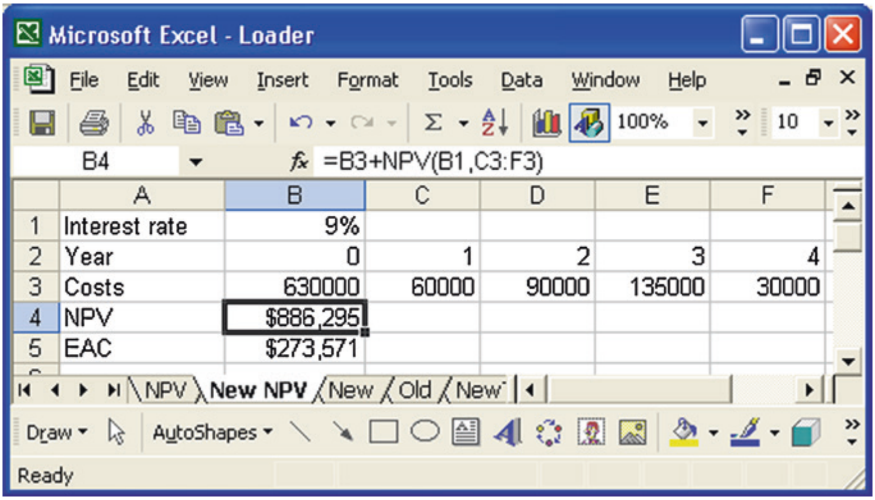


Fig. 5.2 NPV of life cycle cost of a new loader

The format of the NPV function is illustrated in the function field in Fig. 5.2. The Excel NPV function calculates the NPV of a series of values at a given interest rate, for annual payments starting in 1 year's time. An initial cost, which is undiscounted, in this case the acquisition cost from cell B3, must be shown separately from the range of values supplied to the NPV function.

From the spreadsheet, we see that the NPV of the life cycle cost is $886,295, shown at cell B4.

5.2.6.1 Applications of the NPV

The NPV is useful in understanding the total cost involved over the life cycle of the machine and in relating it to revenue factors, such as the value of the work done by the machine in its life time. The NPV of the life cycle cost can be used to compare rival types of machine, with the machine with the lowest NPV being the one to be preferred, provided that the performance is similar. In making comparisons, we must be careful to ensure that the comparison is fair in terms of factors such as the productive capacity of rival machines.

5.2.7 Equivalent Annual Cost (EAC)

EAC is the amount of a regular annual cost which, over a given period of years, has the same NPV as any given series of costs. The EAC converts the NPV into an equivalent annual amount. The term Equivalent Annual Value (EAV) is also be used when income as well as cost is considered. An example of an EAC is a mortgage repayment made at a regular amount per year. The NPV of the payments over the whole period adds up to the amount of the original loan plus the interest payments on the loan.

5.2.7.1 Why Do We Calculate the EAC?

EAC is a useful concept in asset management. It helps in the comparison of options, particularly where the options are dissimilar in type or duration. The difference between two options can often be more easily appreciated, particularly in relation to external or risk factors, when converted into an annual cost. Examples are in comparing life cycle costs of different items, or of similar items over different lives, and comparing the value or cost of competing projects with different durations. For example, in deciding on a house purchase we look at the capital cost, but also we focus on the monthly mortgage repayments and whether we can afford them from our income. This is essentially an "EAC" assessment.

5.2.7.2 Excel Function PMT

We can use the Excel function PMT to calculate an EAC. The name PMT derives from the word "payment". In Fig. 5.3 the Excel function PMT is used to calculate the EAC of the loader, using the data in Fig. 5.2. The function field shows the format of the Excel function PMT. The PMT function value takes the opposite sign to the NPV, and the minus sign in front of the function gives the EAC the same sign as the NPV.

