An Analytic-Deliberative Process for the Selection of Radiation Detection Systems for Shipping Ports and Border Crossings

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Advanced Spectroscopic Portal Monitors

- **Option A "No Change"**
  - Uses current PVT (Poly-vinyl Toluene) Non-spectroscopic technology for primary inspection and hand-held radio-isotope identifier devices (RIIDs) for secondary inspections.
- **Option B "PVT Primary, NaI Scintillator Secondary"**
  - Uses current PVT Non-spectroscopic technology for primary inspection and replaces RIIDS with NaI based spectroscopic system for secondary inspections
- **Option C "NaI Scintillator Primary, HPGe Secondary"**
  - Replaces current PVT technology with an automated, NaI based, spectroscopic system for primary inspections and uses high-resolution HPGe detectors for secondary inspections.
- **Option D "Hybrid Primary, HPGe Secondary"**
  - Small throughput ports use PVT detectors and Large throughput ports use NaI detectors for primary inspections. All ports use HPGe detectors for secondary inspections.
- **Option E "NaI Primary, NaI Secondary"**
  - Uses NaI in both primary and secondary roles with the secondary detector collecting counts for minutes instead of seconds

The Analytic-Deliberative Process for Decision Making

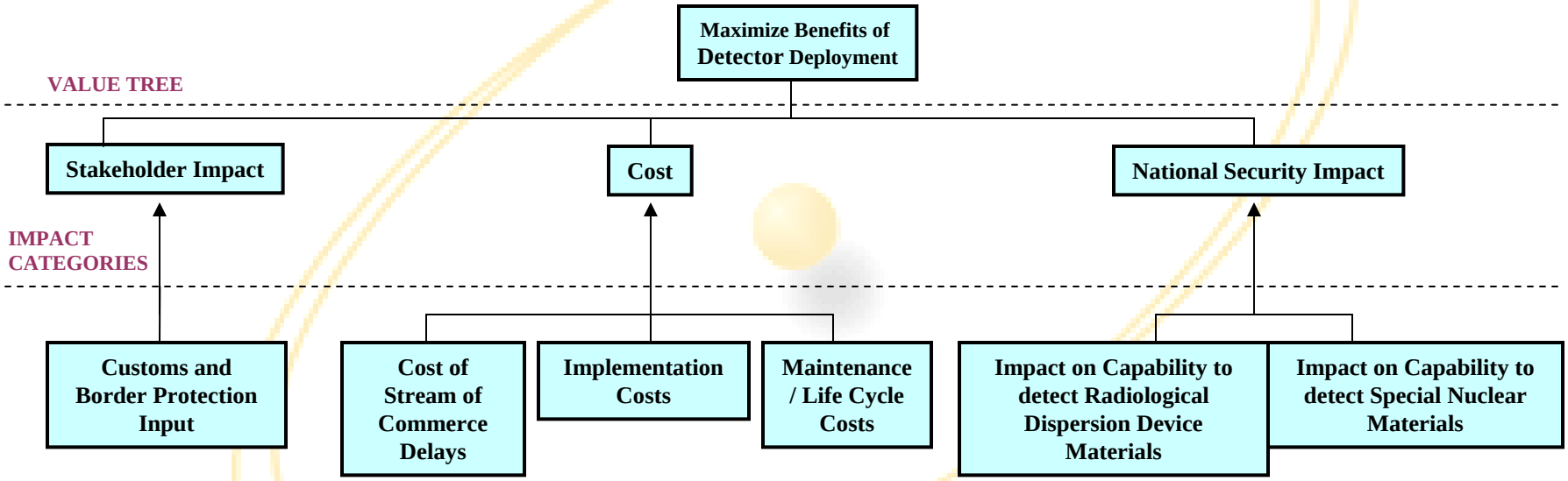
- **Consists of two parts:**
  - **<u>Analysis</u> uses rigorous, replicable methods, evaluated under the agreed protocols of an expert community - such as those of disciplines in the natural, social, or decision sciences, as well as mathematics, logic, and law - to arrive at answers to factual questions.**
  - **<u>Deliberation</u> is any formal or informal process for communication and collective consideration of issues.**

National Research Council, *Understanding Risk*, 1996.

