A GUIDE TO ASSIGNMENT 2

CALCULATION - SOLUTIONS APPROACH

Chapter 2: Project evaluation

This unit discusses techniques that can be used to decide whether it is feasible to proceed with a given project or not. It is obviously very important to be able to decide whether or not the development of a software project will be cost-effective, as the high expense incurred by software development projects in general, has the potential to bankrupt an organisation if the costs outweigh the potential benefits. Study Chapter 2 of the textbook.

Chapter 2 objectives:

The aim of Chapter 2 of the textbook is to introduce the following concepts:

- strategic assessment;
- technical assessment;
- cost-benefit analysis;
- cash flow forecasting;
- cost-benefit evaluation techniques; and
- risk evaluation.

Chapter 2 outcomes:

After studying Chapter 2 of the textbook, you should be able to:

- carry out an evaluation and selection of projects against strategic, technical, economic and risk criteria;
- use a variety of cost-benefit evaluation techniques in order to choose among different project proposals; and
- evaluate the risk involved in a project and select appropriate strategies for minimising potential costs.

Cost-benefit evaluation techniques:

This is a very important section of Chapter 2, and you must study it in detail and ensure that you understand, and can apply, the different techniques as discussed on pages 26 to 34 of the textbook. Some of the techniques described may at first glance not be entirely clear. In this context, please take note of the following:

! Return on Investment (ROI) - Exercise 2.4

The formula for ROI on the next page is given on page 30 of the textbook as:

$$ROI = \frac{\text{Average Annual Profit}}{\text{Total Investment}} \times 100$$

Exercise 2.4 now asks that the ROI for Project 1 be calculated. Refer to Table 2.1 on page 29 for the cash flow projection figures of Project 1. Using these figures, we obtain a net profit of £ 50 000 over a period of 5 years. The average annual profit is thus:

$$50\,000 \div 5 = 10\,000$$

Substitution of average annual profit by £ 10 000 and total investment by £ 100 000 in the formula for ROI, yields:

$$\frac{10\,000}{100\,000} \times 100 = 10\%$$

- The *present value* (PV) and *net present value* (NPV) of a project are discussed on pages 30 to 31 of the textbook. The following variables are used in the formula for PV and NPV:
  t is the number of years into the future that the cash flow occurs and
  r is the discount rate, i.e. the annual rate by which future earnings are discounted.

Note that *r* is a rate and thus expressed as a **percentage %**. Wherever *r* is used in a formula, we should remember that it is used as a **rate** and should thus be interpreted as (*r* x (1 ÷ 100)) = (*r* ÷ 100). In order to compute the present value (PV) of a future cash flow, we need to multiply the cash flow by the discount factor, where the discount factor is calculated by the following formula:

$$\text{Discount factor} = \frac{1}{(1+r\%)^t} = \frac{1}{(1+\frac{r}{100})^t}$$

See page 31, table 2.2, for some discount factors. **The discount factors tables are usually provided in exam sittings.**

The present value of a future cash flow in year *t* is then calculated as:

$$PV = \text{cash flow in year } \boldsymbol{t} \times \text{discount factor}$$

The net present value for a project with ***t*** years worth of cash flows is merely the sum of the present values for each year, thus:

$$NPV = \sum PV,$$ where this sum is taken over *t*.

See exercise 2.5 on page 32 and exercise 2.6 on page 32 for relevant examples.

A fictitious scenario:

Consider the following fictitious scenario and some questions related to it. The table below gives the estimated cash flow for three different projects (in rands R):

Year	Project 1	Project 2	Project 3
0	- R 175 000	- R 150 000	- R 280 000
1	- R 10 000	+ R 5 000	+ R 10 000
2	+ R 20 000	+ R 25 000	+ R 30 000
3	+ R 50 000	+ R 35 000	+ R 50 000
4	+ R 50 000	+ R 80 000	+ R 120 000
5	+ R 65 000	+ R 95 000	+ R 120 000
6	+ R 60 000	- R 10 000	+ R 120 000

Table for fictitious scenario: *Estimated cash flow for three different projects*

Based on the above table, answer the following questions:

1 Calculate the *net profit* of each project.

2 Based on your answer to Question 1 above, which project would you select to develop?

3 Using the *shortest payback method* as discussed in Hughes and Cotterell, which project would you now select for development and why?

4 Calculate the *Return on Investment (ROI)* of each of these projects.

5 Based on your calculation of the ROI of each project in Question 4 above, which project would you select to develop?

6 Assume a *discount rate* of 12%. Calculate the *Net Present Value (NPV)* of each project.

7 Based on your calculation of each project's NPV, which project would you now select for development? In general, what conclusion do you reach regarding the viability of these projects? (Base your answer on the NPVs of each project.)

