Swing weighting

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Swing weighting is a method for setting the weights in a additive multiattribute utility function. See also Multiattribute utility theory.

Note that swing weighting assumes that the worst score on each attribute has a utility of 0 and the best score has a utility of 1.

Given is a set of alternatives and a set of attributes. Let N be the number of attributes.

1. Determine the best and worst value of each attribute over the set of alternatives.

2. Create N+1 fictional alternatives. The first fictional alternative is the "worst-case" and has the worst value on every attribute. The next N fictional alternatives have the worst value on all but one of the attributes; on the remaining attribute, each alternative has the best value on one attribute. (Each of these alternatives has a different best than any of the others.)

3. Rank order the N+1 fictional alternatives. The ranks are determined by the decision-maker. The rank of the worst-case alternative will be N+1, and the rank of the best of the fictional alternatives will be 1.

4. Rate the N+1 fictional alternatives. The rating of the worst-case alternative will be 0, and the rating of the best of the fictional alternatives will be 100. The decision-maker must rate the others and these ratings should be coherent with the rankings. That is, if one fictional alternatives has a better rank than a second, the first should have a higher rating as well. An alternative's rating is the decision-maker's increase in satisfaction if he gives up the worst-case alternative and chooses this one instead.

5. Normalize the ratings by dividing each one by the sum of all the ratings. The normalized rating of the worst-case alternative will still be 0, and the sum of all the normalized ratings will equal 1.

6. The weight for each attribute is the normalized rating of the fictional alternative that has the best value on that attribute.

Example

Consider the following example (based loosely on one in Dieter and Schmidt, 2009).

A design team needs to design a heavy steel crane hook to support ladles filled with molten steel in a steel mill. There are N = 3 attributes: manufacturing cost, reliability, and time to produce. There are three alternatives: (A) welding together build-up steel plates, (B) riveting together build-up steel plates, and (C) a cast-steel hook. They have the following scores on the three attributes:

Alternative	cost	reliability	time to produce
A	$2,200	good	60 hours
B	$2,500	excellent	25 hours

C	$3,000	fair	40 hours

The utilities of the alternatives on each attribute are given in the following table.

Alternative	cost	reliability	time to produce
A	1	0.5	0
B	0.6	1	1
C	0	0	0.5

Among all the alternatives, the best cost is $2,200 degrees, and the worst is $3,000 degrees. The best reliability is excellent , and the worst is fair . The best time to produce is 25 hours, and the worst is 60 hours.

The swing weighting method constructs four fictional alternatives:

	cost	reliability	time to produce
1. (benchmark)	$3,000	fair	60
2. Cost	$2,200	fair	60
3. Reliability	$3,000	excellent	60
4. Time	$3,000	fair	25

The decision-maker's name is Joe. Joe cares a lot about cost and less about reliability. The time to produce is somewhat important, but a swing from 60 to 25 hours is a relatively small benefit. He ranks alternative 2 as best, then 3, then 4.

	cost	reliability	time to produce	rank
1. (benchmark)	$3,000	fair	60	4
2. Cost	$2,200	fair	60	1
3. Reliability	$3,000	excellent	60	2
4. Time	$3,000	fair	25	3

Joe then gives a rating of 40 to alternative 3 because that would satisfy him only 40% as much as alternative 1, and he gives a rating of 10 to alternative 4.

	cost	reliability	time to produce	rank	rating
1. (benchmark)	$3,000	fair	60	4	0
2. Cost	$2,200	fair	60	1	100
3. Reliability	$3,000	excellent	60	2	40
4. Time	$3,000	fair	25	3	10

Based on Joe's input, the normalized ratings can be calculated, as shown in the following table. These become the weights in the utility function.

	cost	reliability	time to produce	rank	rating	weight
1. (benchmark)	$3,000	fair	60	4	0	0
2. Cost	$2,200	fair	60	1	100	100/150 = 0.666
3. Reliability	$3,000	excellent	60	2	40	40/150 = 0.267
4. Time	$3,000	fair	25	3	10	10/150 = 0.067

This ends the swing weighting method. Based on these weights and the single-attribute utilities given before, we can calculate each alternative's multi-attribute utility:

Alternative	Multi-attribute utility
A	0.667(1) + 0.267(0.5) + 0.067(0) = 0.800
B	0.667(0.6) + 0.267(1) + 0.067(1) = 0.734
C	0.667(0) + 0.267(0) + 0.067(0.5) = 0.034

References

Clemen, Robert T., and Terence Reilly, Making Hard Decisions with DecisionTools, Duxbury, Pacific Grove, California, 2001.

Dieter, George E., and Linda C. Schmidt, Engineering Design, Fourth Edition, McGraw-Hill Higher Education, Boston, 2009.