STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY

The Connotative Meaning of Independence in System Evaluations

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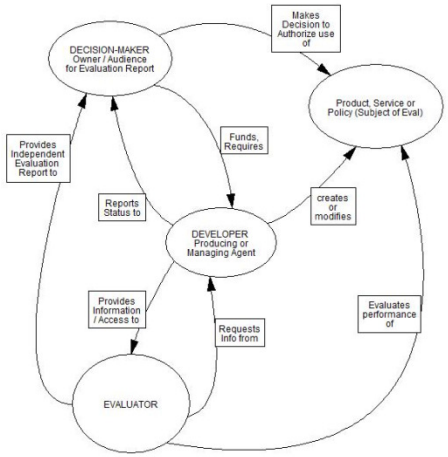
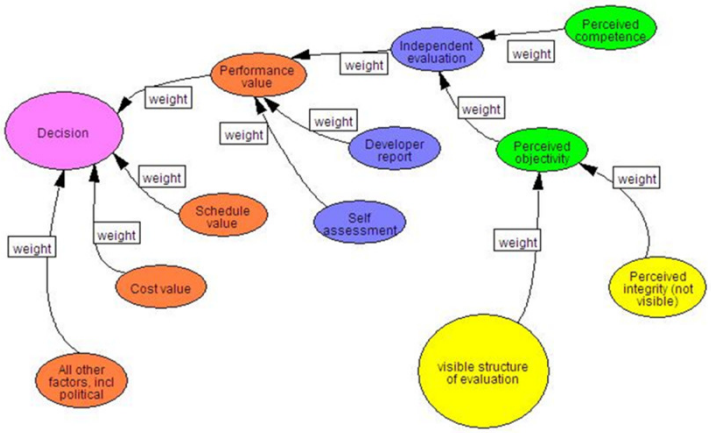
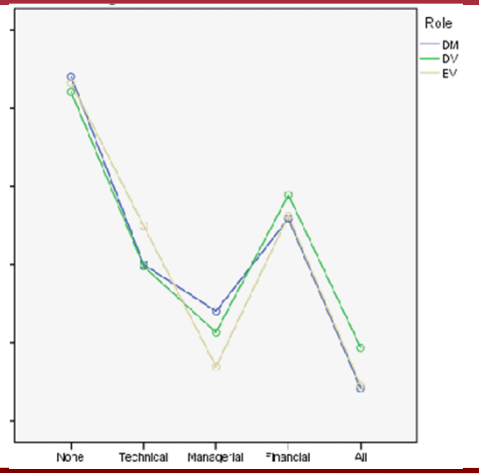
Robert Lowe Barnett







Committee Chair and Members

- Committee Chair:
  - Dr. Brian J. Sauser
- Members:
  - Dr. Arthur B. Pyster
  - Dr. Peerasit Patanakul
    - Howe School of Technology Management
  - Dr. John V. Farr
    - United States Military Academy