Answers:

1 The net profit is the difference between the total cost and the total income of a project over its lifetime. This net profit of each project is indicated in the last row of the table below:

Year	Project 1	Project 2	Project 3
0	- R 175 000	- R 150 000	- R 280 000
1	- R 10 000	+ R 5 000	+ R 10 000
2	+ R 20 000	+ R 25 000	+ R 30 000
3	+ R 50 000	+ R 35 000	+ R 50 000
4	+ R 50 000	+ R 80 000	+ R 120 000
5	+ R 65 000	+ R 95 000	+ R 120 000
6	+ R 60 000	- R 10 000	+ R 120 000
Net profit	**+ R 60 000**	**+ R 80 000**	**+ R 170 000**

Table for answer to question 1

2 Project 3 shows the largest net profit, R 170 000, followed by Project 2 and then Project 1 with R 80 000 and R 60 000 net profit respectively. We would therefore select Project 3 for implementation.

3 The payback period is the time taken to break even or pay back the initial investment (at year 0). All three projects paid back the initial investment at the end of year 5. However Project 1 earns R 0 during this year, whereas Project 2 earns R 90 000 and Project 3 earns R 50 000 profit during year 5.

The actual payback time can be calculated as follows:

Payback: project 1 = Breakeven yr - (Profit made in breakeven yr/ Income in breakeven yr)
= 5-(0/65000)
= **5 years**

Payback: project 2 = Breakeven yr - (Profit made in breakeven yr/ Income in breakeven yr)
= 5-(90000/95000)
= **4.05 years**

Payback: project 3 = Breakeven yr - (Profit made in breakeven yr/ Income in breakeven yr)
= 5-(50000/120000)
= **4.6 years**

This actual payback time, together with the profit earned in year 5 already, makes Project 2 the most desirable project to choose (as opposed to Project 3 in question 2).

4 ROI provides a way of comparing the net profitability to the investment required. The ROI of each project is given in the last row of the table below:

Year	Project 1	Project 2	Project 3
0	- R 175 000	- R 150 000	- R 280 000
1	- R 10 000	+ R 5 000	+ R 10 000
2	+ R 20 000	+ R 25 000	+ R 30 000
3	+ R 50 000	+ R 35 000	+ R 50 000
4	+ R 50 000	+ R 80 000	+ R 120 000
5	+ R 65 000	+ R 95 000	+ R 120 000
6	+ R 60 000	- R 10 000	+ R 120 000
Net profit	**+ R 60 000**	**+ R 80 000**	**+ R 170 000**
Average Profit	**+ R 10 000**	**+ R 13 333**	**+ R 28 333**
ROI	**5.71**	**8.89**	**10.12**

Table for answer to question 4

5 Project 3 has the highest ROI, 10.12, followed by Project 2 and then Project 1 with ROIs of 8.89 and 5.71 respectively. According to the ROI calculation, Project 3 therefore seems the most appropriate project to develop.

6 The *Net Present Value (NPV)* of each project is given in the table below:

Year	Discount factor at 12%	Project 1	Discounted cash flow	Project 2	Discounted cash flow	Project 3	Discounted cash flow
0	1.000	- R 175000	- R 175 000	- R 150 000	- R 150 000	- R 280 000	- R 280 000
1	0.8929	- R 10 000	- R 8 929	+ R 5 000	+ R 4464.50	+ R 10 000	+ R 8 929
2	0.7972	+ R 20 000	+R 15 944	+ R 25 000	+ R 19 930	+ R 30 000	+ R 23 916
3	0.7118	+ R 50 000	+ R 35 590	+ R 35 000	+ R 24 913	+ R 50 000	+ R 35 590
4	0.6355	+ R 50 000	+ R 31 775	+ R 80 000	+ R 50 840	+ R 120 000	+ R 76 260
5	0.5674	+ R 65 000	+ R 36 881	+ R 95 000	+ R 53 903	+ R 120 000	+ R 68 088
6	0.5066	+ R 60 000	+ R 30 396	- R 10 000	- R 5 066	+ R 120 000	+ R 60 792
Net profit		+ R 60 000		+ R 80 000		+ R 170 000	
NPV			**- R 33 343**		**- R 1 015.50**		**- R 6 425**

Table for answer to question 6

7 A project should be selected for implementation if its NPV is positive, and rejected if it yields a negative NPV. As all three projects have negative NPV, we will abandon all of them (however, if pressed to make a selection, Project 2 has the smallest negative NPV, followed by Project 3 and then Project 1 - this would correspond to our order of selection). However, note that Project 2 yields a negative return in year 6, whereas Project 3 still shows a positive return. This may very well indicate that Project 2 has reached the end of its viable economic lifetime.

EXERCISE: SELF ASSESSMENT

- Name and briefly discuss the four characteristics that Brooks pointed out that the projects of software products have in common that make them different from the products of general projects.
- Discuss in details (using diagrams where applicable) the techniques for visualizing progress of software projects.
- Write a brief essay on how to deal with risk in software project management.
- Briefly describe the function of each of the following:

  a) Product Breakdown Structure (PBS)
  b) Product Flow Diagram (PFD)
  c) Activity Network

- Write a brief essay on software project effort estimation laws.