

# The Analytical Hierarchy Process (AHP)

**A Comparative Decision-Making Process for  
Comparative Evaluations in the Context of Simplified  
Acquisitions in FAR 13**

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# Introduction

- FAR 13.106-2(b)(3) permits *comparative evaluation* of offers but does not give specifics about how to implement *comparative evaluations* nor does the FAR contain a *definition of comparative evaluation*.
- In this presentation, we posit that the Analytic Hierarchy Process (AHP) offers a framework to define *comparative evaluation* as well as a process to perform *comparative evaluation*.
- The process is illustrated, in a basic way, with an acquisition example

# What is AHP?

- It is a multi-criteria decision-making evaluation methodology which uses pairwise comparisons to both prioritize the importance of criteria and to select the best alternative.
- It was developed in the late '70s by Dr. Thomas L. Saaty from the Wharton School at the University of Pennsylvania.
- Widely used by the U.S. government and Fortune 500 companies.
- Combines mathematical rigor with ease of use and intuitive understanding.

# An Acquisition Example

- We plan to acquire Genomics Testing Services.
- We have 3 criteria (value indicators): Technical, Past Performance and Price.
- We have 2 alternatives (quotations) from two contractors: Alpha and Bravo
- Which should we select as the “*best value*” quotation?
- Let’s use AHP for the evaluation!

**Note** – For the purpose of this presentation we will simplify the process (e.g. consistency of judgments will not be discussed)

# Some terminology

- *Goal* is a Contracting Officer decision that is *most advantageous to the Government (best value)*. [FAR 13.104](#) and [FAR 2.101](#)
- *Criteria (factors)* are *value indicators*. [FAR 13.106-2\(b\)\(4\)\(i\)](#)
- *Alternatives* are quotations.

# First step: Build a Hierarchy for the Decision

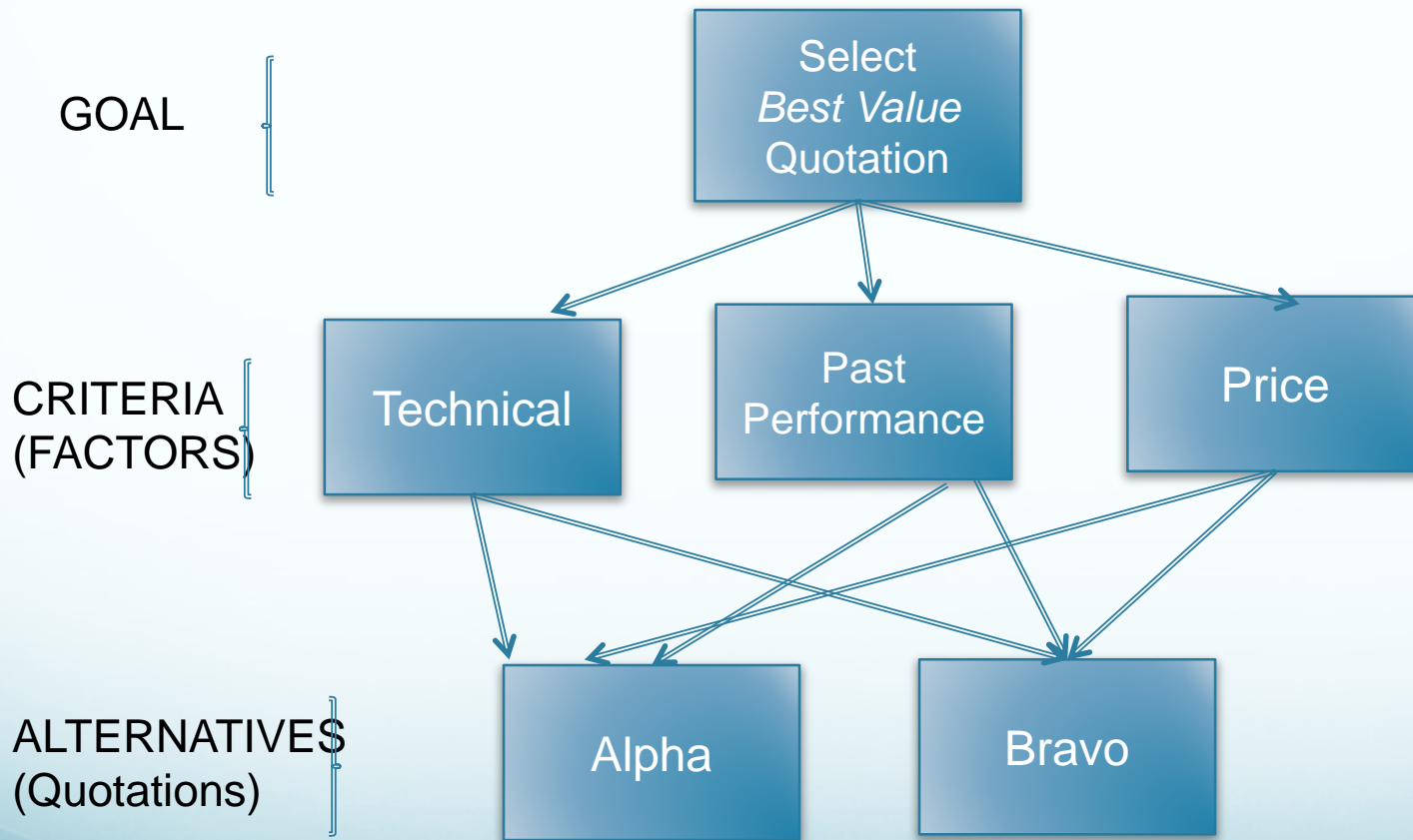


Fig. 1 – Hierarchy for Quotation Evaluation

# Second step: Determine the importance of the criteria with respect to our goal via pairwise comparison (PWC) evaluation

