



# Looking at the Full Picture: Evaluating Alternatives with the Execution Risk Assessment Framework

Robert Henry

The MITRE Corporation

14<sup>th</sup> Annual NDIA Systems Engineering Conference

**The views, opinions, and/or findings contained in this report are those of The MITRE Corporation and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.**

# Getting the Full Picture

- **Trade Space Analysis (AoAs, FSAs, Trade Studies, Course of Action Evaluation, etc.) often focus solely on the cost and benefit and do not address or integrate the organization's ability to successfully execute the alternatives being evaluated**
- **Traditional risk assessment methodologies are inadequate to compare alternatives against each other**
- **Objective:**
  - **Develop a consistent and comparable risk assessment across alternatives**
  - **Reflect risk that could prevent a proposed solution from successfully being implemented (executed) and delivering its promised benefits / capabilities**

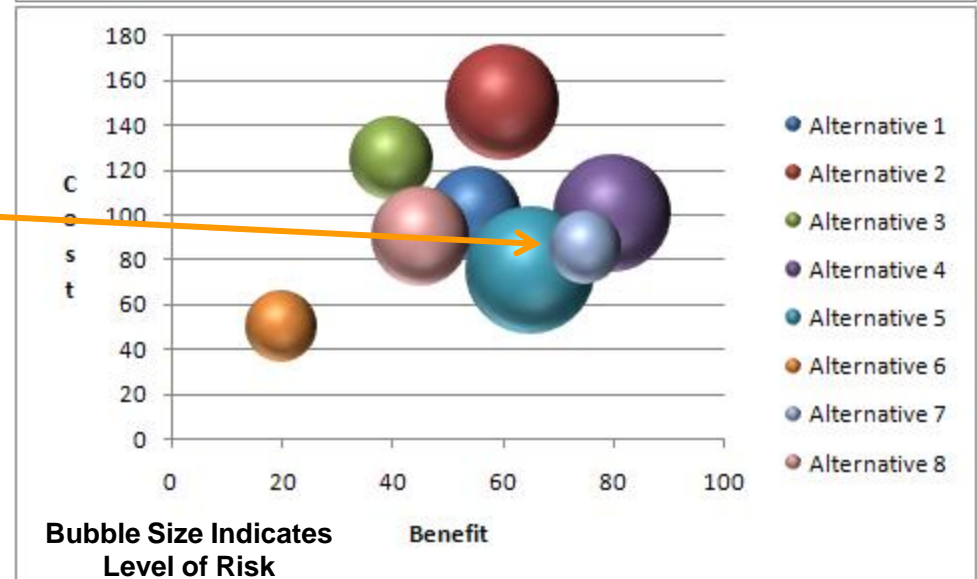
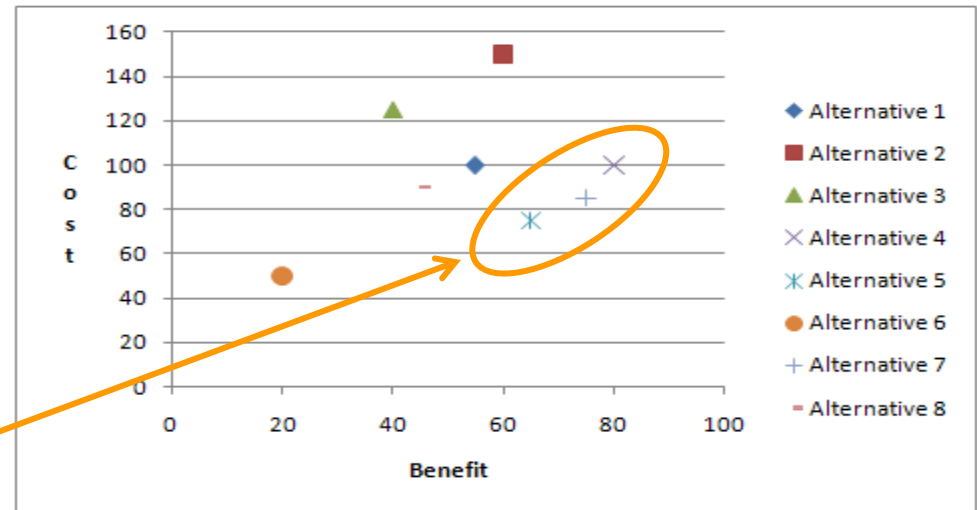
## ULTIMATE GOAL