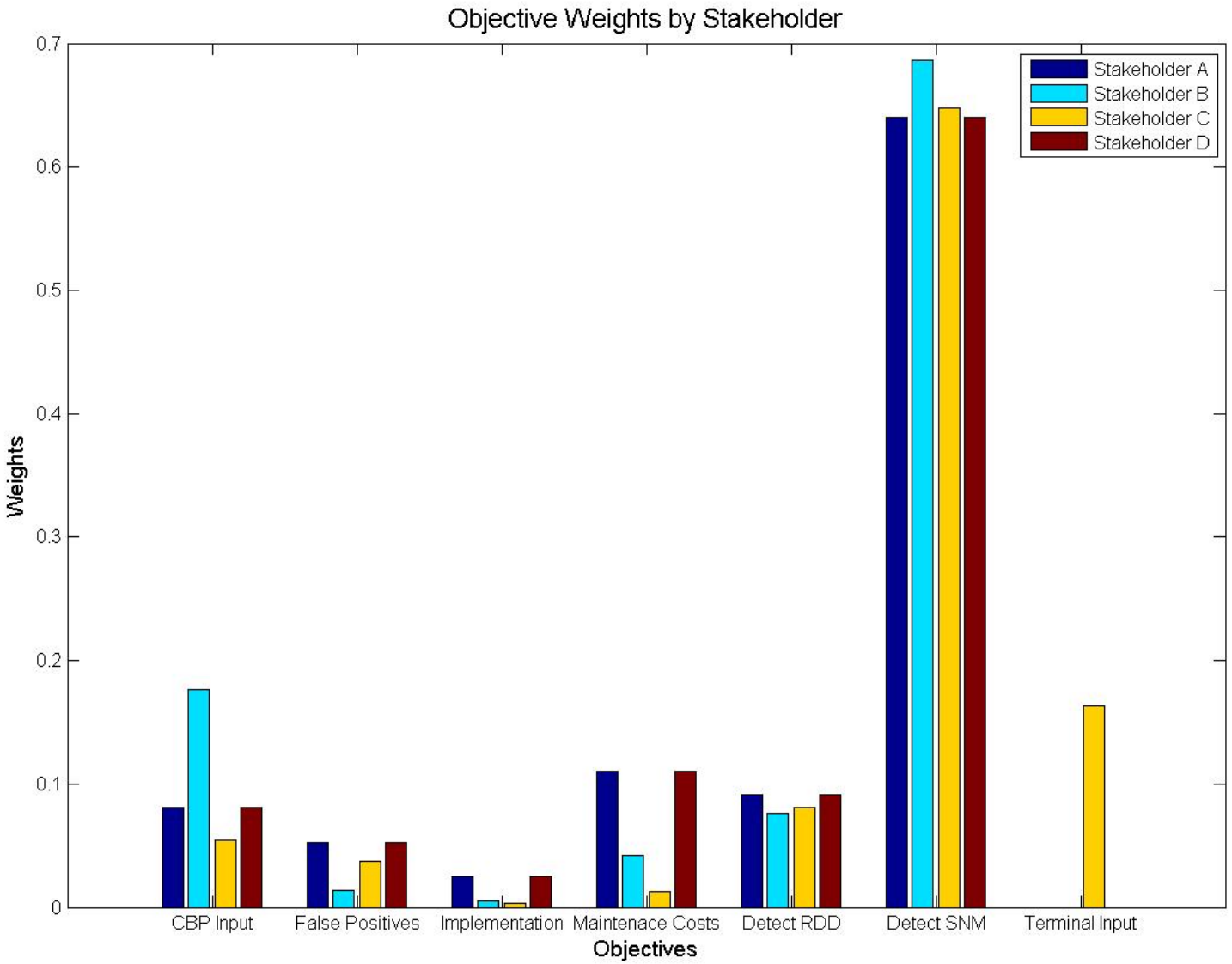
The Stakeholders

- **Stakeholder A: Deputy Assistant Director, Transformation Research and Development**
- **Stakeholder B: Assistant Director, Systems Engineering and Evaluation**
- **Stakeholder C: Principal Deputy Assistant Director, Product Acquisition Directorate**
- **Stakeholder D: Program Manager, System Development and Acquisition**

