Module 3

Spreadsheet modelling in management

Upon completion of this module students will be able to:

Outcomes

- **master** basic spreadsheet techniques;
- **generate** graphs, charts and tables electronically to display data;
- **apply** sensitivity analysis to cash flow problems;
- **evaluate** projects and capital budgets;
- **use** ANOVA analysis on data;
- **apply** spreadsheet tools such as Data Analysis and Goal Seek; and
- **use** simple macros in VBA

Unit 9

Introduction to spreadsheets

Upon completion of this unit students will be able to:

Outcomes

- **understand** menu bars, toolbars and dropdown menus;
- **enter**, **change** and **delete** data in a cell;
- **use** formulas, references and functions;
- **save** and **retrieve** files;
- **format** the appearance of a cell's contents;
- **change** the width of a column;
- **insert** rows ; and
- **move** data from one location to another.

What is a spreadsheet?

Activity 3.1

Activity

Make a spreadsheet

What will you do?

1. Open a new workbook. Enter this table in cells A1 to B7.

Year	Sales
1	112
2	243
3	265
4	310
5	400
6	450

2. Save the workbook as **Annual Sales Figures**. Change all sales entries by adding 100 to each number. Save the workbook and close.

3. Open the workbook again. Enter the words "Total Sales" in Cell A9.

4. Create a new workbook. Enter this table in cells A1 to B5.

1	3
2	5
3	7
4	9
5	11

5. Copy the table to cells E8 to F12. Save the workbook as **Linear Function**.

Solution

This is a straightforward exercise.

Formulas and functions

Activity 3.4

Activity

Do more calculations

Create a new file in Excel and enter the data from the Module 2 section "Charts, graphs and histograms". The table gives the sales figures for the number of pairs of sunglasses sold in a shop in an island resort.

Month and sales figure	Month and sales figures
January: 8	July: 32
February: 6	August: 44
March: 9	September: 36
April: 15	October: 21
May: 18	November: 12
June: 26	December: 10

Choose suitable headings and right-align them. Calculate these in the workbook:

1. Average monthly sales figure.

2. Minimum sales figure.

3. Median and mode for sales.

4. Skewness of the distribution of sales.

5. Variance in sales over the year.

Solutions

Applications: Project evaluation

Activity 3.6

Activity

Determine profitability and analyse sensitivity

What will you do?

Refer to Activity 1.8 in Module 1.

A company in Papua New Guinea has 30,000 PGK (kina or K) to invest in either Project A or Project B. Each project runs over three years. The expected cash inflows at the end of each year are displayed in this table.

Project A	Project B
Year 1: K 10,000	Year 1: K 14,000
Year 2: K 12,000	Year 2: K 12,000
Year 3: K 14,000	Year 3: K 10,000

The required rate of return (discount rate) is 8 per cent p.a.

1. Set up a spread sheet to determine which project is most profitable at this point. Use *NPV* (net present value) as the criterion.

2. Perform a sensitivity ("what if?") analysis to take into account a change in discount rate of 2 per cent, either upwards or downwards.

Solutions

Microsoft Excel - mod3-un9-3assex3-5.xls

File   Edit   View   Insert   Format   Tools   Data   Window   Help

B11   =NPV(B9,B5:B7)+B4

	A	B	C
1	THE NPV OF INVESTMENT PROJECTS		
2			
3	YEAR	CASH FLOW PROJECT A	CASH FLOW PROJECT B
4	0	-30000	-30000
5	1	10000	14000
6	2	12000	12000
7	3	14000	10000
8			
9	DISCOUNT RATE	8%	
10			
11	NPV	660.976	1189.351
12			
13		10%	
14		-473.328	157.776
15		6%	
16		1868.590	2283.697
17			

Unit 10

Tables, charts and graphs in Excel

Upon completion of this unit the student will be able to:

Outcomes

- **set up** tables of data in spreadsheets;
- **generate** frequency tables and histograms;
- **present** data and equations with charts and graphs; and
- **analyse** data with the Descriptive Statistics analysis tool.

Tables and column charts

Activity 3.10

Activity

Get the graphs right

What will you do?

1. The budget for a small farm consists of expenses and income. Total expenses $TE = 10,000 + 235N$, where N is the number of units of land planted. Total income $I = 1,400N$.

   Determine the approximate budget-balancing (break-even) point with Excel's Chart Wizard. (All numbers are in Ghanaian naira.)

2. The supply and demand for a particular product is described by these functions:
   $P_S = 2Q_S^2 - 6Q_S + 2$ and $P_D = Q_D^2 + 2Q_D + 6$

   (P_S is the price per item the producer will accept and P_D is the price the buyer is willing to pay. Q_S is the number of products supplied and Q_D is the number of products demanded.)