Select the alternative with:

**Greatest Benefit, Lowest Cost, & Least Risk**

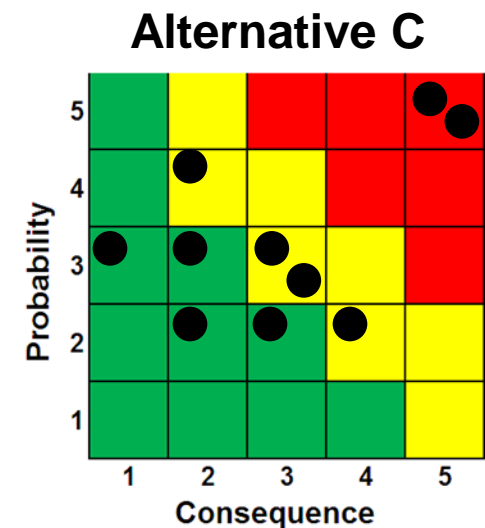
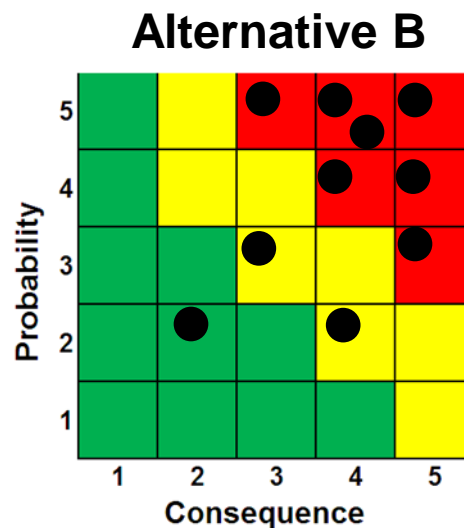
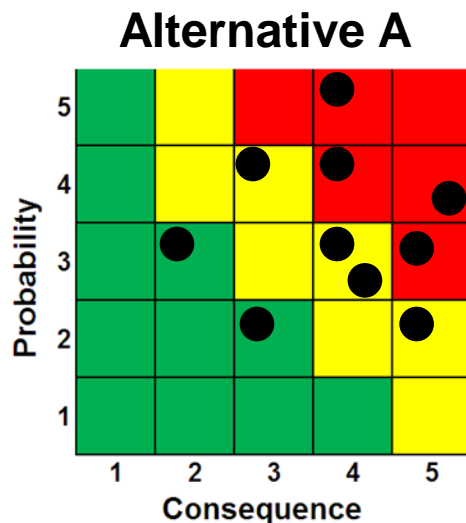
# Limits of Cost-Benefit Analysis (Without Risk)

- Not integrating risk into cost-benefit analysis can lead to selection of a high risk alternative
- Alternative 4, 5, & 7 appear relatively equal from a cost-benefit perspective
- When risk is factored in Alternative 7 is clearly the optimal solution



# Limits of Traditional Risk Analysis

- Traditional risk analysis does not provide the ability to compare the level of risk between alternatives and does not lend itself to providing a summary risk score
- The fact that a given alternative has more high risks than other alternatives does not necessarily mean it is the highest risk alternative
- The magnitude of the high risks in Alternative C may outweigh the high risks in Alternative B



