

Engineering Fundamentals

ENG1101

Decision Matrix Spreadsheet Tutorial

Session Objectives

- Introduce spreadsheets
- Introduce decision matrixes
- Use relative and absolute addressing
- Create a generic decision matrix

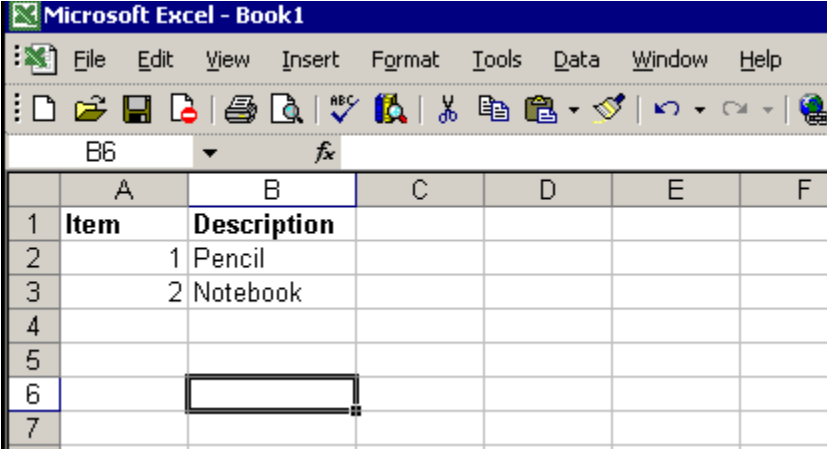
A spreadsheet is a problem solving tool that...

- Stores and processes data.
- Graphically displays data.
- Performs statistical analyses.
- Fits equations to data.
- Solves equations.
- Optimizes solutions through iterative solving.

Spreadsheet Fundamentals

- Developed for accountants for financial use
- Each piece of data is located in a "cell"
- A cell is designated by the column (letter) and row (number)

Example: The word "Item" is in cell A1, which is in column A and row 1.



The screenshot shows a Microsoft Excel window titled "Microsoft Excel - Book1". The menu bar includes File, Edit, View, Insert, Format, Tools, Data, Window, and Help. The toolbar contains various icons for file operations and editing. The active cell is B6. The spreadsheet data is as follows:

	A	B	C	D	E	F
1	Item	Description				
2		1 Pencil				
3		2 Notebook				
4						
5						
6						
7						

What is a Decision Matrix?

- A decision matrix...
 - Lists your **alternatives** (choices or candidates) and your **criteria** (desired outcomes or values).
 - Is a method to numerically evaluate which alternative best fits your criteria.
- The decision matrix does not make a decision for you, it only helps to organize your thoughts.
- See example in Eide, pg. 112, Figure 2.19.

Decision Matrix

Measure of importance of criterion (property)

Criteria	Candidates			
	Weighting Factor (%)	Alternative 1 Rating Score	Alternative 2 Rating Score	Alternative 3 Rating Score
Property 1				
Property 2				
Property 3				
...				
Property n				
Total	100	Total 1	Total 2	Total 3

Rating is how well alternative meets that criterion (property)

Score = Weighting Factor * Rating

Buying a New Car

- Let's say you are buying a new car and are considering three different cars (alternatives).
- You also identified the properties that are most important to you in buying a new car (criteria).

Criteria	Weighting Factor (%)	Candidates		
		Neon Rating Score	VW Jetta Rating Score	Porsche 911 Rating Score
High Performance				
Style/Appearance				
Gas Mileage				
Safety				
High Reliability				
Low Price				
Total	100			

Buyer 1- On a budget

- If you are on a budget, then “Low Price” is your most important criterion and therefore has the highest weighting factor (30%).
- Notice that the weighting factors must add up to 100%. **Measure of importance of criterion**

Criteria	Weighting Factor (%)	Candidates		
		Neon Rating Score	VW Jetta Rating Score	Porsche 911 Rating Score
High Performance	5			
Style/Appearance	10			
Gas Mileage	20			
Safety	15			
High Reliability	20			
Low Price	30			
Total	100			

Rating Alternatives

- Alternatives must be rated on how well they meet each criterion.
- Rating Scale
 - Excellent 9-10
 - Good 7-8
 - Fair 5-6
 - Poor 3-4
 - Unsatisfactory 0-2
- See Eide, pg. 112

Buyer 1- On a budget

- The Neon car is very affordable, therefore it meets the criteria of “Low Price” very well, receiving a rating of 10.

Criteria	Weighting Factor (%)	Candidates		
		Neon Rating Score	VW Jetta Rating Score	Porsche 911 Rating Score
High Performance	5	2	5	10
Style/Appearance	10	3	6	9
Gas Mileage	20	10	6	4
Safety	15	4	8	4
High Reliability	20	6	8	3
Low Price	30	10	6	1
Total	100			

Buyer 1- On a budget

- The total score for the Neon is the highest, making it the best choice for you.