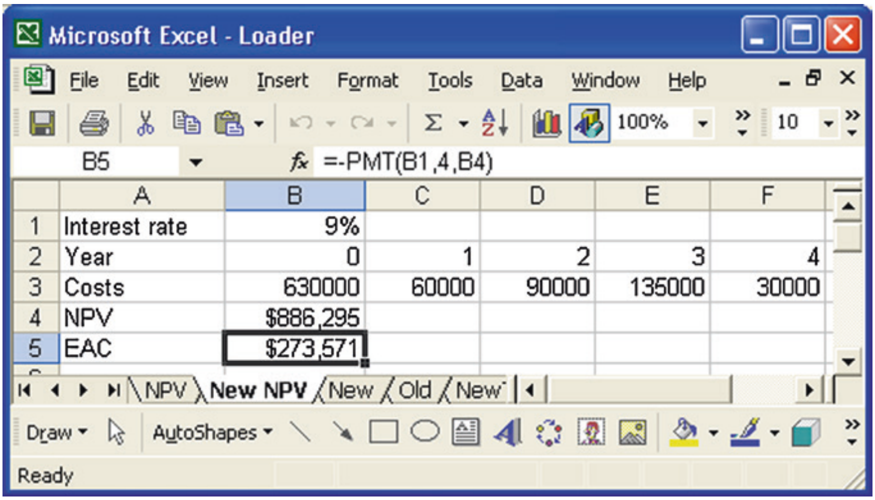
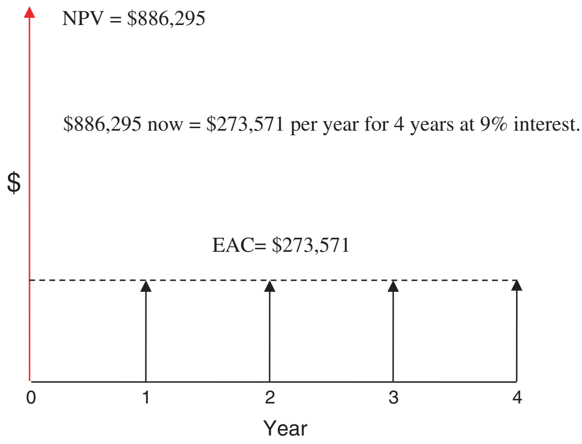


Fig. 5.3 Loader EAC using PMT function

Fig. 5.4 Net present value and equivalent annual cost



In Fig. 5.3, cell B1 shows the interest rate at 9 % and cells B3−F3 show the acquisition and maintenance costs of the loader as before. Cell B5 shows the EAC for the loader, which is $273,571 per year. The EAC provides information to supplement that provided by the NPV, and is useful in asset management decisions such as comparing with possible leasing costs and in replacement decisions.

5.2.8 Relationship Between EAC and NPV

In Fig. 5.3, cells B4 and B5 show the NPV ($886,295) and the EAC ($273,571 per year) for the loader, respectively. Figure 5.4 illustrates the relationship between the NPV and the EAC, with the NPV being the NPV of the series of costs represented by the EAC over the specified life cycle.

5.3 Other Financial Terms

Here are some other financial terms which may be encountered in an asset management context.

5.3.1 Annuity Factor

The annuity factor is the NPV of an amount of $1 per year, received for n years, with the first dollar being received in 1 year's time, at a specified interest rate. The relationship between the NPV and the EAC is:

$$\text{EAC} = \text{NPV}/\text{Annuity Factor} \tag{5.10}$$

Prior to the widespread availability of spreadsheets, tables of the annuity factor were used to calculate the EAC from the NPV. An example of such a table is given in Appendix.

