Multi-attribute Decision Analysis

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Agenda

- What is Multi-attribute Decision Analysis and when should it be used?
  - Two slides from Frank Koch provide the context for this discussion
  - Definition and distinctions
- Common mistakes dealing with multi-attribute
  - Noted by Ralph Keeney
  - Additional mistakes
- Proposed protocol for correctly facilitating and completing multi-attribute DA
- Case Studies
  - Personal
  - Business
- Summary, References, and Appendix
The Big Picture [from Frank Koch]¹

Framing

Analyzing

Descriptive

How people make decisions

Normative

“How people should make decisions”
Normative Decision Making

Descriptive

- How people make decisions
  - Ranking/Weighting
    - AHP
    - Throwing Bones
    - Reading Entrails

Normative

- “How people should make decisions”

Math
What is (and is not) Multi-attribute Decision Analysis?

- Financial measures-of-value (e.g. expected NPV, DPI) are not sufficient for some decisions, which leads to multi-attribute analysis...

- Multi-attribute Decision Analysis is appropriately considering non-financial objectives and their associated trade-offs, which leads to clarity for the decision maker.
  - Keeney refers to this as “Making Value Trade-offs”

- Multi-attribute Analysis is not:
  - Multi-attribute Utility Theory (MAUT)
  - Analytical Hierarchy Process (AHP) [see Koch]
  - Ranking and Weighting
  - Throwing Bones
  - Reading Entrails
When Should Multi-attribute Analysis be Used... (and When Should it not be Used)?

Multi-attribute may not needed for strategic decisions, e.g.
- Project go/no go decisions
  - Capital expenditure authorization
  - Development phase gate decisions
- Technically driven decisions:
  - Product development and launch
  - Field development
  - Well scheduling
- Multi-attribute may not needed for some tactical decisions:
  - Choosing the low bid among multiple proposals

Multi-attribute is needed when subjective non-financial objectives and/or criteria are important.

These can be relatively tactical but real-life decisions:
- Buying a car
- Buying a house
- Choosing a college
- Selecting a site for a new facility
- Choosing a proposal when low bid is not sufficient
- Grading eMBA presentations
Keeney’s “Common Mistakes” and Recommendations

**Common Mistakes**
1. Not understanding the decision context
2. Not having measures for consequences
3. Using inadequate measures
4. Not knowing what the measures represent
5. Making trade-offs involving means objectives [instead of fundamental]
6. Using willingness to swap as a value trade-off
7. Trying to calculate correct value trade-offs
8. Assessing value trade-offs independent of the range of consequences
9. Not having value trade-offs depend on where you start
10. Providing conservative value trade-offs

**Making Good Value Trade-offs**
1. Frame the decision appropriately
2. Structure the value trade-off problem
3. Determine pairs of consequences that are indifferent
4. Revise value trade-offs as appropriate to assure reasonableness
Common Mistakes
To Avoid Destroying Clarity, DO NOT:

- Use unnecessary and complex weighting and scoring schemes (AHP, swing weights, MAUT):
  - “Black Box” analytical complexity
  - Confuses complexity with correct analysis
  - Loses sight of the Big Picture
- Confound cost with other value measures (AHP).
- Confuse independent and dependent variables:
  - The independent attribute (cost) should always be on the x-axis (the decision maker decides how much to spend).
- Weight and score attributes which should be treated as conforming / non-conforming attributes (e.g. safety performance).
- Ask the wrong questions:
  - “Which is more important to you – Cost or Quality?”
How does Multi-attribute Fit into the Decision Analysis Process?

Typical DA Frame:
- Problem Statement
- Issue Raising
- Situation Analysis
- Stakeholder Analysis
- Objectives Hierarchy
- Decision Hierarchy
- Decision Tree
- Strategy Table
- Influence Diagram

Typical DA Analysis:
- Financial Model
- Risk and Uncertainty Assessment
- Tornado
- Cumulative Probability
- VOI / VOC
- Implementation

Multi-attribute Analysis:
- Additional Attributes
- Attribute Scoring
- Subjective versus Quantitative: Trade-offs
Proposed Protocol: To add Clarity: (“Keep It Simple”) 

1. Determine whether Financial value measures (NPV, DPI) are sufficient to make the decision(s)
   - Purchasing decision: Can you live with accepting the low bid?
2. Complete the financial analysis so that costs and associated uncertainties are sufficiently understood
3. Score the alternatives relative to the subjective Fundamental Objectives
   - Discard non-conforming alternatives / bids / proposals
4. Plot Beauty versus Cost to show the trade-offs between alternatives
5. Develop the story to accompany the graph
Case #1: Choosing Among Job Opportunities
Which Job Would You Choose?

Fundamental Question:
Is the potential financial advantage of Job C worth trading off the Professional and Social objectives?

