

Multi-Attribute Utility Analysis Spreadsheet Guide To Use

The spreadsheet file MAUA_WKS.WK1 is provided to simplify computing multi-attribute utilities of alternative combinations of three attributes, using data collected during the utility interview portion of this case study. The spreadsheet is composed of four parts; the single attribute k-value and number of data points area, the attribute value input area, the utility value input area, and the utility calculation area. A printout of the entire spreadsheet input area is presented in Figure 1.

Attribute		1	2	3	K
		Cost	Weight	MTBF	
Scaling ks		0.20	0.40	0.50	-0.2709
# Points		6	2	2	
		Cost	Weight	MTBF	
Point	1	0.50	0.30	0.80	1
Point	2	0.75	2.00	1.50	2
Point	3	1.00			3
Point	4	2.00			4
Point	5	3.00			5
Point	6	4.00			6
Point	7				7
Point	8				8
Attribute		Cost	Weight	MTBF	
		Utility	Utility	Utility	
Point	1	1.000	1.000	0.000	1
Point	2	0.800	0.000	1.000	2
Point	3	0.700			3
Point	4	0.500			4
Point	5	0.300			5
Point	6	0.000			6
Point	7				7
Point	8				8
Attribute		1	2	3	
Attribute Values		0.834	1	1.3	
Single Attr. Utility		0.7664	0.5882353	0.7142857	
Multi-Attribute Utility			0.6993005		
		Set/Variable (1/0)	Supplied Values	Resulting Values	
Cost		1	0.834	0.834	
Weight		0	1	0.6008562	<- Calculated
MTBF		1	0.85	0.85	
MAUtility		1	0.5	0.5	

Figure 1: Input areas for MAUA_WKS Spreadsheet are the dark, solid boxed areas in the figure.

Each column (labeled 1, 2, and 3 as well as Cost, Weight, and MTBF) corresponds to the three attributes that are being treated in this case study. Proceeding down the column associated with any one of the three attributes, we first come to a pair of cells, labeled "Scaling ks" and "# points." In the first of these, you place the k-value that you determined for that attribute. In the second, indicate the total number of utility data points (including endpoints) that you were able to determine during your utility interview (an upper limit of 8 points are provided for in this spreadsheet).

In next part of the input area (where you see the values 0.5 and 4 in the first column, etc) you put the values for which you were able to determine utilities during the interview. In the third grey area, you put the utility values which correspond to the points that you supplied in the above area. It is VITALLY IMPORTANT that the values presented in the upper half (the attribute values) be input in increasing order. If the values are input in decreasing order, an error message will be presented in the offending row(s). (See Figure 2).

Attribute		1	2	3	K
		Cost	Weight	MTBF	
Scaling ks		0.20	0.40	0.50	-0.2709
# Points		3	2	2	
		Cost	Weight	MTBF	
Point	1	0.50	0.30	0.80	1
Point	2	ERR	2.00	1.50	2
Point	3	4.00			3
Point	4				4
Point	5				5
Point	6				6
Point	7				7
Point	8				8
Attribute		Cost	Weight	MTBF	
		Utility	Utility	Utility	
Point	1	1.000	1.000	0.000	1
Point	2	0.800	0.000	1.000	2
Point	3	0.700			3
Point	4	0.500			4
Point	5	0.300			5
Point	6	0.000			6
Point	7				7
Point	8				8
Attribute		1	2	3	
Attribute Values		0.834	1	1.3	
Single Attr. Utility		0.7844267	0.5882353	0.7142857	
Multi-Attribute Utility			ERR		

Figure 2: Input areas for MAUA_WKS Spreadsheet With Erroneous Inputs

To illustrate the use of the spreadsheet, suppose that upon reduction of your interview data, you find that the k value for cost is 0.1 and that the single attribute utility function has the following form:

Cost	U(Cost)
0.5	1.0
0.8	0.8
1.0	0.7
2.0	0.5
3.0	0.3
4.0	0.0

Correctly inputting these values into the MAUA_WKS spreadsheet would yield the spreadsheet shown in Figure 3.