5.3.2 Capital Recovery Factor

The Capital Recovery Factor, C, is the reciprocal of the Annuity Factor. It is the amount we need to receive per year for *n* years to have an NPV of $1 at the specified interest rate. The Capital Recovery Factor is the amount that must be paid each year over the given repayment period, per dollar of initial capital, in order to repay that capital and the interest on the outstanding capital at each stage. These concepts are related by the following equations:

$$\text{Capital Recovery Factor} = 1/\text{Annuity Factor} \tag{5.11}$$

$$\text{EAC} = \text{NPV} * \text{Capital Recovery Factor} \tag{5.12}$$

5.3.3 Equivalent Unit Cost (EUC)

Sometimes we need to make comparisons between items which serve similar purposes but have different capacities. For example, we may be deciding whether to purchase haulage trucks of 50 or 200 tonne capacity. The concept of EUC is useful here. The EUC is the EAC divided by the number of units of production which the item has capacity to generate, per year. For comparison purposes, we will need to make standardizing assumptions for each of the relevant items, such as how many shifts are worked by each type of equipment. We refer to the productive capacity per year as the Annual Production Capacity (APC). The EUC is then given by:

$$\text{Equiv. Unit Cost} = \text{Equiv. Annual Cost}/\text{Annual Production Capacity} \tag{5.13}$$

5.4 Asset Investment Criteria

In this section, we describe the methods used in evaluating the financial merits of investments in physical assets and illustrate these by examples. The examples used are intended to illustrate the principles involved and it will be understood that practical situations typically involve more detail and a wider range of relevant factors, including possibly less readily costable benefits. The investments that we are considering may be of a variety of types, including asset acquisitions, modifications, upgrades, overhauls, or other improvements to existing plant or facilities. Topics dealt with include the following:

- Net present value
- Payback period
- Internal rate of return
- Excel function IRR
- Minimum acceptable rate of return
- Profitability index
- Discussion of project financial measures
- Comparison and selection of projects
- Planning horizon

5.4.1 Net Present Value

If we are to invest in an acquisition or development, key financial questions are;

- what returns can we expect?
- when can we expect to get them?
- will the investment be worthwhile?

The NPV tells us what an investment is worth. For an investment to be worthwhile, the NPV must be positive and it must also be sufficiently large to satisfy other criteria that we shall consider in this section.

A first step in any investment decision is usually to estimate the NPV of the investment, using the methods already detailed in Sect. 5.2, and in particular Eq. 5.8. An example is given as Exercise 5.5.1, NPV of Material Handling System, at the end of this chapter.

5.4.2 Payback Period

The payback period is the time required to recoup an investment. Suppose that we initially invest an amount V_0 in a given capability and that it generates returns V_1, V_2, V_3,… in years 1, 2, 3,… The payback period is reached when the NPV of the sum of V_1, V_2, V_3,… first exceeds V_0. An investment which has a short payback period is attractive because there is less risk that things will go wrong over a short time frame.

Use of the payback period avoids the difficulty of evaluating a long series of returns, since all we focus on is how quickly the series becomes positive.

Figure 5.5 illustrates the concept of the payback period.

An example is given as Exercise 5.5.2, Pay Back Period of Material Handling System, at the end of this chapter.

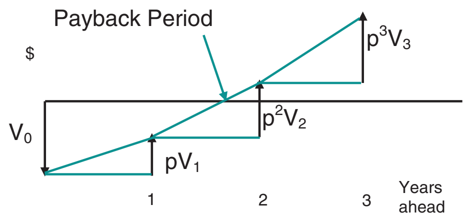


Fig. 5.5 Payback period cumulative plot

5.4.3 Internal Rate of Return (IRR)

Suppose that we invest an amount V_0 and that it generates returns V_1, V_2, V_3,…V_n in years 1, 2, 3,…, n. The internal rate of return is the value of the interest rate which makes the present value of the sum of the returns exactly equal to the value of the initial investment.

Thus if,

$$V_0 = pV_1 + p^2V_2 + p^3V_3 + \cdots + p^nV_n \tag{5.14}$$

Then p is the discount factor for which the corresponding interest rate is the internal rate of return (IRR).