Professional And Social

$eNPV$ of salary and benefits
Case #2: Retirement [Frank Koch]

- Frank has previously reported how he:
  - Framed his retirement decision
  - Completed the analysis and made the decision(s)
- Financial (cost): cost of living, taxes, cost of housing
- Subjective attributes (“Net Present Happiness”):
  “must understand your [and your spouse’s] Objectives Hierarchy”
  - Discarded non-conforming alternatives
  - Balanced trade-offs between remaining alternatives and cost
  - Understood alternatives of subjective ambivalence and used this as negotiation strategy (reverse auction)

<table>
<thead>
<tr>
<th>State</th>
<th>City</th>
<th>Setting</th>
<th>Home</th>
<th>Convertible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas</td>
<td>Corvallis</td>
<td>Development</td>
<td>Keep</td>
<td>Frank gets one</td>
</tr>
<tr>
<td>Oregon</td>
<td>Eugene</td>
<td>Coastal</td>
<td>Buy New</td>
<td>Frank doesn’t</td>
</tr>
<tr>
<td></td>
<td>Coos Bay</td>
<td>Woods</td>
<td>Build New</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Houston</td>
<td></td>
<td>Buy Old</td>
<td></td>
</tr>
</tbody>
</table>
Case #3: Mid-life Crisis New Car

Which car would you purchase?

- Financial measure: List price
- Subjective attributes: “Fun”
  - Horsepower
  - Handling
  - “Green” (i.e. mpg)
- Aesthetic appeal

<table>
<thead>
<tr>
<th>Make/Model</th>
<th>2010 Chevrolet Corvette Grand Sport</th>
<th>2011 Ford Shelby GT500</th>
</tr>
</thead>
<tbody>
<tr>
<td>List price</td>
<td>$54,770</td>
<td>$48,645</td>
</tr>
<tr>
<td>Curb weight</td>
<td>3360 lb</td>
<td>3820 lb</td>
</tr>
<tr>
<td>Engine, transmission</td>
<td>6.2-liter V-8, 6-sp manual</td>
<td>5.4-liter supercharged V-8, 6-sp manual</td>
</tr>
<tr>
<td>Horsepower, bhp</td>
<td>436 @ 5900</td>
<td>550 @ 6200</td>
</tr>
<tr>
<td>Torque, lb-ft</td>
<td>428 @ 4600</td>
<td>510 @ 4250</td>
</tr>
<tr>
<td>0-60 mph</td>
<td>4.1 sec</td>
<td>4.4 sec</td>
</tr>
<tr>
<td>0-100 mph</td>
<td>9.2 sec</td>
<td>9.2 sec</td>
</tr>
<tr>
<td>0-1320 ft (1/4 mile)</td>
<td>12.4 sec @ 116.5 mph</td>
<td>12.6 sec @ 118.9 mph</td>
</tr>
<tr>
<td>Top speed</td>
<td>190 mph*</td>
<td>155 mph*</td>
</tr>
<tr>
<td>Braking, 60-o mph</td>
<td>112 ft</td>
<td>117 ft</td>
</tr>
<tr>
<td>Braking, 80-o mph</td>
<td>197 ft</td>
<td>197 ft</td>
</tr>
<tr>
<td>Lateral accel (200-ft skidpad)</td>
<td>0.96g</td>
<td>1.00g</td>
</tr>
<tr>
<td>Speed thru 700-ft slalom</td>
<td>70.7 mph</td>
<td>69.6 mph</td>
</tr>
<tr>
<td>EPA city/highway</td>
<td>16/26 mpg</td>
<td>15/23 mpg</td>
</tr>
</tbody>
</table>
Case #4: Which Software System to Buy
(adapted from a real case; sometimes you get lucky)

- Based on proposals generated from a detailed RFP, five conforming proposals were “short listed.”

- Subjective criteria included:
  - Functional Fit
  - Publisher (financial stability, experience, depth)
  - Value-added Reseller (VAR) (financial stability, experience, depth)
Case #5: Choosing an Office Suite (adapted from a another lucky case)

- Stand-alone, fully functioning office space needed
  - 8,500 ft² +/-, downtown Houston, 3Q 2008
- Subjective criteria (attributes):
  - Location (relative to services, bus lines, HOU150, etc.)
  - State of build-out
  - Time frame (lease term, availability)
- Shortlisted 4 properties after looking at over 30.
- The property with the highest qualitative score was also the least expensive, which is unusual.
Case #6: Scoring Executive MBA Presentations

- Teams have ½ hour to present their Projects to a mock Decision Review Board.
- The instructor facilitates the DRB to score each team relative to subjective criteria:
  - Discovery / Problem Understanding
  - Correct Frame
  - Logical and Consistent Analysis
  - Clear Presentation of Insights
  - Team Cohesiveness
  - Oral Presentation Skills.
- A scale of 0 to 7 is used, where 0 is “confused,” 1 is “close to correct,” and 7 is “perfect.”
- Individual DRB members score each presentation separately and then reach consensus via discussion.
  - Logical breakpoints between grades become apparent.
Summary: Keep Multi-attribute Decision Analysis Simple!

1. Are financial value measures sufficient to make the decision?
2. Complete financial analysis.
3. Score the non-financial objectives.
   - Eliminate non-conforming alternatives / proposals / bids.
4. Plot “Beauty” versus “Cost.”
   - Examine and discuss trade-offs.
5. Develop and present The Story.
References

1. Koch, Frank, several presentations and several personal conversations, 2008-2011.