# Execution Risk Methodology / Approach

## ■ Develop risk scale tailored to organization

- Delineate / define risk categories
- Define uniform scoring against risk categories
  - Utilize 0-100 range
  - Define meaningful segments within range (e.g., 0-20 = low)
  - Assign colors to each segment (Green, Yellow, Red) to support visualization and summarization
  - Provide text description for each segment & risk category; may include criteria specific to the risk category to indicate the level of risk
- Vet scales with community / leadership, revise as needed

Risk Category	Risk Level	Risk Score
Low Risk	0-20	Green
Medium Risk	21-40	Yellow
High Risk	41-100	Red

## ■ Develop risk score for each risk category, for each alternative via application of risk scales in facilitated meetings with SMEs

- Document basis of assessment (capture rationale)

## ■ Develop overall risk score by combining category risk scores via “roll-up” rule

## ■ Update based on feedback; finalize

*Methodology has been applied to multiple Government Sponsors*

# Risk Categories/Segments

## ■ Twelve (12) risk categories have been defined:

- Funding / Resources
- Personnel / Skill Mix
- Confidence in Cost Estimate
- Advocacy
- Schedule
- Statutory / Regulatory
- Tech Maturity
- Technical Performance
- Operational - Deployability
- Operations / Sustainment
- Integration Complexity
- Interoperability

## ■ Six (6) risk segments have been defined:

- $0 < 20$ , Low, **Green**
- $20 < 40$ , Low-Medium, **Green**
- $40 < 60$ , Medium, **Yellow**
- $60 < 80$ , Medium-High, **Yellow**
- $80 < 100$ , High, **Red**
- $100$ , Catastrophic, **Red**