This is illustrated in Fig. 5.6 which shows the initial investment and the cumulative discounted cash flow for its subsequent returns. The internal rate of return is the rate at which a project generates returns from the money invested in it. It is the return on the *unrecovered balances,* not the rate of return on the initial investment over the whole period of the project.

The internal rate of return (IRR) of a project provides a measure of profitability which can be compared with returns on other investments. The IRR calculation is also a form of risk analysis. The higher the IRR, the less susceptible the project is to risk.

5.4.3.1 Excel Function IRR

Calculation of the IRR is complex, as it involves solving Eq. 5.14 for the discount factor, p, and hence getting the value of the internal rate of return, r. Excel includes an IRR function which will carry out the necessary calculations. An illustration of the use of the Excel IRR function is given in the solution to the Communications System Exercise at the end of this chapter, Fig. 5.10.

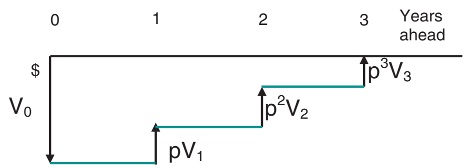


Fig. 5.6 The internal rate of return makes the NPV equal to the initial investment

5.4.4 Minimum Acceptable Rate of Return (MARR)

It is common business practice to expect an investment to achieve at least a certain internal rate of return, if it is going to receive financial approval. This return is known as the Minimum Acceptable Rate of Return (MARR) or as the Hurdle Rate. The minimum acceptable rate of return is a return which will cover:

- the costs incurred in carrying out the project,
- the cost of capital, including both the interest charged and the repayment of the capital over the period of the investment,
- an element of profit on the project,
- an allowance for risk.

Typically, this leads to a MARR of not less than 15 %.

An example of a MARR calculation is given in the solution to the Communications System Exercise, Fig. 5.10.

5.4.5 Profitability Index

Another investment measure is the Profitability Index. This is defined as:

$$\text{Profitability Index} = \text{NPV of Earnings Net Investment/Investment} \tag{5.15}$$

The calculations are based on discounting at the MARR. For a project to be acceptable, its Profitability Index must be greater than 1. Competing projects can be ranked by their profitability index.

An example of a profitability index calculation is given in the solution to the Communications System Case Study Exercise, Fig. 5.11.

5.4.6 Return on Investment (ROI)

In the case of a specific project, the Return on Investment is the same as the Internal Rate of Return which we have already considered. When considering the activities of the organization as a whole—as opposed to individual projects—we define the return on investment as follows:

$$\text{ROI} = \text{Annual Operating Profit \$/Value of Operating Assets \$.} \tag{5.16}$$

Thus, for example, an organization with $1 billion in operating assets and $100 million in operating profit would have a ROI of 10 %.

5.4.7 Project Financial Measures—Summary

The following project financial measures have been outlined. Here we summarize some of their features. In practice, we may evaluate several of the measures to help us in our investment decisions.

a. Net Present Value NPV: This is the only measure that indicates the size of a project. It does not give an indication of risk, but analyses can be carried out under different scenarios and at different interest rates as an aid to evaluating risk.
b. Payback Period: Gives an indication of how soon we expect a project to be "in the black." A short payback period is a highly desirable feature in an investment, as it is then less sensitive to risk and to revenue or costs estimates which can become inaccurate over time.
c. Internal Rate of Return IRR: This is probably the most widely used measure. When compared with the Minimum Acceptable Rate of Return (MARR), it indicates whether a project is financially worthwhile and gives an indication of risk. A project with a high IRR is less vulnerable to risk.
d. Profitability Index: Simpler in concept than the IRR, but plays the same role in estimating the financial viability of a project.