   Use Excel to find the equilibrium point graphically.

Solutions

1.

N	TE	I
2	10470	2800
4	10940	5600
6	11410	8400
8	11880	11200
10	12350	14000
12	12820	16800

Enter data. Highlight range A2:C7 and use Chart Wizard (XY Scatter).
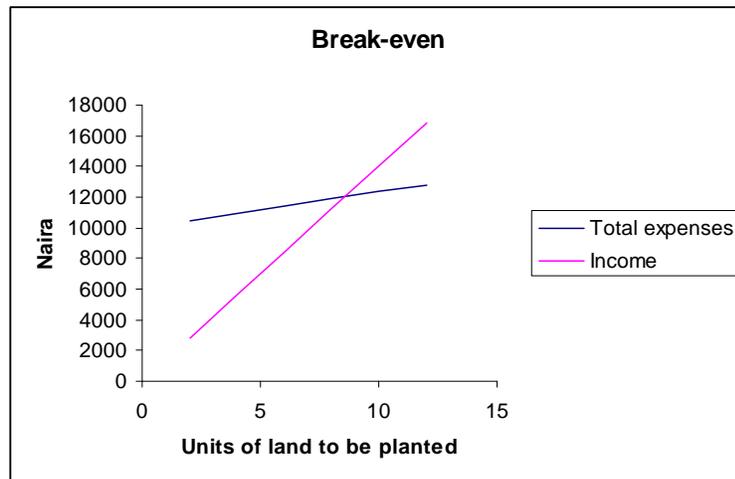
Break-even

The break-even point can be determined analytically as $N = 8.58$ units of land that need to be planted for costs to equal income.

2. The graphs show portions of the two parabolas.

Break-even price

Analytically, the supply price equals demand price where $Q = 8.45$. The quantity should be rounded off, say to 9 units from the supplier's point of view.

Activity 3.11

Activity

Analyse data

What will you do?

1. Do a Descriptive Statistics data analysis for revenue for the year 1996 in the data for Figure 15.

2. Interpret and discuss each of the values in the Descriptive Statistics box.

Solutions

1.

	A	B
16		
17	1996	
18		
19	Mean	147.3333
20	Standard Error	5.936958
21	Median	141
22	Mode	#N/A
23	Standard Deviation	20.56623
24	Sample Variance	422.9697
25	Kurtosis	-0.49284
26	Skewness	0.66683
27	Range	64
28	Minimum	120
29	Maximum	184
30	Sum	1768
31	Count	12

2. The mean monthly company revenue for 1996 was 147.33 (units may be in thousands or millions). Standard error refers to the error if we were doing linear regression on the data.

The median of 141 means half of the months (that is, 6) had revenue of less than 141, and six months had revenue above 141. There is no mode. The standard deviation shows a deviation around the mean of 20.566 units for the data when seen as a sample.

The positive skewness means that more than half the values lie to the left of the mean. The negative kurtosis means that tails of the distribution are thinner than for a normal distribution. The probability of extreme values is therefore smaller than for the normal distribution.

Unit 11

ANOVA and Goal Seek

Upon completion of this unit students will be able to:

- **interpret** ANOVA statistics; and
- **find** implicit solutions of equations using Goal Seek.

Outcomes

Comparing data sets with ANOVA

ANOVA stands for **An**alysis **Of Va**riance.

Activity 3.14

Activity

Analyse and interpret

What will you do?

The body mass of groups of people from four different countries is measured in kilograms.

Which group has the largest average mass? Can you make a statistically significant judgement?

Use ANOVA analysis and interpret the output.

Group A	Group B	Group C	Group D
67	62	72	58
72	94	65	62
55	110	96	53
58	81	98	57
71	90	118	66

Solutions

Anova: Single factor

SUMMARY

Groups	Count	Sum	Average	Variance
Group A	5	323	64.6	59.3
Group B	5	437	87.4	311.8
Group C	5	449	89.8	458.2
Group D	5	296	59.2	24.7

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between groups	3651.75	3	1217.25	5.701405	0.007502	3.238872
Within groups	3416	16	213.5			
Total	7067.75	19				

Group C seems to have people with the largest mass and variance in mass.

Consult the F ratio (*F*) and F critical value (*F crit*).

If F > F crit, then there is a statistically significant difference**.**

If *F < F crit,* then the score differences are best seen as chance differences or due to natural variation.