# Execution Risk Scale

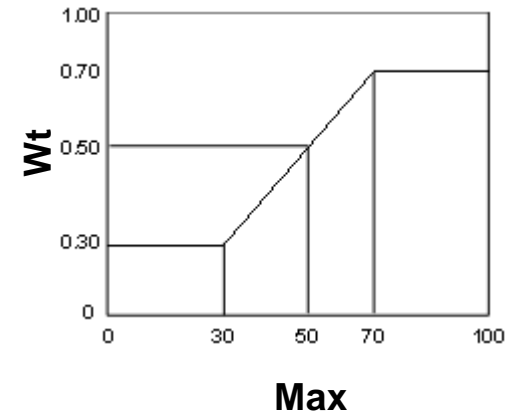
## Sample Scale

Category	Details	Low 0 < 20 score	Low-Med 20 < 40	Med 40 < 60	Med-High 60 < 80	High 80 < 100	Catastrophic 100
	<b>This refers to:</b>	The risks in this area will have a <b>little to no impact</b> on the Alternative's achieving its stated outcome objectives.	The risks in this area will have a <b>minor impact</b> on the Alternative's achieving its desired result, to the extent that one or more of its stated outcome objectives will fall below goals but well above minimum acceptable levels.	The risks in this area will have a <b>moderate impact</b> on the Alternative's achieving its desired result, to the extent that one or more of its stated outcome objectives will fall well-below goals but above minimum acceptable levels.	The risks in this area will have a <b>significant impact</b> on the Alternative's achieving its desired result, to the extent that one or more of its stated outcome objectives will fall below minimum acceptable levels.	The risks in this area will have a <b>severe impact</b> on the Alternative's achieving its desired result, to the extent that one or more of its critical outcome objectives will not be achieved.	<b>Showstopper.</b> The Alternative will not achieve any of its outcome objectives.
Funding / Resources	Funding and resource availability in the time increment needed.	High confidence that the funding and resources are available and secured in the timeframe needed. Budgets reflect full funding support for component programs.	Strong confidence that the funding and resources are available and supported in the timeframe needed. Budgets reflect full funding support for component programs.	Reasonable confidence that the funding and resources are likely in the timeframe needed. Budgets reflect funding support for components but with a focused interest on other requirements.	Low confidence that the funding and resources are being pursued in the time increment needed. Organization is investigating purchasing alternative equipment that negates Alternative capabilities.	Little/no confidence that the funding and resources have not been identified and are not supported. Organization is purchasing or have purchased alternative equipment that negates Alternative capabilities.	Funding and resources are not available for successful execution of the Alternative.
Personnel / Skill Mix	Availability of needed personnel / skill mix to support the mission.	High confidence that the required personnel / skill mix will be available.	Strong confidence that the required personnel / skill mix will be available.	Reasonable confidence that the required personnel / skill mix will be available.	Low confidence that the required personnel / skill mix will be available.	Little/no confidence that the required personnel / skill mix will be available.	Showstopper concern that the required personnel / skill mix will be available.
Confidence in Cost Estimate	Cost estimate confidence	High confidence in the cost estimate.	Strong confidence in the cost estimate.	Reasonable confidence in the cost estimate.	Low confidence in the cost estimate.	Little/no confidence in the cost estimate.	Showstopper concern about the cost estimate.
Advocacy	Internal or external agency opposition for this Alternative to be developed and deployed. Addresses organizational, political, and programmatic support.	There is little to no internal or external opposition to the Alternative.	Internal or external opposition will have minor impact to the implementation of this Alternative.	Internal or external opposition will have moderate impact to the implementation of this Alternative.	Internal or external opposition will have significant impact to the implementation of this Alternative.	Internal or external opposition will have severe impact to the implementation of this Alternative.	This Alternative is completely opposed by one or more internal or external stakeholders. Opposition is a showstopper for this Alternative.
Schedule	Confidence in Alternative schedule to execute on time and be available for the timeframe needed.	High confidence the Alternative will execute on schedule and be available for the timeframe needed.	Strong confidence the Alternative will execute on schedule and be available for the timeframe needed.	Reasonable confidence the Alternative will execute on schedule and be available for the timeframe needed.	Low confidence the Alternative will execute on schedule and be available for the timeframe needed.	Little/no confidence the Alternative will execute on schedule and be available for the timeframe needed.	The Alternative's schedule cannot be executed.
Statutory / Regulatory	Legal/legislative, policy, acquisition processes, waiver needs, treaties, MOUs	This Alternative is in compliance with all current statutes, acquisition processes, treaties, MOUs; there is a low risk of any regulatory guidance, waiver needs, that would delay this Alternative	This Alternative is in compliance with current statutes and regulations, acquisition processes, treaties, and MOUs; however, investigation is needed to determine whether this Alternative will require future waivers, legal, or policy change.	This Alternative has a need for regulatory guidance or waiver, that is common, but has a chance to delay this Alternative development, deployment, and operations.	This Alternative has a need for regulatory guidance or waiver, that is common, but may not be successful that would impact this Alternative development, deployment, and operations.	This Alternative development and operations will require changes to the current statutes, regulatory guidance, acquisition processes, policy, treaties, or MOUs.	Alternative require waivers, legal, policy, or treaty change that will not be supported.