5.5 Exercises

5.5.1 Discounted Cash Flow Revision Question

Explain the following terms:

a. Interest rate
b. Present value
c. Discount factor
d. Net Present Value
e. Cash flow diagram
f. Equivalent Annual Cost
g. Annuity factor
h. Capital Recovery Factor
i. Payback period
j. Internal rate of return
k. Minimum acceptable rate of return
l. Profitability index

5.5.2 Materials Handling System—Net Present Value Exercise

A planned new materials handling system in a chemical plant has costs and returns which have been estimated as follows. The returns, or net benefits, are the savings made by the system, in comparison to an earlier less efficient system which it replaces. An interest rate of 5 % is to be assumed in this case.

a. System purchase and installation at beginning of year 1 costs $1,000,000.
b. Additional costs associated with workflow changes and training in year 1, less benefits in year 1, amount to a net cost of $200,000, considered effective at end of year (EOY).
c. Net benefits in year 2 are $500,000 (EOY) and thereafter $750,000 pa (EOY).

5.5.2.1 Tasks and Questions

a. Construct a cash flow diagram.
b. Create a spreadsheet to determine the NPV of the project up to 5 years ahead.

5.5.3 Materials Handling System—Payback Period Exercise

A planned new materials handling system in a chemical plant has costs and returns which have been estimated as follows. An interest rate of 5 % is to be assumed in this case.

d. System purchase and installation at beginning of year 1 costs $1,000,000.
e. Additional costs associated with workflow changes and training in year 1, less benefits in year 1, amount to a net cost of $200,000, considered effective at end of year (EOY).
f. Net benefits in year 2 are $500,000 (EOY) and thereafter $750,000 pa (EOY).

5.5.3.1 Tasks and Questions

Create a spreadsheet to estimate the payback period.
Comment on the suitability of the project in terms of the payback period.

5.5.4 Communications System Exercise

Purchase of a new communications system by a maintenance organization has been estimated to save money in travel time and staffing. The cost of the new

Table 5.1 Communications system estimated cost and savings

Year	0	1	2	3	4	5
Cash flow end of year	−$2,500,000	$500,000	$750,000	$900,000	$900,000	$900,000

system is $2,500,000. The system will be used over a 5-year period in which the expected savings year by year are as shown in Table 5.1.

Tasks and questions:

- Create a spreadsheet to calculate the Internal Rate of Return.
- The Minimum Acceptable Rate of return for projects used as a company guideline is 15 %. Does this project meet the guideline requirements?
- What is the Profitability Index for the Communications System?
- Would you recommend that the investment in the communications system should proceed?

5.6 Financial Analysis of a Turbo-Generator Project—Exercise

An electric power generation company can install a small gas turbine-powered generator at an initial cost of $15 million, to provide peak load power. The revenue from the sale of electricity from this plant, and the corresponding expenses have been estimated, on an End of Year basis, as shown in the following data table.

Year	Revenue ($Million)	Expense ($Million)
1	12	5
2	12	5
3	13	6
4	13	7
5	14	8

The Minimum Acceptable Rate of Return used by the company is 15 %. Calculate the following.

a. The NPV of the project over 5 years at a cost of capital of 8 % ($11.53 million)
b. The payback period (3 years).
c. Show that the internal rate of return over 5 years is approximately 35 %.
d. What is the value of the project to the company, over and above the minimum acceptable return ($7.40 million).