Introduction

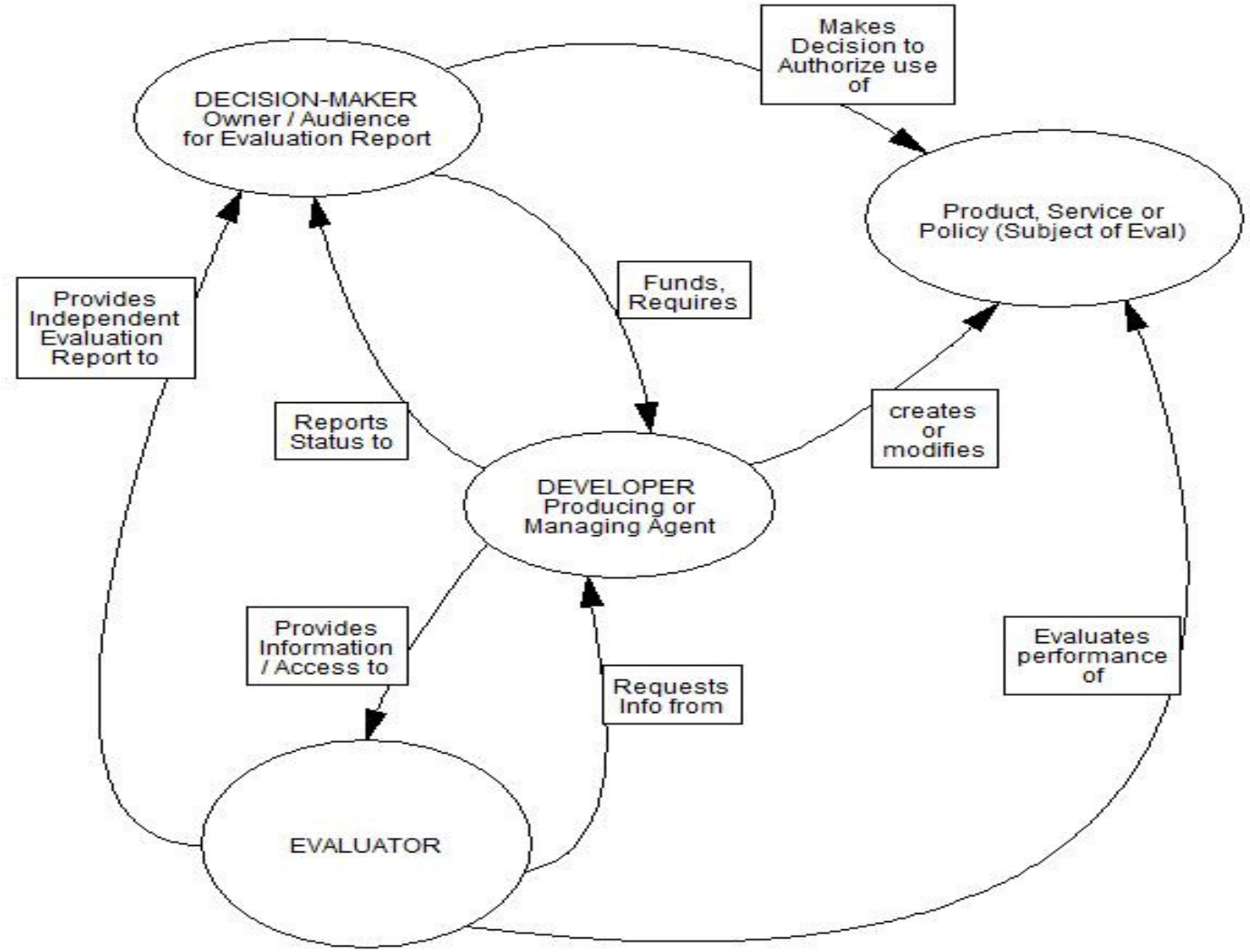
- Problem Statement
  - Including independent evaluation can be costly
  - Value to the decision-maker not yet been measured
  - Independence can not be scaled with any precise rationale

- Problem Motivation
  - Need for a shared understanding of what independence means
  - Do not know how to tailor for cost saving

