Procurement Decision Support for Portuguese MoD: 
The MACBETH Approach and the Acquisition of 8x8 AWV

http://web.ist.utl.pt/carlosbana

Carlos António Bana e Costa
Professor of Decision and Information
DEG - Department of Engineering and Management
CDM-ISM - Centro de Management Studies of IST
IST - Institute Superior Tecnico (School of Engineering of IST)
UTL - Technical University of Lisbon

Table of Contents

- Public procurement, transparent bid evaluation, EU legal framework
- Common critical mistakes in bid evaluation
- Weighting criteria: Legal requirement - Define weights of criteria before bids are known. How to do it properly?
- Scoring bids with MACBETH
- The MoD 8x8 AWV acquisition program
Public tender evaluation in the fields of defence and security: EU recent legal framework – Directive 2009/81/EC

The Most Economically Advantageous Bid

Directive 2009/81/EC dictates that when multiple evaluation criteria – rather than just price – are used, the award must be made to “the tender most economically advantageous to the contracting authority” (art. 70). Furthermore...

(71) Where the contracting authorities/entities choose to award a contract to the most economically advantageous tender, they shall assess the tenders in order to determine which one offers the best value for money.

This invites the development of a multicriteria additive value model
### Multicriteria value measurement

- Structuring criteria; describing levels of performance
- Weighting evaluation criteria
- Scoring bids on each criterion; measuring value (attractiveness)
- Recommending

### Some common critical mistakes in tender evaluation

- Bad structuring
- Mix performance appraisal with value measurement
- Importance weighting
- Ordinal scoring

---

### Weighting criteria – Legal requirement: Define weights before bids are known

Directive 2009/81/EC dictates that evaluation criteria and their weights must be announced necessarily before the tenders are known:

> To ensure compliance with the principle of equal treatment in the award of contracts, it is appropriate to lay down an obligation, which has been established by case-law, to ensure the necessary transparency to enable all tenderers to be reasonably informed of the criteria and arrangements which will be applied to identify the most economically advantageous tender. It is therefore the responsibility of contracting authorities/entities to indicate the criteria for the award of the contract and the relative weighting given to each of those criteria, in sufficient time for tenderers to be aware of them when preparing their tenders. Contracting authorities/entities may derogate from indicating the weighting of the criteria for the award in duly justified cases for which they must be able to give reasons where the weighting cannot be established in advance, in particular on account of the complexity of the contract. In such cases, they must indicate the descending order of importance of the criteria.

It is not possible to weight the criteria with reference to the most and least attractive performances of tenders on each criteria.

**How to do it properly?**
Critical mistake – Importance weighting

Scenario 1 (3 bids accepted A, B, C):
Worst deadline = 10 months

<table>
<thead>
<tr>
<th>Cost</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.000 €</td>
<td>100</td>
</tr>
<tr>
<td>90.000 €</td>
<td>80</td>
</tr>
<tr>
<td>50.000 €</td>
<td>50</td>
</tr>
</tbody>
</table>

Scores: 100, 20, 0
Importance grades: 1, 2, 3, 4, 5

A ▶ 0×0,625 + 100×0,375 = 37,5
B ▶ 20×0,625 + 40×0,375 = 27,5
C ▶ 100×0,625 + 0×0,375 = 62,5

Critical mistake – Importance weighting

Scenario 2 (C rejected ⇒ 2 bids accepted A, B):
Worst deadline = 8 months

<table>
<thead>
<tr>
<th>Cost</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.000 €</td>
<td>100</td>
</tr>
<tr>
<td>90.000 €</td>
<td>80</td>
</tr>
<tr>
<td>50.000 €</td>
<td>50</td>
</tr>
</tbody>
</table>

Scores: 100, 20, 0
Importance grades: 1, 2, 3, 4, 5

A ▶ 0×0,625 + 100×0,375 = 37,5
B ▶ 100×0,625 + 0×0,375 = 62,5
How to do it properly?
Define ‘Good’ and ‘Neutral’ reference levels

- Define two reference levels
  of intrinsic value on each evaluation criterion
  - ‘Good’ level (an undoubtedly attractive performance)
  - ‘Neutral’ level (neither attractive nor unattractive)

Moreover, our experience has revealed that
the effort required in identifying Good and Neutral levels
contributes to a better understanding of the values,
objectives and concerns that the criteria are intended to appraise