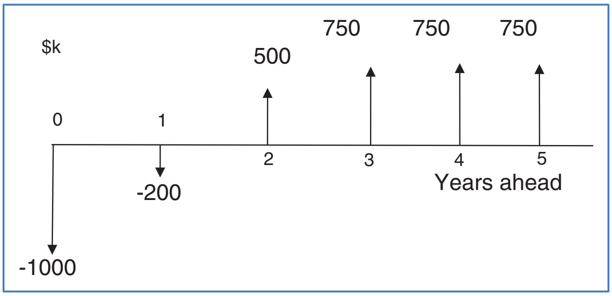


Fig. 5.7 Materials handling system cash flow

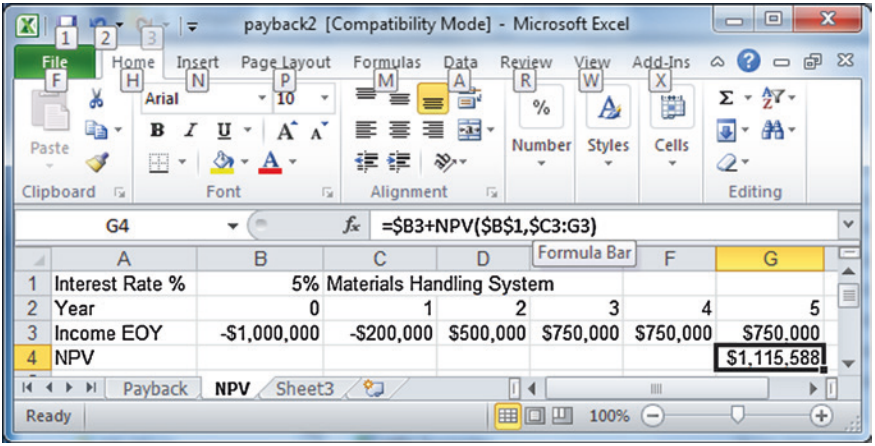
5.6.1 Materials Handling System—Net Present Value Solution

5.6.1.1 Cash Flow Diagram

The cash flow diagram is shown in Fig. 5.7.

5.6.1.2 Net Present Value

The calculation of the NPV generated by the materials handling system over a 5 year horizon is shown in Fig. 5.8, using the Excel NPV function. The result is an NPV of $1,115,588 shown at cell G4. This is the net benefit generated by the new system over the 5 year period.



	A	B	C	D	E	F	G
1	Interest Rate %	5%	Materials Handling System				
2	Year	0	1	2	3	4	5
3	Income EOY	-$1,000,000	-$200,000	$500,000	$750,000	$750,000	$750,000
4	NPV						$1,115,588

Fig. 5.8 Net present value of materials handling system

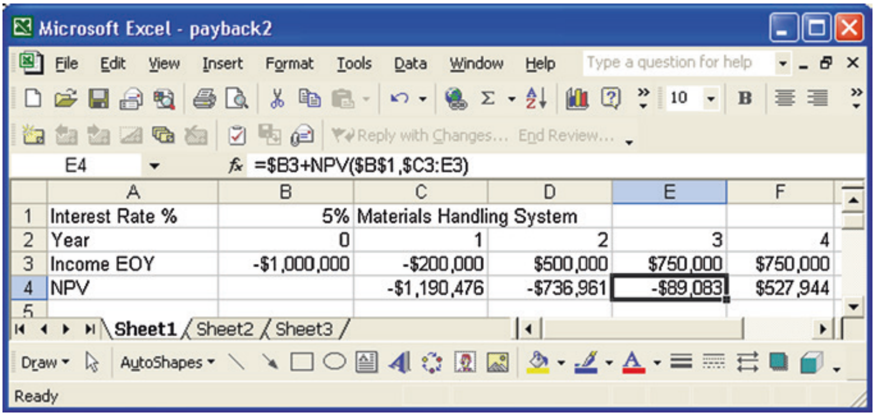


Fig. 5.9 Materials handling payback period calculation

5.6.2 Materials Handling System Payback Period—Solution

To determine the payback period, we calculate the cumulative NPV of the investment plus its related returns, working forward year by year until a positive value is obtained. Figure 5.9 shows the calculation of the NPV of the investment plus returns working forward year by year. The financial data are in row 3, and row 4 shows the NPV of the cumulative returns up to years 1, 2, 3, and 4.