Score = Weighting Factor * Rating

Criteria	Weighting Factor (%)	Candidates					
		Neon		VW Jetta		Porsche 911	
		Rating	Score	Rating	Score	Rating	Score
High Performance	5	2	10	5	25	10	50
Style/Appearance	10	3	30	6	60	9	90
Gas Mileage	20	10	200	6	120	4	80
Safety	15	4	60	8	120	4	60
High Reliability	20	6	120	8	160	3	60
Low Price	30	10	300	6	180	1	30
Total	100		720		665		370

Buyer 2- Unlimited budget

- If you are now a buyer with unlimited funds then your values change and so do the weighting factors.
- Now “High Performance” and “Style/Appearance” are the most important.

Criteria	Weighting Factor (%)	Candidates		
		Neon Rating Score	VW Jetta Rating Score	Porsche 911 Rating Score
High Performance	30			
Style/Appearance	30			
Gas Mileage	5			
Safety	20			
High Reliability	10			
Low Price	5			
Total	100			

Buyer 2- Unlimited budget

- Notice that the rating for each alternative doesn't change, because each candidate still meets the criteria the same.
- When your values change, only the weighting factor should be affected.

Criteria	Weighting Factor (%)	Candidates		
		Neon Rating Score	VW Jetta Rating Score	Porsche 911 Rating Score
High Performance	30	2	5	10
Style/Appearance	30	3	6	9
Gas Mileage	5	10	6	4
Safety	20	4	8	4
High Reliability	10	6	8	3
Low Price	5	10	6	1
Total	100			

Buyer 2- Unlimited budget

- Now the total score for the Porsche is the highest, making it the best choice for you.

Criteria	Weighting Factor (%)	Candidates					
		Neon		VW Jetta		Porsche 911	
		Rating	Score	Rating	Score	Rating	Score
High Performance	30	2	60	5	150	10	300
Style/Appearance	30	3	90	6	180	9	270
Gas Mileage	5	10	50	6	30	4	20
Safety	20	4	80	8	160	4	80
High Reliability	10	6	60	8	80	3	30
Low Price	5	10	50	6	30	1	5
Total	100		390		630		705

Let's Try It...

- Open Excel and open a new spreadsheet
 - Go to *File* □ *New* □ *Spreadsheet*
- Create a blank Decision Matrix
 - Enter the text below in cells

These are merged cells

Criteria	Weighting Factor (%)	Alternative 1		Alternative 2		Alternative 3				
		Rating	Score	Rating	Score	Rating	Score			
Property 1										
Property 2										
Property 3										
Property 4										
Property 5										
Total										

Text Formatting Hints



- To merge cells:
 - Highlight the cells to be merged
 - Click on square with “A” in it.
- *To unmerge cells:*
 - *Select the cell to be unmerged*
 - *Go to Format ⇒ Cells ⇒ Deselect “Merge Cells”*
- *To word-wrap text in a cell:*
 - *Select the cell/cells to format*
 - *Go to Format ⇒ Cells...*
 - *Click on the Alignment tab and select Wrap Text*

Spreadsheet Calculation Basics

- Calculations or equations are done in their own cell.
- Each equation begins with an "=".
- Equations can use relative and absolute addressing.
- Equations may contain functions. For example:
 - =sum(L#:L#) Adds a group of numbers
 - =average(L#:L#) Computes the average

Relative Addressing

- Cells can be added (+), subtracted (-), multiplied (*), and divided (/) simply by typing their cell reference.
- For example, if you would like to add the contents of cells B2 and C2, you would type in a new cell:

=B2+C2

- If this formula is ***copied***, the cell locations will automatically be **incremented as shown below.**

=B2+C2 ⇒ =B3+C3

	A	B	C	D
1				<i>Internal Equation</i>
2		3	2	=B2+C2
3		6	8	=B3+C3
4		9	16	=B4+C4
5	Sum	18	26	=sum(D2:D4)

	A	B	C	D
1				
2		3	2	5
3		6	8	14
4		9	16	25
5	Sum	18	26	44

Copying Hints

- Being able to copy repetitive formulas in a spreadsheet will save you a lot of time.
- There are several methods for doing this.
- Method One – Copy/Paste
 - Select the cell/cells containing the formula to be copied
 - Do NOT highlight the formula within the cell
 - Go to *Edit* ⇒ *Copy*
 - Highlight the cells you would like to place the copy in
 - Go to *Edit* ⇒ *Paste*

Copying Hints – Continued

- Method Two – Quick Fill
 - Select the cell containing the formula to copy
 - Do NOT highlight the formula within the cell
 - Move the cursor to the lower right-hand corner of the cell
 - The cursor should change to a plus sign
 - Click and hold the left mouse button and drag the cursor over the cells you'd like to place the copy in.
- Method two can only be used with cells that are adjacent to the cell you are copying from.

Checking Formulas

- Whenever you copy and paste formulas you will need to check to make sure they copied correctly.
- One way to do this:
 - Double-click on the cell you would like to check
 - This color-codes the formula and cells it references, making it easier to check the formula
 - It also puts the cell in edit mode, so be careful what you type or click on
 - To get out of the cell **WITHOUT** making changes, hit ESC
 - To get out of the cell keeping the changes you made, hit Enter

Let's Try It...

