ANALYZING SUBJECTIVE DECISIONS
WITH A SPREADSHEET

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Despite what many critics believe, business decisions are rarely based on costs or profits alone. Usually there are subjective considerations that muddy the waters and make decisions a lot tougher than simply choosing the alternative with the best "bottom line." For example, suppose your company plans to open a new office or plant in another city. It is relatively easy to estimate the operating costs at different locations, but this is only part of the story. Some locations may have competitive advantages. The labor supply may be important. Most companies will also consider the quality of life in different cities, especially when employees must relocate.

Decisions like this, where many of the decision factors are subjective or judgmental in nature, may seem beyond the scope of a spreadsheet model. Not so. In 1-2-3 or Symphony, you can build a model that analyzes a variety of subjective decision factors and finds the best tradeoff available. You can also analyze tradeoffs between subjective and objective factors such as costs or profits.

This is an abstract idea so let's work through an example, a plant location decision faced by a small manufacturing company. The principles apply to virtually any business decision that depends on subjective information. The company's sales had grown enough to justify an additional plant. At the time this analysis was done, they had narrowed the list of candidate sites down to a large industrial city in the Midwest and a smaller city in the sunbelt region. If I reveal the names of the cities I am certain to offend someone, so let's call them cities A and B, respectively. The spreadsheet used to choose between these cities is shown in Figure 1. There are six steps in building this type of spreadsheet.

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    FIGURE 1.

        A         B         C         D         E         F         G         H
  1 PLANT LOCATION ANALYSIS
  2
  3                                                   SCORES
  4                                               ------------------
  5 DECISION FACTORS                              CITY A   CITY B   WEIGHT   (A/B)^W
  6 --------------------------                    --------  -------- -------- --------
  7 Annual mfg. costs ($000)                      $4,380   $4,325      5      1.07
  8 Cost of living (index)                           100       87      3      1.52
  9 Avg. commuting distance (miles)                   27       10      2      7.29
 10 Skilled labor supply                               1        6      4      0.00
 11 Ability to subcontract work                        3        9      3      0.04
 12 Government attitude                                7        1      4   2401.00
 13 Quality of schools                                 8        3      4     50.57
 14 Cultural opportunities                             2        8      2      0.06
 15 Climate                                            9        2      1      4.50
 16
 17                                               PREFERENCE NUMBER:    11.51
 18
 19                                               YOUR DECISION IS:   CITY B
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STEP 1 - LIST THE DECISION FACTORS

First, list all factors relevant to the decision. Don't be afraid to list something that seems marginally important. Sensitivity analysis, discussed below, will tell you whether a factor is really important or not. At this point you should set up the spreadsheet in 1-2-3 or Symphony. Enter the headers in rows 1-6 and the decision factors in column A.

STEP 2 - SCORE THE DECISION FACTORS

The second step is assign a score to each decision factor. The meaning of the score depends on the factor. For annual manufacturing costs, the scores are in dollars. For the cost of living, the scores are indexes, with city A as 100. The average commuting distances to the plant sites are scored in miles. The subjective factors are scored on a scale of 1 (best) to 10 (worst). Any other scale can be used so long as it is consistent. Columns E and F in Figure 1 are consensus scores assigned by the members of the company's executive committee. Before we go to the next step, enter the scores in columns E and F. Format cells E7 and F7 to currency with zero decimals. The format of these cells doesn't affect the results but it helps clarify the spreadsheet.

STEP 3 - WEIGHT THE DECISION FACTORS

Now we have to decide how important each decision factor really is. This is done by assigning weights. Consensus weights assigned by the executive committee are shown in Figure 1. Enter the weights in Column G. The weights range from 1 to 5 and the greater the weight, the more important the decision factor. Annual manufacturing cost is most important, with a weight of 5. Climate is least important and gets a weight of 1. The other factors fall between these two extremes.

STEP 4 - COMPUTE WEIGHTED RATIOS
Now we're ready to write formulas to analyze the decision. One approach would be to take a sum or a weighted average of the scores in columns E and F. Many people use this approach in similar problems but it really makes no sense. The scores are measured on different scales. Adding the scores is the classic mistake of adding apples and oranges. A better way to compare the decision factors is to convert the scores to ratios, one for each decision factor. Then each ratio is raised to an exponent equal to its weight. Finally, we multiply all the ratios together to get a number that indicates the best alternative. This result is called a "preference number" and it is free of problems with scale. Move to cell H7 and enter (E7/F7)^G7. This is the ratio of manufacturing costs in city A to costs in city B, raised to a power equal to the weight assigned. The same formula is used for all the factors. Copy cell H7 to the range H8..H15.

By converting the numbers to ratios, the "apples and oranges" problem goes away. For a given decision factor, a ratio simply indicates whether one alternative is better than another. It doesn't matter whether the numerator and denominator of the ratio are measured in dollars, miles, or anything else.