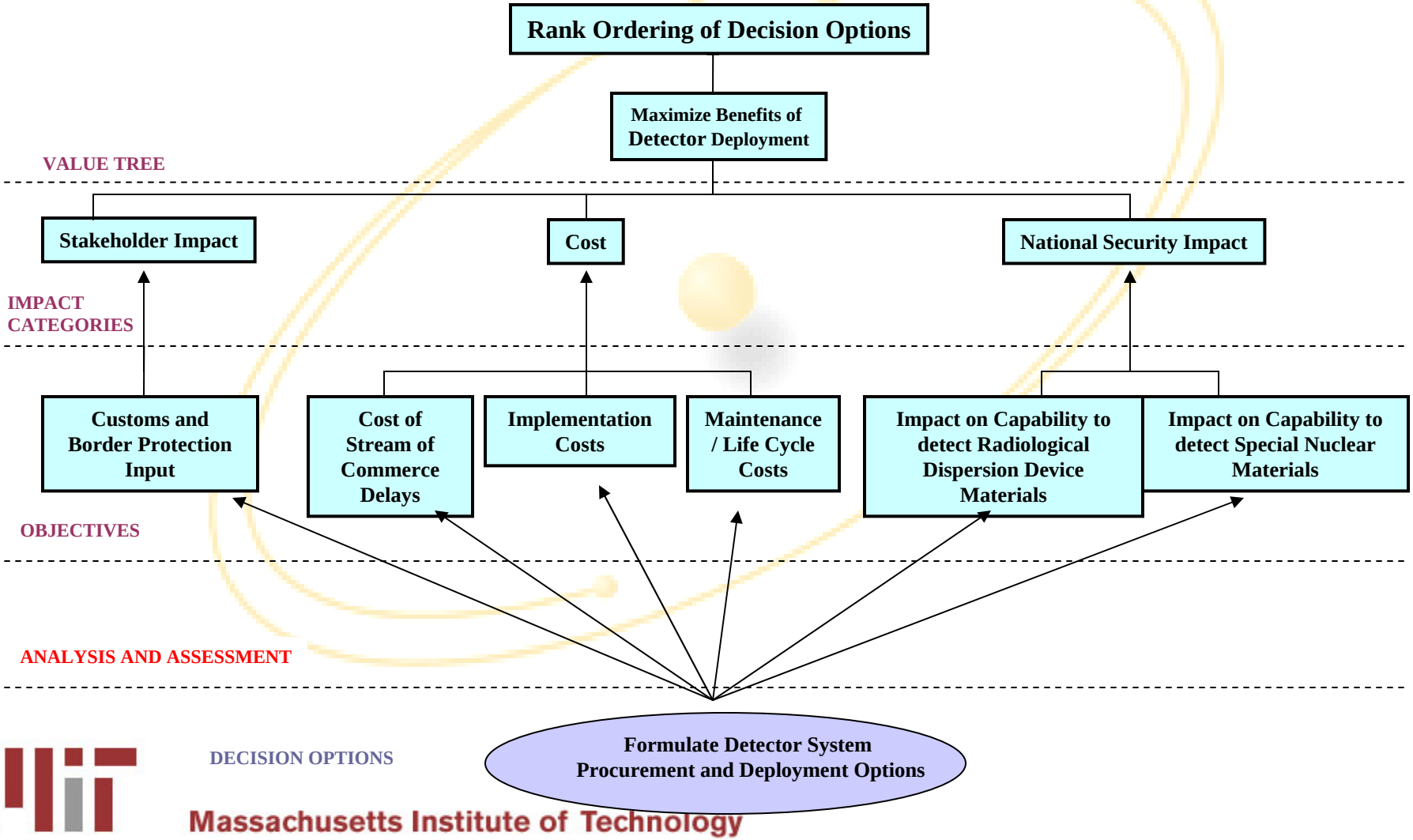
The Value Tree



Weights of Stakeholder Objectives



Analysis


Rank Ordering of Decision Options
Maximize Benefits of Detector Deployment
VALUE TREE
Stakeholder Impact
Cost
National Security Impact
IMPACT CATEGORIES
Customs and Border Protection Input
Cost of Stream of Commerce Delays
Implementation Costs
Maintenance / Life Cycle Costs
Impact on Capability to detect Radiological Dispersion Device Materials
Impact on Capability to detect Special Nuclear Materials
OBJECTIVES
ANALYSIS AND ASSESSMENT
DECISION OPTIONS