- Enter in the given numbers for Weighting Factor.
- Enter in the given numbers for Rating.
- Enter the formula for the **first** Alternative 1 score.
 - =Weighting Factor * Rating
- Copy the formula into the four cells below it using the Quick Fill method – check the formulas and notice how they incremented.

Criteria	Weighting Factor (%)	Alternative 1 Rating	Alternative 1 Score	Alternative 2 Rating	Alternative 2 Score	Alternative 3 Rating	Alternative 3 Score
Property 1	20	3	60	2	2	2	2
Property 2	10	7	70	1	5	5	5
Property 3	40	4	160	8	3	3	3
Property 4	5	6	6	3	8	8	8
Property 5	25	5	125	4	9	9	9
Total							

Let's Try It...

- Copy formulas from the Alternative 1 column into the Alternative 2 column.
- *Use the Copy/Paste method*
- Check the formulas. Did they copy correctly?
 - No! They shouldn't have...

Criteria	Weighting Factor (%)	Alternative 1 Rating	Alternative 1 Score	Alternative 2 Rating	Alternative 2 Score	Alternative 3 Rating	Alternative 3 Score
Property 1	20	3	60	2	120	2	
Property 2	10	7	70	1	70	5	
Property 3	40	4	160	8	1280	3	
Property 4	5	6	30	3	90	8	
Property 5	25	5	125	4	500	9	
Total							

These answers are not correct



Why didn't the formulas copy correctly?

- Spreadsheets help you copy formulas by automatically incrementing the cell references

A1 \Rightarrow B1 \Rightarrow C1

- Your last copied formulas did not copy correctly because of this incrementing
- How do you tell Excel NOT to increment the address?
 - Absolute Addressing
 - Only relevant when COPYING a formula

Absolute Addressing

- \$ designates absolute addressing
 - **Type \$ in the formula or use shift F4 as a shortcut.**
 - **For example: =B2+\$C\$2**
- If the first formula below is copied, B2 will increment and \$C\$2 will NOT increment.

Absolute Addressing

	A	B	C	D
1				<i>Internal equation</i>
2		3	2	=B2+\$C\$2
3		6	8	=B3+\$C\$2
4		9	16	=B4+\$C\$2
5	Sum:	18	18	=SUM(\$B\$2:\$B\$4)

Absolute Addressing

	A	B	C	D
1				
2		3	2	5
3		6	8	8
4		9	16	11
5	Sum:	18	18	18

Let's Try It...

- Update the formulas for the first Alternative 1 score to use Absolute addressing for the Weighting Factor.

$$= \$B3*C3$$

Only the column (B) is absolute, not the row (3)

- Copy this formula into the 4 cells below it and then to Alternatives 2 & 3.

Criteria	Weighting Factor (%)	Alternative 1 Rating	Alternative 1 Score	Alternative 2 Rating	Alternative 2 Score	Alternative 3 Rating	Alternative 3 Score
Property 1	20	3	60	2	40	2	40
Property 2	10	7	70	1	10	5	50
Property 3	40	4	160	8	320	3	120
Property 4	5	6	30	3	15	8	40
Property 5	25	5	125	4	100	9	225
Total							

Let's Try It...

- Sum the weighting factors and each of the scores using the sum function

=sum(L#:L#)

- ***Hint: in the cell type “=sum(” then highlight the cells to be added and hit return***

Criteria	Weighting Factor (%)	Alternative 1 Rating Score	Alternative 2 Rating Score	Alternative 3 Rating Score			
Property 1	20	3	60	2	40		
Property 2	10	7	70	1	10	5	50
Property 3	40	4	160	8	320	3	120
Property 4	5	6	30	3	15	8	40
Property 5	25	5	125	4	100	9	225
Total	100		445		485		475

Completing Your Homework

- To finish your decision matrix for your homework, you simply need to...
 - Fill in the engineering majors you chose for alternatives
 - Fill in the five criteria you feel are most important
 - Update the weighting factors and ratings for each to reflect your values and research
- Printing your homework. Two copies...
 - One showing the numbers (default setting)
 - One showing the formulas

Printing out Equations/Formulas

In Excel

- To show formulas:
 - Go to *Tools* ⇒ *Formula Auditing* ⇒ *Formula Auditing Mode*
 - Formulas will show up on sheet
 - Check *Formulas* and *Column & Row Headers*
 - If equations do not fit in the cells:
 - Increase column width
 - Reverse procedure to turn the formulas off
- To print only a portion of the screen:
 - Highlight portion to print
 - *Go to File* ⇒ *Print Area* ⇒ *Set Print Area*

Hopefully by this point you...

- Are familiar with spreadsheet basics, including formatting text, entering formulas, and using functions.
- Understand how to use relative and absolute addressing.
- Have a generic decision matrix, with the correct formulas entered.

Also, don't forget to SAVE your work!