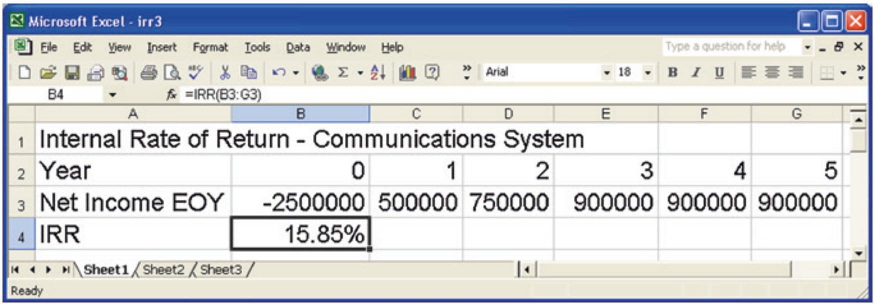
As an example of the calculation, the formula field shows the formula used to calculate the returns up to end of year 3. This is given by the initial investment, from cell B3, plus the NPV of the returns from end of year 1 to end of year 3, from cells C3:E3. The result for year 3 is −$89,083, showing that we have not fully recouped the investment by the end of year 3. However, for year 4 we get a positive value of $527,944, shown in cell F4. Hence we see that the payback period for this investment is a little over 3 years.

The project appears worthwhile as the payback period is reasonably short and the benefits may continue for some time ahead. However, there is always the possibility of further technical developments in a time frame of 5 years plus.

5.6.3 Communications System Solution

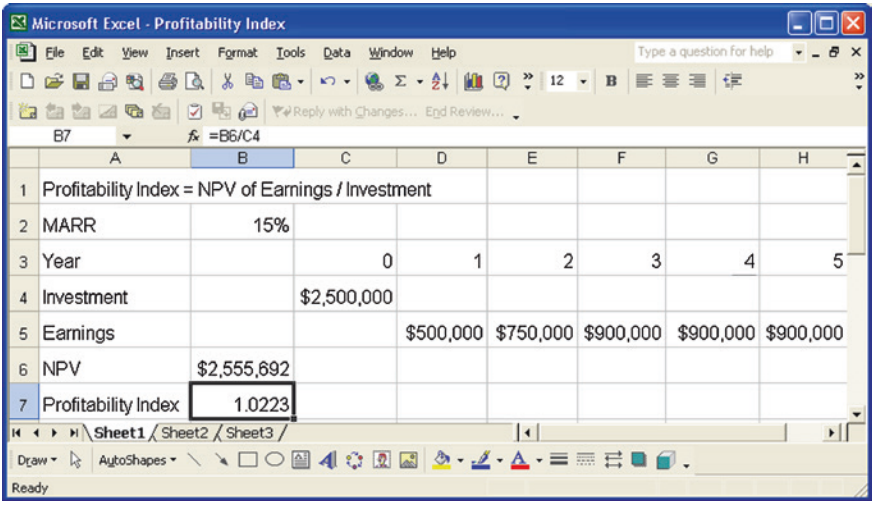
Figure 5.10 shows the calculation of the IRR using Excel. The investment amount of $2,500,000 is in cell B3 and the expected savings are in cells C3−G3. Cell B4 shows the IRR which is 15.85 %. The IRR function is shown in the function field.

In this example the IRR is 15.85 %, so that, at a MARR of 15 %, the project is just acceptable.



	A	B	C	D	E	F	G
1	Internal Rate of Return - Communications System						
2	Year	0	1	2	3	4	5
3	Net Income EOY	-2500000	500000	750000	900000	900000	900000
4	IRR	15.85%					

