Appendix 2: Using an investment model

To evaluate any investment, it is necessary to define its objectives, measure these (as far as possible) in financial terms, and then relate the resulting financial parameters to some overall measure of value for the investment over its life (typically whole-life net present value, as explained below). Generally, the value of an investment is based on the balance of benefits over costs. Typically the main measures of cost and benefit, stage-by-stage, are shown in Table 13.

Benefits and costs are both typically spread over periods of time, as cash flows. It is impossible to conduct anything other than the simplest investment appraisal without building a cash flow model.

Appraisal techniques

There are a number of techniques currently used to appraise projects, which are all based on the principle of comparing costs with benefits. Most appraisals are conducted using either a payback period, IRR or NPV. The latter is perhaps the most widely used approach, with good reason.

The payback period is simply the number of years of cash flow needed to meet the initial investment. Its simplicity has, however, to be offset by lack of consideration of the time value of money and of cash flows and risks beyond the payback period. The second method, IRR, does not have these disadvantages but gives no indication of the amount of value or profit each project will provide. The NPV approach overcomes these difficulties, although it does introduce subjectivity in the requirement to establish a discount rate.

Real or nominal cashflows

Investment appraisals are generally conducted initially on the basis of real costs and revenues, calculated in terms of today's money value. Using nominal cash flows, allowing for future inflation,

Table 13. Measures of cost and benefit

		Key financial parameters		Other
Stage	**Description**	**Benefits**	**Costs**	**parameters***
1.	Opportunity identification		Cost of study	
2.	Appraisal		Appraisal cost	
3.	Investment planning		Financing cost	
4.	Asset creation		Capital cost	Scope Performance/quality Timing
5.	Operation	Revenue Non-revenue benefits	Operating cost Maintenance cost Renewals cost	
6.	Close-down	Resale/residual value	Decommissioning cost Cost of staff redundancies Disposal cost	

* These have potential impact on one or more financial parameters

could be confusing at this initial stage because it would produce absolute figures which, particularly in the later years, might be extremely large and hold little relevance in today's terms for such an appraisal. However, adjustments must be made to allow for any costs and benefits which will not escalate approximately in line with future inflation, and these adjustments may need to be based on assumptions about future inflation rates.

Where the project is going to be financially free standing, normally financial models will also be required at a later stage which are based on nominal figures allowing for an assumed rate of inflation in calculating future cash flows. Sensitivity testing using different assumed inflation rates will usually be necessary, in view of the uncertainty in this field. These financial models will also need to allow for any fixed rate funding and the effect of taxation on the economics of the project. Consolidation of accounting statements will also require nominal figures.

It may sometimes happen that a project that appears financially viable using real costs and revenues looks unprofitable once the full financial model is prepared, and *vice versa*. Even if (as we would recommend) the risk analysis is carried out using real costs and revenues, in order to retain a good 'feel' for all the estimates made in respect of future years, it would still be worth running a preliminary version of the full financial model at a fairly early stage, to prevent abortive work on a project which will not meet investors' financial requirements.

Choice of discount rate

The generally accepted discount rate appropriate to the analysis of UK public service investments is 3.5% per annum in real terms. Many commercial firms use discount rates higher than 3.5%, which serve to reduce the significance of future revenues, and maintenance and operating costs, over the whole life of the asset in comparison with initial construction costs. This handbook shows how to link RAMP with an investment model but it does not purport to discuss all aspects of the construction of that investment model or the discount rate to use. In particular the choice of an appropriate discount rate is an important but complex matter which is outside the scope of this handbook. Ultimately the choice of the discount rate will depend partly on issues such as the company's cost of funds and any hurdle rates that the company sets for its investments. Some companies may wish to use a higher/lower discount rate for projects which they regard as having a higher/lower inherent risk (i.e. a risk which is incapable of mitigation) than for their other projects. If this inherent risk varies significantly over different phases of the project, it may sometimes be appropriate to use different discount rates for each phase.

A high discount rate should not be seen as a substitute for a detailed risk analysis as this could lead to the rejection of profitable low risk projects in favour of more profitable projects that carry unacceptable levels of risk (see Section 1.5). Where the cash flows are based on nominal figures, a higher discount rate will be appropriate than where real cash flows are used.

Actuaries can advise on the choice of a suitable discount rate for the purpose in hand, taking account of the above-mentioned points and developments in modern financial theory in recent years.

Discounting

Discounting is at the heart of the NPV technique. The rationale for discounting is based on the fact that a sum of money now is worth more than at a future time. For example, if we have to forego having £100 in cash for (say) 12 months, then we would need to be paid a sum of interest to cover the loss in value of the money (due to inflation) and the opportunity missed to earn some return by investing the money for a year. Thus if we judge that our losses for waiting a year are 8%, then we are saying that £100 today is equivalent in value to £108 in a year's time.

Another way of saying the same thing is that £100 in a year's time is worth

$$£(100 / (100 + 8)) \times 100 = £92.59 \text{ now.}$$

Similarly, £100 in two years' time is now worth

$$£(100 / (100 + 8)) \times (100 / (100 + 8)) \times 100$$

$$\text{i.e. } £(100 / (100 + 8))^2 \times 100 = £85.73$$

If interest is expressed as a fraction (i.e. 8% = 0.08) then we can restate the above, expressing the net present value of £100 in one year as £(1 / 1.08) × 100 = £92.59. Extending the calculations, Table 14 can be used to calculate the NPV of a cash flow of £100 per year at the end of each of the next three years.