- When comparing two factors we ask the question: “When comparing factor A with respect to factor B, which factor is more important? How much more important?”
- E.g. If we believe that “Tech” is very strongly more important than Past Performance, we can use the scale on the right to assign a numeric value of 7 to the comparison.
- These values are tabulated in a PWC matrix (next slide).

| <b>Comparison Verbal Judgment</b> | <b>Numeric Value</b> |
|-----------------------------------|----------------------|
| Extremely important               | 9                    |
|                                   | 8                    |
| Very Strongly more important      | 7                    |
|                                   | 6                    |
| Strongly more important           | 5                    |
|                                   | 4                    |
| Moderately more important         | 3                    |
|                                   | 2                    |
| Equally important                 | 1                    |

Table 1 - PWC Intensity Scale



## 2nd step (cont)– Tabulating PWC Matrix:

- A pairwise comparative (PWC) evaluation matrix is needed to tabulate all possible comparisons using the 1-9 intensity scale (previous slide)

|                  | Technical | Past Performance | Price |
|------------------|-----------|------------------|-------|
| Technical        | 1         | 7                | 3     |
| Past Performance | 1/7       | 1                | 1/3   |
| Price            | 1/3       | 3                | 1     |

Table 2 –  
PWC Matrix

- According to this PWC matrix table:
- Technical is “very strongly more important” than Past Performance (7)
- Technical is “moderately more important” than Price (3)
- Price is “moderately more important” than Past Performance (3)

# Second step (cont) – Calculating the Priorities (weights) of the criteria

- The priorities are obtained by raising the table (matrix) to a large power to capture all the interactions, adding the entries in each row and dividing by the total sum of the rows as shown below when the matrix is raised to the power of 2 three times ( $=2^3$ ).

Table 3a – PWC matrix raised to the power of 2 & calculated priorities

|                  | Technical | Past Performance | Price  | Sum    | <b>Priority</b> |
|------------------|-----------|------------------|--------|--------|-----------------|
| Technical        | 27.254    | 207.44           | 75.190 | 309.89 | <b>0.669</b>    |
| Past Performance | 3.580     | 27.254           | 9.878  | 40.71  | <b>0.088</b>    |
| Price            | 9.878     | 75.190           | 112.32 | 112.32 | <b>0.243</b>    |
|                  |           |                  |        | 462.92 | <b>1</b>        |

# Second step (cont) – Calculating the Priorities (weights) of the criteria

- Typically we report the original table with the comparison judgments and add a column with the calculated priorities.

Table 3b –  
PWC matrix  
with original  
PWC judgments  
& Priorities

|                  | Technical | Past Performance | Price | <b>Priority</b> |
|------------------|-----------|------------------|-------|-----------------|
| Technical        | 1         | 7                | 3     | <b>0.669</b>    |
| Past Performance | 1/7       | 1                | 1/3   | <b>0.088</b>    |
| Price            | 1/3       | 3                | 1     | <b>0.243</b>    |

- The Priority column indicates the relative importance of each of the factors to be used in the supplier evaluation

# Second step (cont): Interpreting Criteria Weight Results

- The criteria weights can be interpreted as the relative % of importance of each factor with respect to the overall importance of all criteria.
- These criteria weights (priorities) are summarized below.

| Criteria         | Weights |
|------------------|---------|
| Technical        | 66.90%  |
| Past Performance | 8.80%   |
| Price            | 24.30%  |

**Criteria Weights**

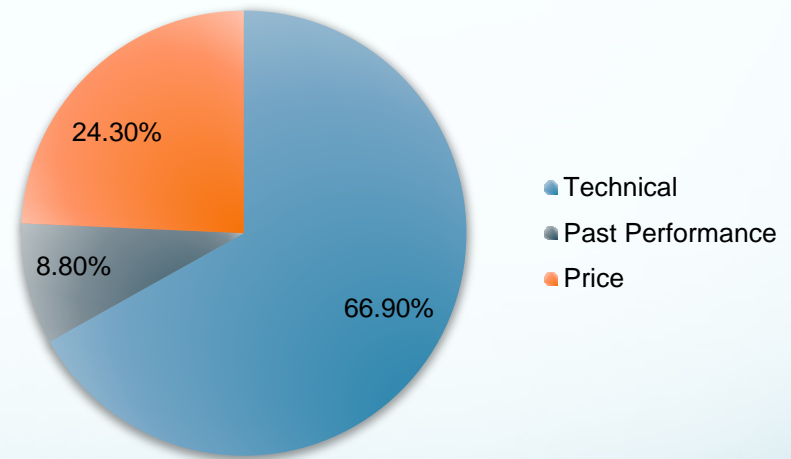


Fig. 2 – Relative importance of each criterion

# Third Step – PWC of alternatives with respect to each criterion

- Next we evaluate the alternatives comparatively with respect to each criterion separately to obtain so called local priorities of the alternatives.
- With Respect to Technical Alpha is very strongly more preferred
- With Respect to Past Performance Beta is strongly more preferred
- With respect to Price Beta is extremely more preferred