Attribute		1	2	3	K
		Cost	Weight	MTBF	
Scaling ks		0.20	0.40	0.50	-0.2709
# Points		3	2	2	
		Cost	Weight	MTBF	
Point	1	0.50	0.30	0.80	1
Point	2	0.75	2.00	1.50	2
Point	3	1.00			3
Point	4	2.00			4
Point	5	3.00			5
Point	6	4.00			6
Point	7				7
Point	8				8
		Cost	Weight	MTBF	
		Utility	Utility	Utility	
Point	1	1.000	1.000	0.000	1
Point	2	0.800	0.000	1.000	2
Point	3	0.700			3
Point	4	0.500			4
Point	5	0.300			5
Point	6	0.000			6
Point	7				7
Point	8				8
		1	2	3	
Attribute Values		0.834	1	1.3	
Single Attr. Utility		0.7664	0.5882353	0.7142857	
Multi-Attribute Utility			0.6993005		

Figure 3: MAUA_WKS Spreadsheet With Correct Inputs (based on table in text)

Of course, the purpose of the spreadsheet is not to save your single attribute utility information. Rather, it will enable you to calculate the utility of any legal combination of attributes. These values can be supplied in the three unprotected cells at the bottom of the table, and the

multi-attribute utility of the combination will be calculated in the cell below (outlined in the figures).

Note in particular that the multi-attribute output cell will contain the value "ERR" under the following conditions:

1. Any one of the values supplied for calculation of the multi-attribute utility is outside of the range of values provided in the utility function input areas
2. The first half of the data input for the single attribute utility functions is erroneous.

Beneath the base input area is an extended input area for more complex analyses of your utility information. This input area is presented in Figure 4. This four column table accepts inputs in the second and third columns. The second column {labeled "Set/Variable (1/0)} should contain three ones and one zero, while the third column should supply values for each line containing a '1' in the preceding column. Failure to supply three '1's in the second column or supplying values outside of the legal limits in the third column will result in 'ERR's in the fourth column.

Attribute	Set/Variable (1/0)	Supplied Values	Resulting Values
Cost	1	0.834	0.834
Weight	1	1	1
MTBF	1	0.85	0.85
MAUtility	0	0.5	0.4108541 <- Calculated

Figure 4: Expanded Utility Analysis Input & Output Area - MAUA Calculation Mode

Given those three values, this table will calculate the fourth value consistent with the other three. If the first three items are provided (Cost, Weight, and MTBF), the multi-attribute utility of that combination will be calculated, just as is done in the preceding table. However, if the user instead supplies Cost, Weight, and a target multi-attribute utility value, the spreadsheet will attempt to determine the MTBF necessary to achieve the targeted utility value. If the targeted utility value is too high or too low, an 'ERR' will appear in the fourth column.

Attribute	Set/Variable (1/0)	Supplied Values	Resulting Values
Cost	1	0.834	0.834
Weight	0	1	0.6008562 <- Calculated
MTBF	1	0.85	0.85
MAUtility	0	0.5	0.5

Figure 5: Expanded Utility Analysis Input & Output Area - Target MAUA Calculation Mode

This table, therefore, provides the user with the ability to compute lines of constant utility, through the use of the two-way Data Table option supplied by Lotus 123.

NOTE: If the Set/Variable column contains four '1's, the spreadsheet will simply calculate the multiattribute utility value, ignoring the supplied MAUA number.

Attribute	Set/Variable (1/0)	Supplied Values	Resulting Values
Cost	0	0.834	ERR <- Calculated
Weight	0	1	ERR <- Calculated
MTBF	1	0.85	0.85
MAUtility	0	0.5	0.5

Attribute	Set/Variable (1/0)	Supplied Values	Resulting Values
Cost	0	0.834	ERR <- Calculated
Weight	1	1	1
MTBF	1	0.85	0.85
MAUtility	1	0.5	0.5

Figure 6: Expanded Utility Analysis Input & Output Area - Error Modes