Thus we can express any future cash flow as a net present value by using the above formula and an appropriate interest (or 'discount') rate.

As another example, suppose the total capital cost of a project is £50 million, of which £20 million is spent at the end of year 1 and £30 million at the end of year 2. Then, at a discount rate of 10%, the NPV of the capital cost is: $£[(1/1.1) \times 20 + (1/1.1)^2 \times 30]$ million = £42.97 million.

Thus each key parameter affecting the value of an investment, whether it is an individual payment or a series of cash flows, can be expressed as an NPV. Finally, by adding the NPVs for benefits and deducting those for costs, an overall whole-life NPV for the investment can be calculated.

A deterministic or a stochastic approach

The traditional approach to projecting future cash flows, the deterministic approach, is to consider each item separately and estimate its most likely value. The next step is to conduct sensitivity tests which typically involve making a pessimistic and optimistic estimate in addition to the most likely. All of the results of the investment appraisal are then presented based on three scenarios; pessimistic, optimistic and the most likely.

The conclusion that can be drawn from such an analysis is necessarily limited. The answer may lie somewhere between the pessimistic and optimistic scenarios and is most likely to be the middle scenario. But how likely is most likely and is optimistic equally as likely as pessimistic? To answer these questions – and others such as, what is the probability of a rate of return less than *x*% or between *y*% and *z*% – a stochastic approach may be needed.

A stochastic approach involves fitting statistical distributions to cash flow items. Where there is only limited information about a particular risk, it may be possible to use a subjective estimate of the statistical distribution which is consistent with the information that *is* known and may be sufficiently accurate for practical purposes.

As a consequence of inputting data into the cash flow model in the form of statistical distributions, the result of the investment appraisal can also be presented as a statistical distribution (see example shown in Figs 14 and 15). Having a distribution of NPVs from such an appraisal clearly provides decision makers with the ability to make more informed decisions. It allows an assessment of probability of

Years	Future value: £	NPV formula	Value now: £
1	100	$(1/1.08) \times 100$	92.59
2	100	$(1/1.08)^2 \times 100$	85.73
3	100	$(1/1.08)^3 \times 100$	79.38
	NPV		**257.70**

Table 14. Net present value of a cash flow of £100 per year

Real project costs	£ million
Development costs	1.80
Land purchase	2.30
Design work	4.20
Building costs	32.50
Plant and machinery	22.50
Consultant's fees (technical, risk etc)	3.80
Pre-opening costs	4.60
Total costs (current prices)	**71.70**
Key dates	
Construction starts	July 2006
Operations start	October 2008
Major refurbishment	July 2015
Assumptions (margins over RPI)	**p.a.**
Revenue (£13 m. per annum initially)	-0.50%
Operating costs (£3 m. per annum initially)	0.50%
Capital costs — buildings	2.00%
— plant and machinery	1.00%

Figure 14. Typical investment model

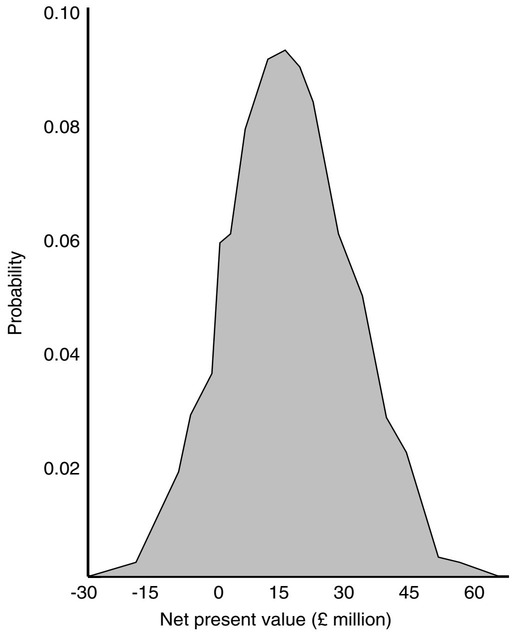

Figure 15. Net present value at 6% real discount rate

loss calculations and gives a better insight into the sensitivity of the project to adverse conditions.

This stochastic approach has to be used with discretion. Dependence should be allowed for; thus it would be inappropriate to ignore the fact that there is a linkage between short-term interest rates and inflation. The number of cash flow items expressed as a statistical distribution should also be limited in order to make the process more realistic and manageable.

The decision on whether to use a stochastic or a deterministic approach depends on the scope of the investment appraisal. Clearly, the level of sophistication required and the information that is likely to be available will determine the approach to be adopted. A stochastic approach is therefore only likely to be appropriate for medium to large projects.

Scenario analysis is a useful practical alternative to a full stochastic approach (see Section 9.2 and the section *Probability distributions* in Appendix I). It is likely to be worthwhile to carry out scenario analysis before embarking on a stochastic model, because the former is much less expensive and can often give a sufficient 'feel' of the risks for the purpose in hand. Moreover, scenario analysis helps to avoid the danger, inherent in stochastic modelling, of losing sight of the key assumptions on which the results depend.

Accuracy

Even a simple model has to be correct. The nature of cash flow models is that small mistakes can have significant consequences, particularly for marginal projects. It is essential that models are documented and independently audited, both for structure and accuracy of input. Equally important is the reasonableness of the cash flows. Clearly, they are only estimates but they should be checked by a third party where possible, and validated against past experience. Allowance must be made in the cash flows for all the 'knock on' effects arising from the project in respect of the sponsor's central costs or other activities.