It also doesn't matter whether the numerator and denominator are rounded as long as the rounding is consistent. For example, the ratio of $4,380 to $4,325 is the same as the ratio of $4,380,000 to $4,325,000.

STEP 5 - COMPUTE THE PREFERENCE NUMBER
Now let's combine the weighted ratios. Move to cell F17 and enter the label PREFERENCE NUMBER:. In cell H17, enter the formula +H7*H8*H9*H10*H11*H12*H13*H14*H15. The result is 11.51 and means that City B is the best choice. B is best because its scores are in the denominator of each ratio. Remember that the scores are assigned so that smaller numbers are better. Any time the preference number is greater than 1, B must be the best alternative. If the preference number is less than 1, A must be best because its scores are in the numerator of each ratio. Another possibility is that the preference number turns out to be exactly 1. This won't happen often, but if it does, we are indifferent between the two cities.

These rules are hard to remember so let's put them in the spreadsheet. Move to cell F19 and enter the label YOUR DECISION IS:. In cell H19 enter the following formula: @IF(H17=1, " TOSSUP", @IF(H17<1, " CITY A"," CITY B")). This formula says that if H17 is equal to 1, the label TOSSUP is displayed. When H17 is less than 1, CITY A is displayed. The third possibility is that H17 is greater than 1, so CITY B is displayed.

Don't try to attach any meaning to the magnitude of the preference number. Cell H17 does not mean that B is 11.51 times better than A. It means only that B is better. Just how much better is a question for philosophers. It cannot be answered by the model.

SENSITIVITY ANALYSIS

Now we have a recommended decision that is consistent with the opinions of the company's executive committee. But an opinion is just that. We need to know how the decision changes if the inputs change. To illustrate, let's experiment with the weight assigned to the cost of living. One of the members of the executive committee had second thoughts about this weight and felt that it was too high.

Move the cursor to cell G8 and change the weight from 3 to 2. The decision stays the same, City B. Try a weight of 1. Again City B is best. Now try 4 and 5. Since the cost of living already favors City B, these weights don't change anything either. Thus the decision is not sensitive to the cost of living. In fact, the cost of living makes absolutely no difference, provided that everything else in the model stays the same. Before we go on, change the weight in cell G8 back to 3.

Another member of the executive committee was concerned that the weights on the decision factors favoring City A were too low. Let's see if these weights make any difference.

There are three factors favoring City A: skilled labor supply, the ability to subcontract work, and cultural opportunities. Move the cursor to cell G10 and change the weight to 5. The decision stays the same. Change the weight in cell G10 back to 4.

Now move the cursor to cell G11, the weight on the ability to subcontract work. Change the weight from 3 to 4. The decision stays the same. Now try 5. Again the decision is the same. Change the weight back to 3.

Finally, let's experiment with the weight on cultural opportunities. Move the cursor to cell G14 and try larger weights. Only if we are willing to increase the weight to at least 4 does the decision change to City A. The executive committee naturally balked at this, so the decision was made to locate in City B.

USING AND MISUSING DIMENSIONLESS ANALYSIS

Figure 1 is called a "dimensionless analysis" model because the preference number has no natural dimension such as dollars or miles. It serves only to indicate the decision that is consistent with the preferences (the scores and weights) expressed in the model.

Dimensionless analysis can compare only two alternatives at a time. But this is not really a limitation. If you have more than two alternatives, start with any two and find the best choice. Take the best choice and compare it another alternative. Keep going in pairs until you cover all the alternatives.

For example, suppose there are three alternatives, A, B, and C. First set up a model that compares A and B. Suppose A beats B. Now compare A and C. If A beats C, you are done. There is no need to compare B and C because A beats both.

In setting up a model, make sure that you are consistent in assigning scores. There are two methods. In Figure 1, smaller scores mean better throughout the table. Any preference number less than 1 favors alternative A while any number greater than 1 favors B. The second method is to have larger scores mean better throughout the table. In this case any preference number less than 1 favors B, while any number greater than 1 favors A.

It doesn't matter which method you use so long as you don't mix the two. That is, don't have smaller numbers mean better for some decision factors and worse for others. If you mix the two methods, the preference number is meaningless.

Sometimes it is hard to avoid mixing the two methods. For example, in Figure 1, what if we wanted to use profits rather than manufacturing costs, but keep all the other numbers the same? The solution is to multiply the weight assigned to profits by -1. This inverts the ratio. If A's profits are larger than B's, the negative weight makes the ratio less than 1, which is consistent with the rest of the model. This is confusing but it is the only option if you can't find another way to express the problem.

Like any other model, dimensionless analysis is a very limited abstraction of the real world. But it is a considerably richer abstraction than models which deal only with costs or profits. The real advantage of dimensionless analysis is that it forces you to organize and evaluate all the data relevant to a decision, however fuzzy that data might be.