In this case, *F* = 5.7014 and *F crit* = 3.23887. Since clearly *F > F crit,* the differences in mass are statistically significant. We can say with certainty (95%) that the masses of these groups show Group C to have individuals with the largest mass.

Goal Seek

Activity 3.15

Activity

Use Goal Seek

What will you do?

1. The relation between quantities *P* and *Q* is given by:
   $P^2 = 2Q^3 + Q^2 - 15.46$
   Use Goal Seek to determine the value of *Q* when *P* = 13.5.

2. The future value of an ordinary annuity is 24,000 kina.
   There are annual payments of 1,500 kina every year for 10 years.
   What was the annual rate of return over the period?
   (See Module 1, Unit 1, "Annuities" and use Goal Seek.)

3. Find the monthly interest rate R if the PV of four cash inflows C_1, C_2, C_3 and C_4 at the end of each of 4 months is given as: $PV = 600, C_1 = 150, C_2 = 200, C_3 = 250, C_4 = 280$

Solutions

1.

	B1		▾	f_x =SQRT(2*B2^3 + B2^2 - 15.46)			
	A	B	C	D	E	F	
1	P	13.5					
2	Q	4.463003					
3							
4							
5							

Goal Seek Status

Goal Seeking with Cell B1 found a solution.

Target value: 13.5
Current value: 13.50000233

[OK] [Cancel] [Step] [Pause]

The value of Q is 4.463.

2. $FV = R\dfrac{(1+i)^n - 1}{i}$ with $R = 1,500, n = 10, FV = 24,000$

Value for i is $0.1008 = 10.08\%$

3. $PV = \dfrac{C_1}{(1+r)} + \dfrac{C_2}{(1+r)^2} + \dfrac{C_3}{(1+r)^3} + \dfrac{C_4}{(1+r)^4}$

C1	150
C2	200
C3	250
C4	280
PV	600.0003
Rate	0.154539

$R = 15.45\%$.

Unit 12

Other spreadsheet facilities for model building

The section on VBA can be considered optional. However, VBA is used extensively in the management and financial environment.

Upon completion of this unit students will be able to:

Outcomes

- **apply** a range of Excel functions in building management and business models;
- **implement** simple VBA; and
- **understand** the use of macros.

More Excel functions

Activity 3.17

Activity

Practise these functions

What will you do?

Figure 24 shows an extract from a data set of daily share price returns (%) for five shares over the first 132 trading days in 2008. The total data set is in a spreadsheet.

Daily return (%)

Trading day no.	Share A	Share B	Share C	Share D	Share E
123	2.0	3.55	−4.5	3.4	1.48
124	−1.2	2.1	0.0	1.2	0.0
125	0.0	−2.4	−0.8	1.05	0.0
126	1.4	−3.0	0.6	0.0	−2.8
127	3.6	1.0	1.0	1.18	−1.73

Figure 3 Extract from data set

All share price returns are normally distributed.

Copy the extract into a spread sheet in the range A1:F6.

1. It has been estimated that for 2008 the average daily return for Share B is 1.75 per cent and the daily volatility is 2.52 per cent.

    What is the probability that the daily return for Share B will be less than −1 per cent? (Use NORMDIST. Also solve this manually using the Appendix at the end of Module 2.)

2. You want to know if the daily return for Share D was higher than 1% on day 124. If that was the case, let "GOOD" appear in cell G3; otherwise let "BAD" appear. (Use the "IF" function).

3. Find the return for Share C for day 126 using the VLOOKUP function.

4. Generate random percentage returns for 20 days for Share B. (You must use the normal distribution from the RNG function.)

Solutions

1. From the Appendix:

    $$P(R_B < -0.01) = P(\frac{R_B - 0.0175}{0.0252} < \frac{-0.01 - 0.0175}{0.0252})$$

    $$= P(Z_B < -1.091)$$

    $$= 0.5 - 0.36214$$

    $$= 1.3786$$

    Using NORMDIST:
    Enter =NORMDIST(-0.01,0.0175,0.0252,TRUE)

    Answer = 0.1375

2. Enter =IF(E17>0.01,"GOOD","BAD") in any cell. In this case, we had the value of D for Day 124 in cell E17.

    The value "GOOD" will appear.

3. =VLOOKUP(126,A15:F20,5,FALSE). The value 0 is returned.

4. Returns will vary.

**Case study:
Group research project**

This case study involves accountability ratings for companies. Accountability is defined as "a company's ability to explain and justify its actions, and to take responsibility for the consequences of those actions" (Accountability Rating™).