Scoring bids

Example: Suppose there are three bids B1, B2 and B3
  - Bids should be ranked according to the relative attractiveness of
    their performances on each criterion

  B2 preferred to B1 preferred to B3

  - Is ranking by relative attractiveness enough to know if the most attractive bid is good or bad? Defining Good and Neutral references resolves the issue

  B2 → Good → B1 → B3 → Neutral

  - On each criterion, one wants to know not only if one bid is more attractive than another but also by how much

  B2 → Good → B1 → B3 → Neutral

  weak

  Moderate
Assessing value judgments: MACBETH

MACBETH is an interactive multicriteria decision support approach for:

- Evaluate options on multiple criteria...
- ... that uses qualitative judgments of differences in attractiveness ...

... in order to generate value scores for the options on each criterion and weights to the criteria.

- MACBETH introduces seven qualitative categories of difference in attractiveness:
  (Judgmental disagreement or hesitation between two or more consecutive categories, except indifference, is also allowed.)

MACBETH process of scoring bids on each criterion

- Step 1: Define Good and Neutral reference performances
- Step 2: Rank-order bids and references
  
  \[
  B_2 \rightarrow \text{Good} \rightarrow B_1 \rightarrow B_3 \rightarrow \text{Neutral}
  \]

- Step 3: Use the MACBETH categories of difference of attractiveness to:
  - Step 3.1: Evaluate qualitatively the difference between good and neutral (recommended: ‘Strong’)
  - Step 3.2: Evaluate qualitatively the difference between each bid and each reference
  - Step 3.3: Evaluate qualitatively the difference between each two bids
Dealing with inconsistency

Each time that a qualitative judgments is elicited, the consistency of all the judgments thereto made by the respondent is verified...

... and suggestions are offered to resolve inconsistencies if they arise.

Deriving scores

From the consistent set of judgments...

... MACBETH derives a score for each bid...

... which the respondent should subsequently validate and may adjust if necessary...

... within a range compatible with the judgments elicited.
Acquisition of military equipment for the Portuguese Ministry of Defense

Portuguese Ministry of Defense (MDN),
National Armaments Directorate (DGAED)

Acquisition processes concluded:
- 8x8 Armored Wheeled Vehicles (AWV)
- Targeting Pods
- Light Weapons
  - Automatic Rifles 5.56mm
  - Light Machine Guns 5.56mm
  - Pistols 9mm
- + Ministry of Economy: New model for the evaluation of Offset Projects

Ongoing projects:
- Light Tactical Armored 4X4 Vehicle

Forthcoming processes:
- Light Helicopters
- Upgrade of M113 Armored Personnel Carrier
The MoD 8x8 AWV acquisition program

- In order to ensure maximum competitiveness on the AWV acquisition program, a “public competitive bidding with selection of proposals for negotiation” was launched.
- This decision was taken by the Minister of Defense on July of 2003.
- The conduction of the AWV acquisition program was assigned to the MoD’s National Armaments Directorate (DGAED).
- (DGAED is the entity responsible, among others activities, for the supervision, coordination, control and execution of the Armed Forces equipment programs. [http://antigo.mdn.gov.pt/Defesa/Estrutura/Organigrama/DGAED/missao_DGAED.htm](http://antigo.mdn.gov.pt/Defesa/Estrutura/Organigrama/DGAED/missao_DGAED.htm))
- Acquisition program phases and timeline:
• Selected vehicle: PANDUR II 8X8
  - The Armored wheeled vehicles PANDUR II 8X8 results from a development of the PANDUR I 6X6, produced by the Austrian company Steyr Daimler-Puch Spezialfahrzeug GmbH, currently a member of the multinational group General Dynamics, European Land Combat Systems
• Contract value: ~360M€ for 260 VBR 8X8 + ~140M€ for the 33 optional vehicles (including logistical support: training, documentation, special tools and spare parts for a period of 10 years)
Structuring screening and evaluation criteria

**Identification of mandatory requirements**
*(screening criteria)*
*for each AWV Variant*

**Example of one of the 243 mandatory requirements identified:**

Requirement [19]: “Automatic transmission with, at least, 6 gears forward and 1 gear backward”