Technology Maturity	Maturity of technologies associated with the alternative	Key technologies are ready and mature and require little/no effort to execute the Alternative.	Key technologies are expected to be ready and mature in time to execute the Alternative.	Key technologies are not ready and mature and require moderate effort to execute the Alternative.	Key technologies are not ready and mature and require significant effort to execute the Alternative.	Key technologies will not be ready and mature and will have a severe impact on this Alternative.	Key technologies will not be available and no alternative is available.
Technical Performance	Confidence in performance expectations, meet specified capabilities	There are no technical performance problems identified that will have any impact on achieving the stated outcome objectives expected from the Alternative.	Limited technical performance problems have been identified that will have a minor impact on achieving the stated outcome objectives expected from the Alternative.	Technical performance problems have been identified that will have a moderate impact on achieving the stated outcome objectives expected from the Alternative.	Technical performance problems have been identified that will have a significant impact on achieving the stated outcome objectives expected from the Alternative.	Serious technical performance problems have been identified that will have a severe impact on achieving the stated outcome objectives expected from the Alternative.	Major technical performance problems have been identified that will prevent achieving any of the stated outcome objectives expected from the Alternative.
Operational - Deployability	Deployment capacity and Fielding readiness (opportunity for denied access/operations)	The Alternative's functionality is currently deployed with full permissions and no additional actions are needed to be taken to ensure Alternative functionality. No risk to planned operations due to Alternative functionality.	The Alternative is currently semi-deployed or anticipated to have few deployment or permission issues. Some operational functionality planning, such as deployment with other required components remain.	Deploying the Alternative requires permissions and supporting assets that may compete with other requirements. This could delay deployment and/or impact the required operational functionality.	Deploying the Alternative requires significant permissions and assets that compete with other requirements. This will probably delay deployment and impact the required operational functionality.	Deploying the Alternative is at risk because of the assets and permissions that are needed, and/or the Alternative requires significant on-site support to ensure functionality, if it is not granted, the Alternative has severely reduced functionality.	The Alternative is incompatible with planned operations and deployment, and permissions are not available, therefore deployment is not viable.
Operations / Sustainment	Ability to operate and/or sustain system over lifetime of system	Alternative has little to no impact on operations and sustainment of system.	Alternative has minor impact on operations and sustainment of system.	Alternative has moderate impact on operations and sustainment of system.	Alternative has significant impact on operations and sustainment of system.	Alternative has severe impact on operations and sustainment of system.	System cannot operate or be sustained.
Integration Complexity	Difficulty associated with integrating multiple components	Integration issues are understood and will have little to no impact on the implementation of this Alternative.	Integration issues are somewhat complex and will have a minor impact on the implementation of this Alternative.	Integration issues are complex and will have a moderate impact on the implementation of this Alternative.	Integration issues are rather complex and will have a significant impact on the implementation of this Alternative.	Integration issues are highly complex and will have a severe impact on the implementation of this Alternative.	Complexity of integration issues are a showstopper and prevent implementation of this Alternative.
Interoperability	Ability to interconnect (physical, Rx/Tx, formats, frequency, licensing, synchronization) to ensure processing of data from multiple sources	Connections & formats are specified and understood and will have little to no impact on the implementation of this Alternative.	Connections & formats are specified and understood and will have a minor impact on the implementation of this Alternative.	Connections & formats are somewhat specified and understood and will have a moderate impact on the implementation of this Alternative.	Connections & formats are not well specified and understood and will have a significant impact on the implementation of this Alternative.	Connections & formats are not very well specified and understood and will have a severe impact on the implementation of this Alternative.	Connections & formats are showstopper and prevent implementation of this Alternative.