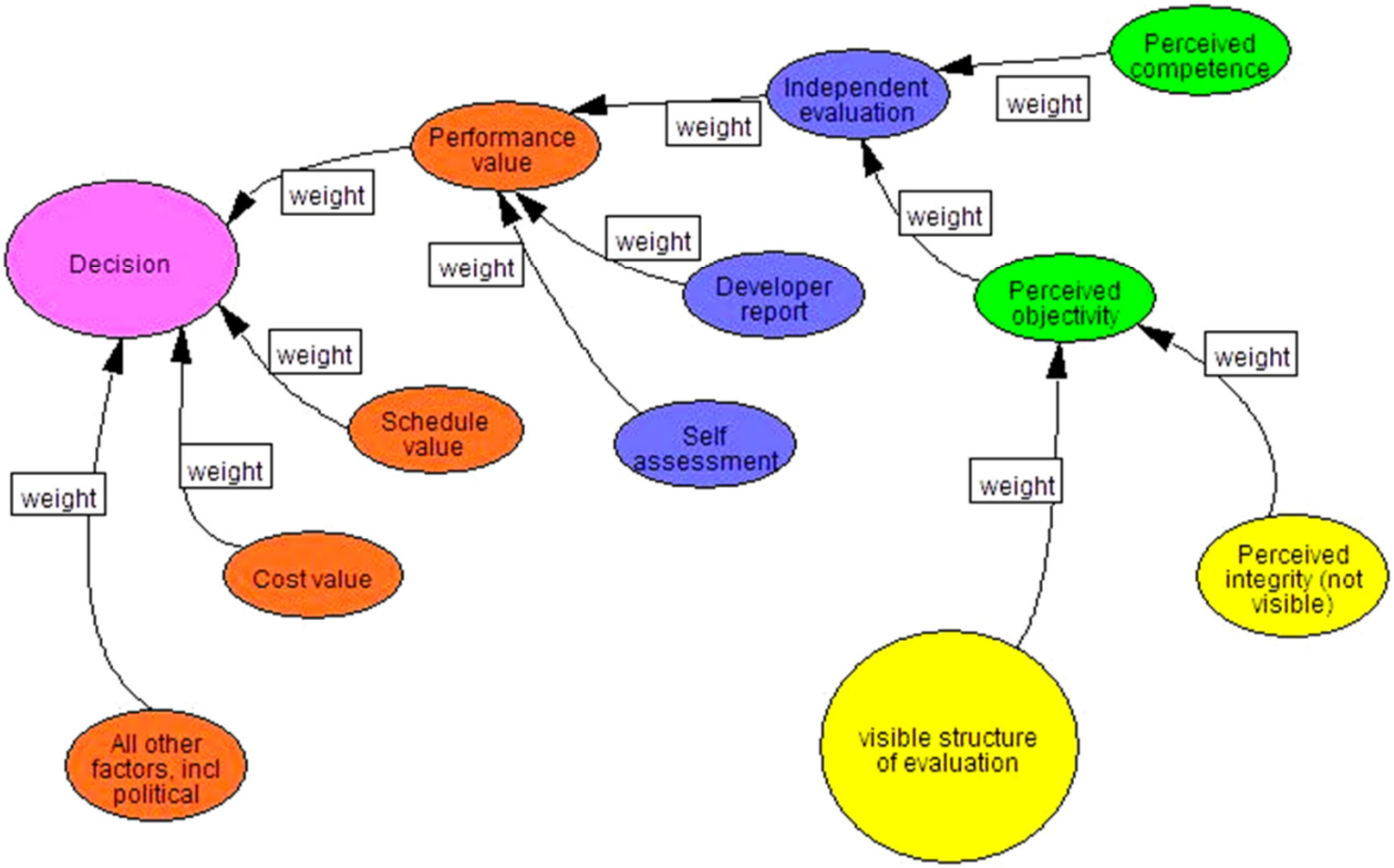
Background/Uniqueness

- Problem Background
  - Little to no research into independence definition and measurement found in systems engineering literature
  - Aspects of the decision making process include
    - thinking (rational, cognitive),
    - feeling (affective, motive), and
    - behaving (habitual, customary, traditional)
  - More research in other disciplines, including
    - Financial Accounting
    - Program/Policy/Regulatory Evaluation
    - Corporate Governance, Central Banks
  - Commonalities in the structure of evaluation scenarios across multiple disciplines makes this a "systems problem."

Background/Evaluation Model



Background/Decision Influences



Methods/Hypotheses

- **Hypothesis 1: Reliable Measure:** The connotative meaning of evaluator independence can be described by the Evaluation-Potency-Activity (E-P-A) three-factor model for affective response.
  - [Alternatively, the measurement may be 1-factor (uni-dimensional), or 2-factor].

- **Hypothesis 2: Stakeholder Roles**: There are statistically significant differences in factor scores between groups of participants.
  - (Roles: Decision makers; Developers/ Producers; and Evaluators).

- **Hypothesis 3: Independence Parameters**: There are statistically significant differences in factor scores between the alternative independence scenarios for the three IEEE parameters
  - (Technical, Managerial, and Financial). (IEEE 2005, 90)

Methods/Research Design

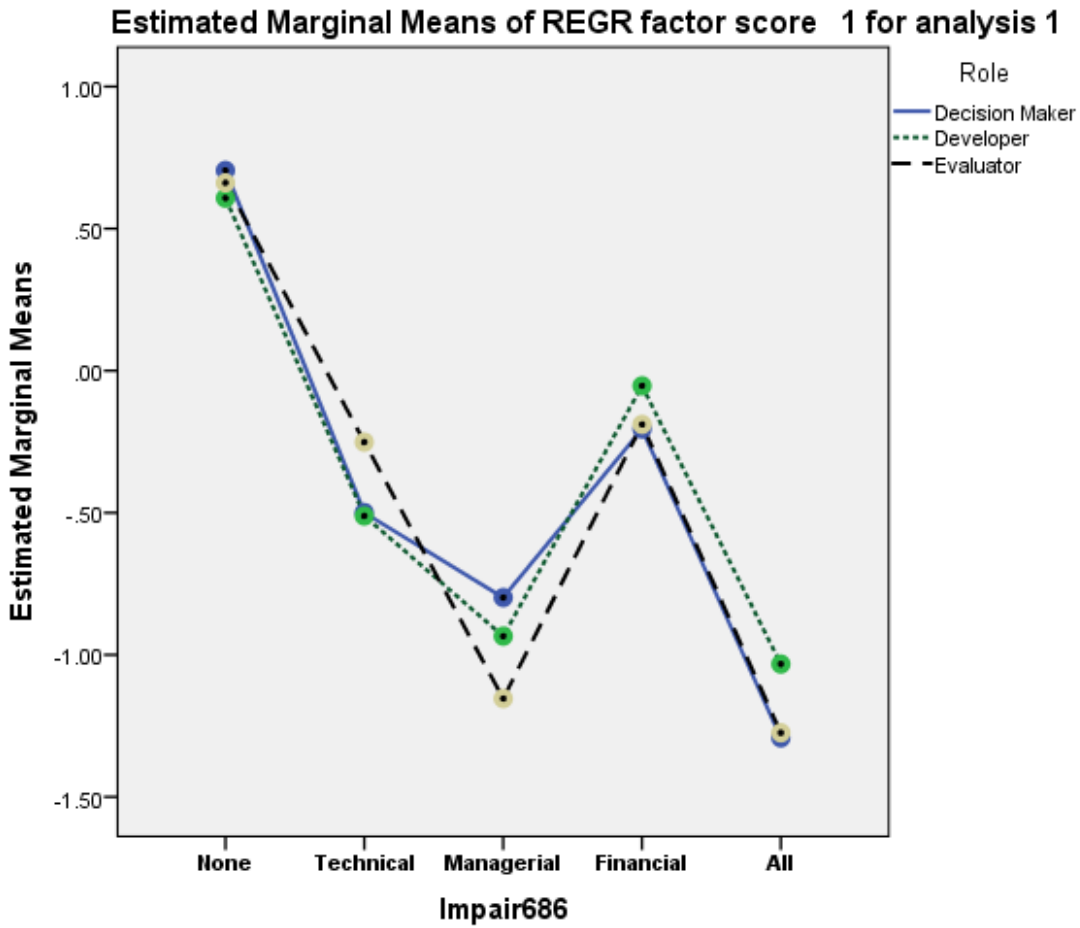
- Methods Employed
  - In situ controlled-task protocol
  - Scenarios based on IEEE Software V&V Standard, Annex C
  - Two Scenarios; first w/no impairments to independence, using
    - Semantic Differential Scales (Indirect – 7-point)
    - Direct Scalar (7 pt Likert: Agreement w/statement of independence)
    - Direct Binary Satisfaction question
  - Factorial Design: 3 Roles x 4 Scenarios = 12 Analysis Cells
  - Sample Size Achieved: 343 Usable surveys, 686 Scenarios
    - In profile: older, highly educated, working in, or retired from, very critical industries,
    - dealing frequently with evaluation reports and considering them important in their work.
    - Transportation (53%+), Military Systems(17%), Space Systems (5%)