**Value tree (partial view)**

<table>
<thead>
<tr>
<th>Tender for Acquisition of 8x8 AWV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspects regarding Costs</td>
</tr>
<tr>
<td>Aspects regarding Offsets</td>
</tr>
<tr>
<td>Aspects regarding Delivery Schedule</td>
</tr>
<tr>
<td>Aspects regarding Technical Requirements</td>
</tr>
<tr>
<td><strong>Operational</strong></td>
</tr>
<tr>
<td>Net weight under battle orders</td>
</tr>
<tr>
<td>Air Transportability</td>
</tr>
<tr>
<td>AWV Combat Systems</td>
</tr>
<tr>
<td><strong>Characteristics of the set repair / weapon MP 12.7</strong></td>
</tr>
<tr>
<td>Time required for reloading the 12.7 mm Heavy Machine Gun</td>
</tr>
<tr>
<td>Time required for replacing the weapon</td>
</tr>
<tr>
<td>Time required for the alignment of the weapon and the aiming device</td>
</tr>
<tr>
<td>Requirements for the missile system operator</td>
</tr>
<tr>
<td><strong>Dimensions and maneuverability</strong></td>
</tr>
<tr>
<td>Night vision equipment</td>
</tr>
<tr>
<td>Interior ammunition storage capacity</td>
</tr>
<tr>
<td>Survival systems</td>
</tr>
<tr>
<td><strong>Technical (generic)</strong></td>
</tr>
<tr>
<td><strong>Logistical</strong></td>
</tr>
</tbody>
</table>
Definition of two reference performance levels GOOD and NEUTRAL from bottom to up in the value tree

**Characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>GOOD</th>
<th>NEUTRAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required for reloading the 12.7 mm Heavy Machine Gun</td>
<td>2 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Time required for replacing the weapon (12.7 mm Heavy Machine Gun and 40 mm Automatic Grenade Launcher)</td>
<td>5 minutes</td>
<td>15 minutes for the same type of weapons or 10 minutes for different types of weapons</td>
</tr>
<tr>
<td>Time required for the alignment of the weapon and the aiming device</td>
<td>5 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Requirements for the missile system operator regarding the possibility of system operation by personnel that needs or not vision correction glasses</td>
<td>The system can be operated by personnel that needs vision correction glasses</td>
<td>The system can only be operated by personnel that doesn't need vision correction glasses</td>
</tr>
</tbody>
</table>

**Defining reference performance levels**

**Costs**

<table>
<thead>
<tr>
<th>Tender for Acquisition of 600 AHW</th>
<th>Costs</th>
<th>Offsets</th>
<th>Delivery Dates</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>€235M</td>
<td>€270M</td>
<td>4th Trim 2006</td>
<td>Good dates, Good TR</td>
</tr>
<tr>
<td></td>
<td>€270M</td>
<td>€200M</td>
<td>4th Trim 2008</td>
<td>Neutral dates, Neutral TR</td>
</tr>
</tbody>
</table>

**Top-level reference performance levels GOOD and NEUTRAL**

<table>
<thead>
<tr>
<th>Costs references</th>
<th>GOOD</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total present acquisition cost</td>
<td>€235M</td>
<td>€270M</td>
</tr>
<tr>
<td>Present total cost of a contract for the supply of spare parts of the power train or all AHW</td>
<td>€40M</td>
<td>€50M</td>
</tr>
</tbody>
</table>
MACBETH weighting at the top-level

Weighting processes were developed the three levels of sub-sub-criteria, sub-criteria and criteria.

**Top-level MACBETH weighting process**

8x8 AWV Tenderers

Companies/Vehicles in tender:

- Steyr-Daimler-Puch Spezialfahrzeug AG & Co KG (Austria)  
  PANDUR II 8x8

- Mowag Motorwagen Fabrik AG (Swisserland)  
  Piranha III C 8x8

- Patria Vehicles OY (Finland)  
  AWV 8x8
AWV 8x8: Tests and Verifications

1st week
- Verification of the mandatory requirements
- Tests on a combat cars track

2nd week
- Field test

3rd week
- Air transportability
- Amphibian tests
T&V of mandatory requirements

Field tests
Air Transportability

Amphibian tests
Decision conferences: Evaluation and group learning; interactivity

The facilitator leads the process without interfering in the content.

Applying the additive model at the top-level of the 4 criteria
Sensitivity Analysis to support recommendation

Weighting sensitivity analysis on Requirements

References