Accountability Rating™ evaluates companies in four key areas (see www.accountabilityrating.com):

1. Strategic intent: Does the company seek to address important social, environmental and broader economic issues in its core business strategy?

2. Governance and management: Are senior executives and the board accountable to stakeholders when setting strategy and formulating policy on extra-financial issues?

3. Engagement: Does the company engage in dialogue with the people and groups who have an interest in its business, may be affected by it or have an effect on it? Does the company publicly report its social and environmental performance?

4. Operational performance: How effective has the company been in implementing its management systems and engagement mechanisms?

The four areas are equally weighted and companies are scored. Accountability Rating™ publishes the scores for the world's largest 100 companies in *Fortune* magazine every year. It also ranks countries and regions.

A study was done in South Africa using Accountability Rating™ measures (*"Correlates of corporate accountability among South Africa's largest listed companies by Eccles, Pillay & de Jongh, *Southern African Business Review*, 2009). The authors reported statistically significant relationships between accountability and company size and industry sector. On this basis, they suggest that a company's size and its industry sector motivate socially responsible corporate behaviour.

Group assignment: Your group should do at least one of these:

1. Register on www.accountabilityrating.com and study the methodology of the rating model.

   Study the findings. Write a paper discussing and/or critiquing the methodology and findings.

2. Read the paper "Correlates of corporate accountability among South Africa's largest listed companies". You can access the paper from the journal's website: http://www.unisa.ac.za/sabusinessreview.

   Do a data analysis on the authors' data to see whether you agree with their findings. Write a report.

This is a more challenging and long-term project and can be tackled at the end of Module 5: set up a questionnaire along the lines of Accountability Rating™ and send it to companies in your own country. Collect and organise the data and perform a data analysis like the one undertaken by the *Southern African Business Review*. Write a short paper discussing your results and see whether you can have it published in a local journal or magazine.

Solutions

It is the Lecturer's decision whether the student's work is evaluated.

Assessment

1.

   a) Do a Descriptive Statistics Analysis for the data in Figure 34.
      Discuss all results.

Year	Pension fund return %
2000	10.00
2001	11.50
2002	13.80
2003	14.43
2004	10.50
2005	15.00
2006	12.28
2007	17.45
2008	−1.06
2009	−2.00

Figure 4

   b) Present the data in a column chart and record a macro in VBA as
      you draw the chart.

2. You need a frequency distribution for the table of data. It describes
   the consumption of electricity (in kilowatt hours) of 40 households
   over the period of a month. Present the outcome as a histogram.

122	88	145	150	79
143	145	134	157	145
210	163	234	85	156
88	110	162	99	154
122	156	210	245	160
145	184	215	141	183
163	215	163	107	145
143	163	145	200	156

Figure 5

3.

    a) Find the value of the internal rate of return IRR from the relation:

$$\frac{C_1}{(1+IRR)} + \frac{C_2}{(1+IRR)^2} + \frac{C_3}{(1+IRR)^3} + \ldots + \frac{C_n}{(1+IRR)^n} = C_0$$

    The annual cash flows are:

$C_0 = 12,000$, $C_1 = 5,000$, $C_2 = 6,000$, $C_3 = 6,500$, $C_4 = 5,000$, $C_5 = 6,000$

    b) Use both Goal Seek and the IRR function to find and compare answers.

    c) Investigate the changes in IRR as you vary the initial investment C_0.

4. The "intelligence quotients" (IQ) of three groups of students are tested. Groups A, B and C correspond to highest-income families to lowest-income families. The researchers claim that students in Group A are the most intelligent because their average IQ is above 120 (namely 123.75). They also claim the students in Group C will not finish college because their average IQ is below 120, and the lowest at 117.88.

    a) On a purely statistical basis, analyse the results (using ANOVA) and report your findings.

    b) Critique the study on grounds such as sample size, ethics and the validity of using a measure such as IQ.

    The data collected by the researchers is displayed in Figure 36:

Group A	Group B	Group C
135	120	120
130	125	118
100	110	125
140	130	128
100	90	125
95	140	120
145	100	130
105	118	120

Figure 6

5. Write a VBA program for the data in Question 4 that enables a user to find out how many students had IQ scores above a certain value in each group.

6. Figure 37 gives an extract from a data set of daily share price returns (%) for four shares during 2007.

Daily return (%)

Trading day no.	Share 1	Share 2	Share 3	Share 4
101	1.0	1.5	−4.5	2.4
102	−1.2	2.1	0.1	−1.2
103	0.5	−1.4	1.8	1.05
104	2.4	−0.4	0.6	0.0
105	1.6	−1.0	1.2	−1.18
106	0.4	0.2	1.0	−2.2

Figure 7

All share price returns are normally distributed.