Scale derived from Lavine, Garvey, McMahon, & Henry

# Overall Risk Assessment

- Roll-up rule developed to ensure high risk is given appropriate weight in overall risk score
  - Rule is called **Maximum Average or MaxAvg**
- Key Variables:
  - Max (MAX) = Maximum risk score (*across risk categories*)
  - Average (AVG) = Average of all risk scores (*across risk categories*)
  - Wt = Weight applied to maximum score (0-100) where
    - $30 < Wt < 70$
    - Wt = 0.3, for MAX < 30
    - Wt = 0.7, for MAX > 70
- General Formulation:
  - Overall Risk Score =  $Wt * MAX + (1 - Wt) * AVG$
- Special Case:
  - If the MAX is 100, then **overall** risk score is 100 by definition



The Maximum Average function was created by Dr. Bruce W. Lamar, The MITRE Corporation, 2005.



# Risk Example (notional)

#	Risk Category	Score	MAX	Wt	MaxAvg	AVG
<b>1</b>	<b>Alternative 1</b>		<b>90</b>	<b>0.70</b>	<b>80</b>	<b>57</b>
	Funding / Resources	20				
	Personnel / Skill Mix	90				
	Confidence in Cost Estimate	70				
	Advocacy	35				
	Schedule	80				
	Statutory / Regulatory	45				
	Technology Maturity	80				
	Technical Performance	70				
	Operational - Deployability	70				
	Dependencies	85				
	Integration Complexity	20				
	Interoperability	20				

**90**  
**Max (x 100)**  
*Rounding occurs*

$$\text{MaxAvg} = \text{Wt} * \text{MAX} + (1 - \text{Wt}) * \text{AVG} = (0.70)(90) + (1 - 0.70)(57) = 80$$

Risk Category	Score	BOA (rationale for scoring)
<b>Status Quo</b>		
Funding / Resources	70	Currently there is funding for personnel; however there is not strong program support. Funding advocacy is below the goal level. Funding for certain functions and data needs are not planned.
Personnel / Skill Mix	40	Dependent on small core of staff. Limited capacity to deal with problems. Dependent upon external expertise for certain functionality.
Advocacy (programmatic, political)	50	Conflicting priorities and the lack of strong advocacy puts supporting in jeopardy. Currently there is no strong opposition to current approach.
Technical Performance	70	Current capability will continue to degrade or be non existent over the time period.

# Risk Summary (Notional)

Alternative Risk Assessment			
Alternatives >  Risk Category (below)	Status Quo	Alternative 1	Alternative 2
	Funding / Resources	70	75
Personnel / Skill Mix	40	75	90
Confidence in Cost Estimate	20	50	50
Advocacy (programmatic, political)	50	65	50
Schedule	5	40	90
Statutory-Regulatory	5	5	5
Data Availability	95	20	20
Technology Maturity	5	20	80
Technical Performance	70	20	80
Operational Deployability	20	60	80
Dependencies	70	35	35
Partnerships	5	40	40
Integration Complexity	5	50	80
Interoperability	5	50	50
MaxAvg	76	65	81
Average	33	43	60

Low	0 < 20
Low-Med	20 < 40
Med	40 < 60
Med-High	60 < 80
High	80 < 100
Catastrophic	100

# Final Thoughts

- **Assembling the “Right Team” is essential to conducting a meaningful assessment**
- **Tailoring the scales to your organization and specific trade space analysis**
- **Identifying clear and defined alternatives is critical**
  - Include the status quo
  - Create new alternatives when mitigations are included
- **Well documented Basis of Assessments must be captured to support validity of the assessment**
- **Roll-up scores should be used to support integration with cost and benefit assessments and should be used with caution**

**The Execution Risk Assessment Methodology is adaptable, quickly applied, and provides meaningful information to decision makers**

# Questions?

**For further information contact:**

- **Rob Henry**
- **339-221-2260 (cell)**
- **781-271-6984 (office)**
- **[rhenry@mitre.org](mailto:rhenry@mitre.org)**

*Execution Risk Assessment*

# Backup

# Risk Segments

- **Low:** The risks in this area will have a **little to no impact** on the Alternative's achieving its stated outcome objectives.
- **Low-Medium:** The risks in this area will have a **minor impact** on the Alternative's achieving its desired result, to the extent that one or more of its stated outcome objectives will fall below goals but well above minimum acceptable levels.
- **Medium:** The risks in this area will have a **moderate impact** on the Alternative's achieving its desired result, to the extent that one or more of its stated outcome objectives will fall well-below goals but above minimum acceptable levels.
- **Medium-High:** The risks in this area will have a **significant impact** on the Alternative's achieving its desired result, to the extent that one or more of its stated outcome objectives will fall below minimum acceptable levels.
- **High:** The risks in this area will have a **severe impact** on the Alternative's achieving its desired result, to the extent that one or more of its critical outcome objectives will not be achieved.
- **Catastrophic: Showstopper.** The Alternative will not achieve any of its outcome objectives.