Formulate Detector System Procurement and Deployment Options

Value Functions and Constructed Scales – An Example

Major Objections: CBP anticipates significant complications integrating the new system

Minor Objections: CBP would prefer a different system than the one chosen but can implement with minor complications

OK-Ambivalence: CBP has no preference between this system and the next competitor

Approval: CBP agrees with and approves of the chosen system

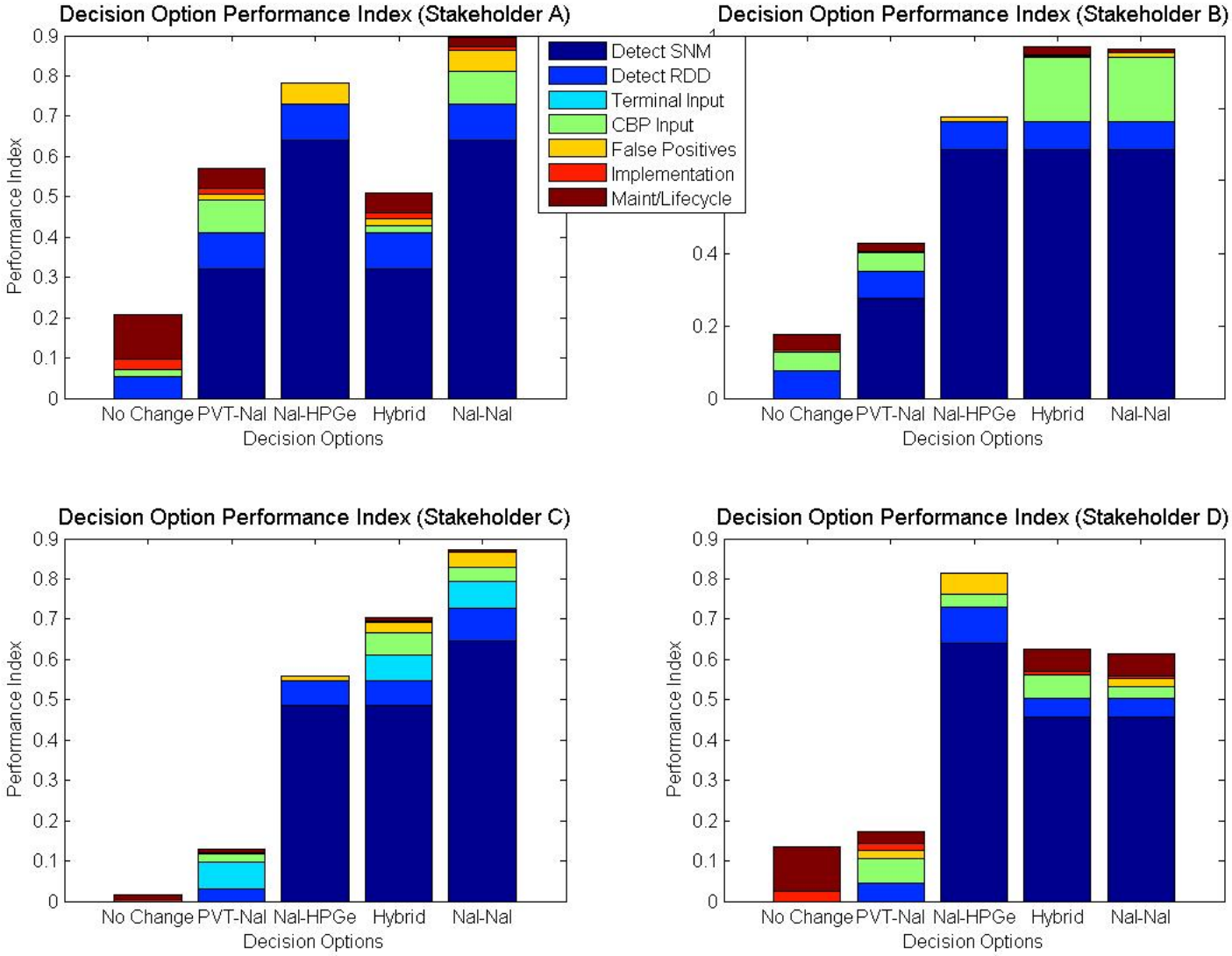
CBP Input	
Level	**Value**
Major Objections	0
Minor Objections	0.22
OK-Ambivalence	0.67
Approval	1