Fig. 5.10 Communication system IRR using excel function

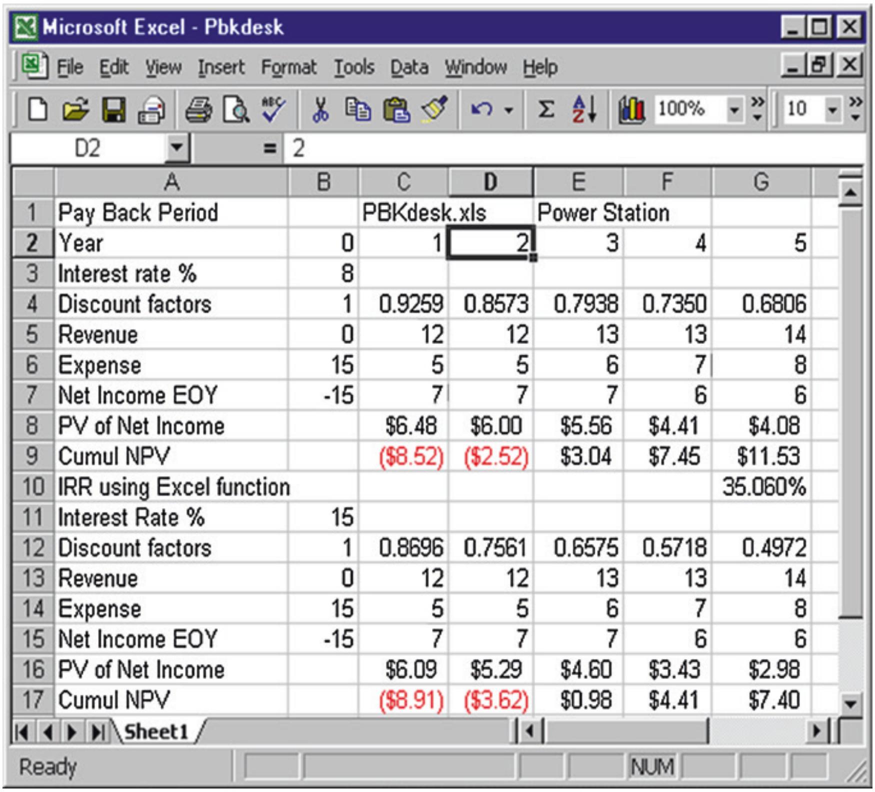


	A	B	C	D	E	F	G	H
1	Profitability Index = NPV of Earnings / Investment							
2	MARR	15%						
3	Year		0	1	2	3	4	5
4	Investment		$2,500,000					
5	Earnings			$500,000	$750,000	$900,000	$900,000	$900,000
6	NPV	$2,555,692						
7	Profitability Index	1.0223						

Fig. 5.11 Profitability index

Figure 5.11 shows the calculation of the Profitability Index. The investment of $2,500,000 is at C4, the returns are at D5−H5. The NPV of the returns is calculated at B6 using the NPV function and the MARR interest rate. The Profitability Index is calculated at B7 and is given by B6/C4. The Profitability Index is slightly greater than 1, which we expect as the IRR is slightly greater than the MARR. In practice, this project may be displaced by others with a higher profitability index.

5.6.4 Financial Analysis of Turbo-Generator Exercise Solution



	A	B	C	D	E	F	G
1	Pay Back Period		PBKdesk.xls		Power Station		
2	Year	0	1	2	3	4	5
3	Interest rate %	8					
4	Discount factors	1	0.9259	0.8573	0.7938	0.7350	0.6806
5	Revenue	0	12	12	13	13	14
6	Expense	15	5	5	6	7	8
7	Net Income EOY	-15	7	7	7	6	6
8	PV of Net Income		$6.48	$6.00	$5.56	$4.41	$4.08
9	Cumul NPV		($8.52)	($2.52)	$3.04	$7.45	$11.53
10	IRR using Excel function						35.060%
11	Interest Rate %	15					
12	Discount factors	1	0.8696	0.7561	0.6575	0.5718	0.4972
13	Revenue	0	12	12	13	13	14
14	Expense	15	5	5	6	7	8
15	Net Income EOY	-15	7	7	7	6	6
16	PV of Net Income		$6.09	$5.29	$4.60	$3.43	$2.98
17	Cumul NPV		($8.91)	($3.62)	$0.98	$4.41	$7.40