Table 5a – Respect to Technical Factor

| Technical | Alpha | Beta | Priority     |
|-----------|-------|------|--------------|
| Alpha     | 1     | 7    | <b>0.875</b> |
| Beta      | 1/7   | 1    | <b>0.125</b> |

Table 5b – Respect to Past Performance

| Past Performance | Alpha | Beta | Priority     |
|------------------|-------|------|--------------|
| Alpha            | 1     | 1/5  | <b>0.167</b> |
| Beta             | 5     | 1    | <b>0.833</b> |

Table 5c – Respect to Price

| Price | Alpha | Beta | Priority   |
|-------|-------|------|------------|
| Alpha | 1     | 1/9  | <b>0.1</b> |
| Beta  | 9     | 1    | <b>0.9</b> |

# Third Step (cont)– PWC of alternatives with respect to each criterion

- Let's interpret the meaning of the local priorities of the alternatives:
- If technical were the only factor, the best value would be Alpha (87.5% of the preference), for past performance the best value is Beta (83.3% of the preference and Beta is preferred with respect to price (90%)

Table 5a – Respect to Technical Factor

| Technical | Alpha | Beta | Priority     |
|-----------|-------|------|--------------|
| Alpha     | 1     | 7    | <b>0.875</b> |
| Beta      | 1/7   | 1    | <b>0.125</b> |

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| Past Performance | Alpha | Beta | Priority     |
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| Price | Alpha | Beta | Priority   |
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## Fourth Step (cont)– Model Synthesis (Selecting the Best Value Supplier)

- Next, calculate the weighted sum of each row in the table to obtain the overall priorities.

|                               | Technical | Past Performance | Price | Overall Priority |
|-------------------------------|-----------|------------------|-------|------------------|
| <i>Criteria Weights -&gt;</i> | 0.669     | 0.088            | 0.243 |                  |
| Alpha                         | 0.875     | 0.167            | 0.100 | <b>0.624</b>     |
| Beta                          | 0.125     | 0.833            | 0.900 | <b>0.376</b>     |



Best Contractor:  
**62.4%** of the  
Overall  
preference!

Table 6 – Model Synthesis (Selecting the best contractor)

# AHP can be used to implement FAR 13 comparative evaluations for selection of the “best value” quotes

| Comparative Evaluation is:   | AHP Methodology is:   |
|--|---|
| Applicable to FAR 13 procedures  | Applicable to other procedures in the industry  |
| Direct Comparison of one quotation with another in a uniform and fair manner   | Direct Comparison of one quotation (alternative) with another in a uniform and fair manner to obtain the relative priority (preference) of each |
| Contrasted with FAR 15, because FAR 13 solicitations are not required to state the relative importance assigned to each evaluation factor . <a href="#">FAR 13.106-1(a)2</a> | In addition, it is possible to do this same comparative evaluation if the different evaluation factors need to have different importance        |
| Identifying and choosing the "Best value"  | The "Best" alternative can be obtained through a process of synthesis   |
| Appropriate when you expect that quotes received will have "enough common-ground, equivalence, or similarities to permit a meaningful " <i>comparative evaluation</i> "      | Appropriate whenever the elements being compared can be meaningfully compared between them with respect to an overall goal or criterion.        |

Table 7 – FAR 13 comparative evaluation and AHP process



# Conclusion

- We have determined both the relative importance of the criteria and alternatives through a process of comparative evaluation.
- This process has been done pairwise and synthesized to obtain first the criteria importance weights and next the overall priorities (preferences) to select the best value quotation.
- We have shown that an AHP approach is consistent with *comparative evaluation* in FAR13!

# Conclusion: Definition

- The AHP framework yields a useful definition of *comparative evaluation* as applied to the Federal Acquisition Regulations (FAR).
- Using the terminology of the FAR:
  - *Comparative evaluation* is the structured and orderly, side by side pairwise comparison of quotations, each with the other, with respect to value indicators which are consistently applied and results in a Contracting Officer decision for the best value quote.

# AHP Software

- In real life, the process is much simpler and painless thanks to software availability.
- A Popular open source available software is: [SUPER DECISIONS v3](#).
- You can read a [Practical Decision Making Using Super Decisions v3](#) by Mu & Pereyra-Rojas (2017) book to learn how to use AHP with the software.

# Bibliography

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Thank you

Questions?