Analyze and Rank the Decision Options

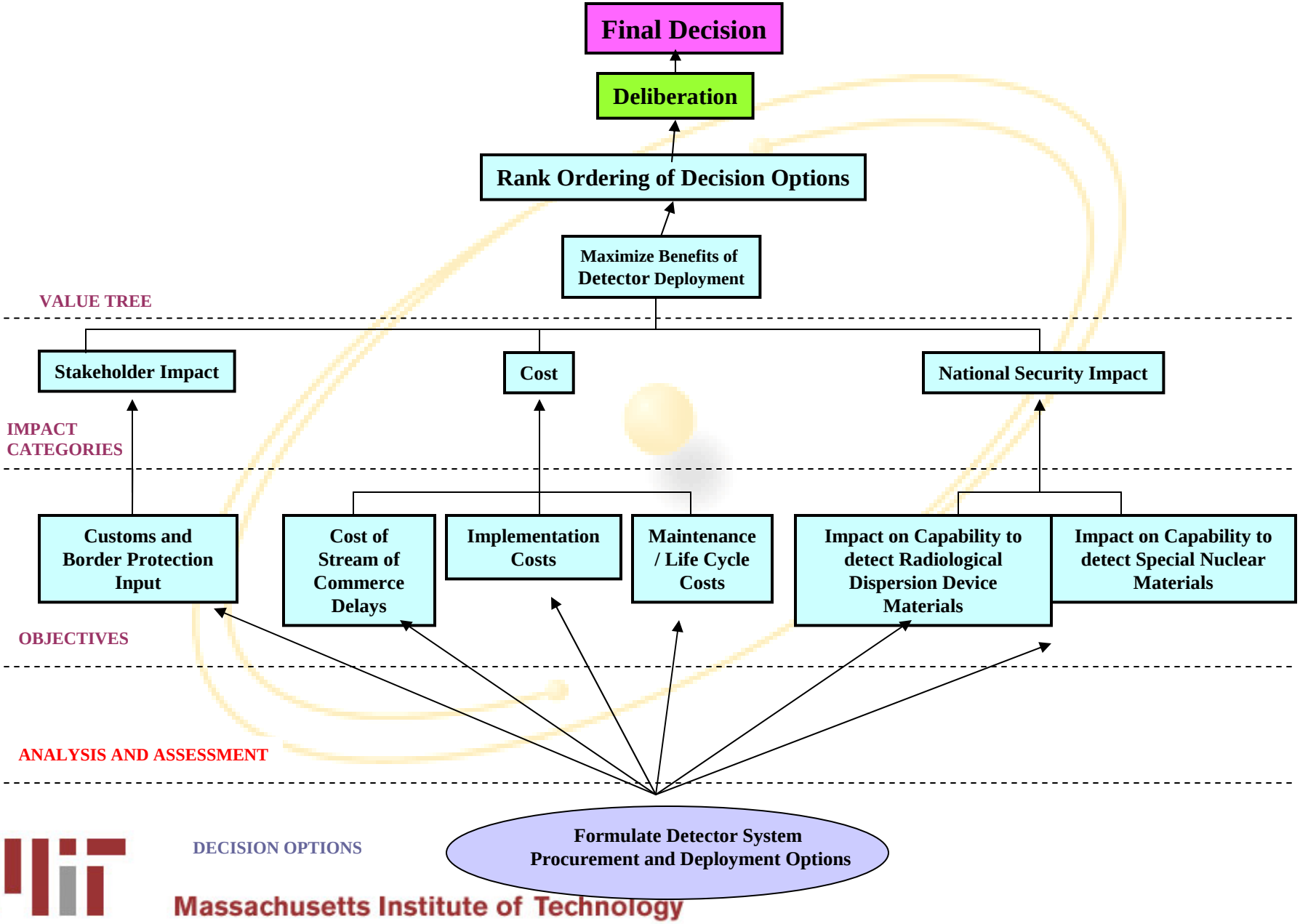
- **The Performance Index for alternative j, is defined as the sum of values associated with the j^{th} decision option's performance in achieving each objective, multiplied by the relative importance weight w_i for that objective.**