Results/Factor Structure

- 22 scales used to test correlations around Evaluation (8), Potency (7) and Activity (7) concepts
- Initial Factor Analyses found 3 eigenvalues above 1.0, one clearly dominant (11.209; 1.433; 1.134; 0.960)
  - High loadings from Evaluation and Potency on first factor
- On subsequent trials, eliminated weaker variables, one at a time, down to 19 variables, by..
  - Lowest Communalities
  - Lowest maximum loadings
- Second factors were never reliable (< 80% shared variance) across split-halves and all role subsets

Results/Single Factor Solution

- Scenarios Distinct
- Roles Clustered
  - Shared Meaning
- Order of Value
  - No impairments
  - Financial Imp.
  - Technical Imp.
  - Managerial Imp.
  - All Impairments
- Binary question supported order
  - 89% Correlation



Results/Hypothesis Summary

- The findings indicate that:
  - The relative value of independent evaluation alternatives can be measured.
  - Independence is viewed through the same lens by diverse parties to evaluations.
  - Managerial independence is more important than Technical or Financial independence (using IEEE standard definitions).
- Hypothesis 1 Measure for Relative Value of Independence Scenarios
  - 3-Factor E-P-A Not Supported
  - One Factor solution reliable
- Hypothesis 2 Stakeholder Roles: Not Supported
- Hypothesis 3 Independence Parameters: Supported

Results/Quality of Measures

- Performed discriminant analysis to determine which measures best predicted Satisfactory / Unsatisfactory
- Indirect questions have potential to reduce bias in conflicted environment

Input measure for Discriminant Analysis	**Percentage correct in cross-validation**
Factor score from 22 variables	88.10%
Top variable - P7WS (Weak – Strong)	86.30%
Top 2 variables, adding E2BG (Bad – Good)	88.30%
Top 3 variables, adding E4RS (Risky – Safe)	88.80%
Top 4 variables, adding P2IR (Imaginary – Real)	89.10%
Top 5 variables, adding E1AB (Adverse – Beneficial)	88.80%
Top 6 variables, adding P3IC (Incomplete – Complete)	88.90%
Top 7 variables, adding E5SO (Subjective-Objective)	88.90%
Factor score from same 7 variables	89.10%
Question 1, independence maintained?	85.90%
Question 11, important to your occupation?	51.50%

Conclusions/Future Research

- Successfully established a reliable measure for the connotative, affective meaning of independence in system evaluations
- Demonstrated other measures which may have the same discriminating power for assessing acceptability of independence scenarios
  - Can be used to discriminate between alternative evaluation independence scenarios and in some cases will be more reliable than direct questions in establishing the strength of affective meaning.
- Determined that this affective meaning is substantially shared across the stakeholder groups involved in systems engineering decision making.
- Future Research: refinement of constructs
- Future Research: use in studies with broader scope
- Future Research: much more in current data base