Copy the extract into a spread sheet in the range A1:E7.

a)   It has been estimated that, for 2007, the average daily return for Share 1 is 2.1 per cent and the daily volatility is 3.52 per cent. What is the probability that the daily return for Share 1 will be more than 2.5 per cent? (Use NORMDIST. Also solve this by hand, using the table at the end of Module 2).

b)   You want to know if the daily return for Share 2 was higher than 2 per cent on day 102. If that was the case, let "HIGH" appear in cell F3; otherwise let "LOW" appear.

c)   Find the return for Share 3 for day 105 using the VLOOKUP function.

d)   Generate random percentage returns for 20 days for Share 4. (Use the normal distribution from RNG as random number generator.)

Solutions

1. a) and b)

Return	
Mean	10.19
Standard error	2.076933
Median	11.89
Mode	#N/A
Standard Deviation	6.567837
Sample variance	43.13649
Kurtosis	0.578499
Skewness	-1.27784
Range	19.45
Minimum	-2
Maximum	17.45
Sum	101.9
Count	10

The mean return is 10.19% and the standard deviation (volatility) is 6.57%. The median is 11.89%.

The negative skewness means that more than half the values lie to the right of the mean. The positive kurtosis means that tails of the distribution are fatter than for a normal distribution. The probability of extreme values is therefore bigger than for the normal distribution.

2. Enter data in range A1:E8. This is the data array. Then obtain

MIN	79
MAX	245

Select intervals: 0-80, 81-160, 161-240, 241-320

Enter endpoints in cells, say A14:A17. This is the bin array.

Highlight cells B14:B17 and do =FREQUENCY(data array, bin array). The result is:

80	1
160	25
240	13
320	1

Or do Data Analysis, Histogram to obtain frequency and histogram.

Lecturers to review graph for correctness.

3. a) IRR = 37.17% (both Goal Seek and function IRR). If an answer in Excel is not in the right format in terms of number of decimal places or notation, right-click on the cell containing the number and click <Format Cells>. Make the necessary changes.

    b) and c) The bigger initial investment C_0, the smaller the IRR for the same cash inflows in years 1 to 5.

4. a) Use ANOVA.

Anova: Single factor

SUMMARY

Groups	Count	Sum	Average	Variance
Group A	8	990	123.75	319.6429
Group B	8	958	119.75	136.2143
Group C	8	943	117.875	27.55357

ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Between groups	144.0833	2	72.04167	0.447084	0.645437	3.4668
Within groups	3383.875	21	161.1369			
Total	3527.958	23				

Group C has the smallest IQ average, but the results are not statistically significant. It is clear that the variation within groups is larger than the variation between groups. $F < F_{crit}$ shows that the score differences are best seen as chance differences.

b) The sample size is so small as to have almost no value. Opinions about the value of a measure such as IQ differ. In any case, it is not ethical to use a quantitative measure indiscriminately to make judgements about the future contributions and values of humans.

5. Use the example for the macro Sub CountHighSales() in the Course Manual.

```
Sub CountHighIQ()

    Dim i As Integer

    Dim j As Integer

    Dim numberHigh As Integer

    Dim scoreCutoff As Integer

  scoreCutoff = InputBox("What score value do you want to check for?")

    For j = 1 To 3

        numberHigh = 0

        For i = 1 To 8

            If Range("A2:C9").Cells(i, j) >= scoreCutoff Then _
```

numberHigh = numberHigh + 1

Next i

MsgBox "For Group" & j & ", scores were above" & _

Format(scoreCutoff, "0 000") _

& "on" & numberHigh & "of the eight students."

Next j

End Sub

6. a) Enter =NORMDIST(0.025,0.021,0.0352,TRUE)

    Value returned: 0.545237

    Therefore $P(S_1 > 0.025) = 54.52\%$

    b) Enter =IF(C3>0.02,"HIGH","LOW") in cell F3. The value
        "HIGH" will appear.

    c) Click on a cell and enter =VLOOKUP(105,A2:E7,4,FALSE).
        The value 1.2 is returned.

The worksheet can look like this:

Trading day no.	Share 1	Share 2	Share 3	Share 4		
101	1	1.5	−4.5	2.4		
102	−1.2	2.1	0.1	−1.2	HIGH	
103	0.5	−1.4	1.8	1.05		1.2
104	2.4	−0.4	0.6	0		
105	1.6	−1.0	1.2	−1.18		
106	0.4	0.2	1	−2.2		

0.545237

    d) All answers will, of course, be different.