$$PI_j = \sum_{i=1}^{N} w_i v_{ij}$$

Stakeholder Ranking of the Decision Options



The Analytic-Deliberative Process



The Deliberation

- **Eliminated *No Change* and *PVT-NaI* from further discussion**
- **Allowed Stakeholders to debate/ clear up misunderstandings**
  - ***Stakeholder D:***
    - **Thought CBP preferred the NaI-HPGe option. Had not read the most recent CBP position paper**
    - **Assumed Dwell Time for Secondary Inspections was too long leading to HPGe detectors outperforming NaI detectors. Convinced this was not true.**
  - ***Stakeholder C:***
    - **Insisted to keep terminal operator views separate from those of the CBP. Argued that TO's views were strictly business related. The final rankings were insensitive to this separation.**

Uncertainties

- **The stakeholders were not as sure of the expected outcomes as they initially believed themselves to be.**

- **They decided to proceed cautiously:**
  - **they would initially use decision option B, PVT-NaI, to gather additional data from actual field use of the new systems.**
  - **If the field reports indicated that the NaI systems performed as expected, then the decision would be switched to hybrid primary inspections and NaI for secondary inspections.**
  - **Finally, if the NaI systems performed as expected in a primary function, then DNDO would consider switching to NaI-NaI for all ports and border crossings.**

References

- **Koonce, A.M., Apostolakis, G.E., and Cook, B.K., "Bulk Power Grid Risk Analysis: Ranking Infrastructure Elements According to their Risk Significance," *International Journal of Electrical Power and Energy Systems*, 30:169-183, 2008.**
- **Li, H., Apostolakis, G.E., Gifun, J., VanSchalkwyk, W., Leite, S., and Barber, D., "Ranking the Risks from Multiple Hazards in a Small Community," *Risk Analysis*, accepted for publication, 2008.**
- **Michaud, D., and Apostolakis, G.E., "Methodology for Ranking the Elements of Water-Supply Networks," *Journal of Infrastructure Systems*, 12:230-242, 2006.**
- **Patterson, S.A., and Apostolakis, G.E., "Identification of Critical Locations across Multiple Infrastructures for Terrorist Actions," *Reliability Engineering and System Safety*, 92:1183-1203, 2007.**