



# VALUING THE INVISIBLE SHIELD

*A Guide to Real Options Analysis for Emergency Management Investments*

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## ABSTRACT

Emergency management practitioners struggle to justify investments in "contingent capabilities:" backup systems, surge capacity, and strategic reserves that provide value only during disasters. Traditional cost-benefit analysis systematically undervalues these preparedness investments because their benefits are uncertain, while costs are immediate and tangible. This article introduces Real Options Analysis (ROA) as a breakthrough methodology for accurately valuing resilience investments. Adapted from financial option pricing models, ROA recognizes that contingent capabilities function like insurance policies, providing the "right but not the obligation" to respond effectively when risks materialize. The 2023 update to Office of Management and Budget (OMB) Circular A-4 explicitly endorses ROA for evaluating uncertain benefits, creating an opportunity for emergency managers to build defensible business cases for preparedness investments. Through practical examples and implementation guidance, this article demonstrates how ROA can transform resilience planning from intuition-based advocacy to data-driven decision making.

## INTRODUCTION

The emergency management community operates in what military strategists call the "fog of war," an environment where uncertainty is the only certainty. The COVID-19 pandemic exposed critical gaps in our preparedness infrastructure, from personal protective equipment (PPE) shortages to overwhelmed healthcare systems. Hurricane Ida demonstrated how traditional infrastructure fails when pushed beyond design limits. The 2021 Texas winter storm revealed the fragility of interconnected systems under extreme stress.

These events share a common thread: organizations with robust contingent capabilities—spare capacity, redundant systems, and pre-positioned resources—weathered the storms better than those operating at peak efficiency under normal conditions. Yet paradoxically, budget processes consistently undervalue these "insurance policies" because their benefits are uncertain and their costs are immediate and tangible.

This valuation challenge represents more than an accounting problem; it strikes at the heart of our national resilience strategy. When decision-makers cannot articulate the value of preparedness investments, communities remain vulnerable to cascading failures that could have been prevented.

## THE RESILIENCE IMPERATIVE: MOVING BEYOND REACTIVE RESPONSE

### Defining Resilience in Practice

For practitioners, resilience is not an abstract concept but a measurable organizational capability. The Federal Emergency Management Agency (FEMA) defines resilience as "the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies" (FEMA, 2019). However, this definition requires practical interpretation.

Resilience manifests in two distinct forms:

**Reactive Resilience** represents what most organizations naturally possess—the ability to mobilize existing resources when a crisis strikes. This includes activating emergency operations centers, implementing mutual aid agreements, and redirecting personnel to critical functions. While essential, reactive resilience often proves insufficient during high-impact events that exceed normal response capacity.

**Proactive Resilience** involves deliberate investments in capabilities designed specifically for uncertain future scenarios. This includes maintaining excess capacity during normal times, developing redundant systems, and pre-positioning resources based on risk assessments rather than current operational needs.

### The Practitioner's Dilemma

Emergency managers face a fundamental challenge: how do you justify spending money today on capabilities that may never be needed? Consider these real-world examples:

- **Excess Hospital Capacity:** Maintaining surge capacity costs approximately \$2,000 per bed annually in foregone revenue, yet proved invaluable during COVID-19 peaks.
- **Backup Communication Systems:** Redundant radio networks sit idle most of the time but become priceless when primary systems fail during disasters.
- **Strategic Reserves:** Stockpiling PPE requires warehouse space and periodic replacement, generating costs without apparent benefits until a pandemic strikes.

Each represents a classic contingent capability—expensive to maintain, uncertain in benefit, but potentially invaluable when needed.

## UNDERSTANDING CONTINGENT CAPABILITIES: THE BUILDING BLOCKS OF RESILIENCE

### Characteristics of Contingent Capabilities

Contingent organizational capabilities differ fundamentally from regular operational capabilities in five key dimensions:

- 1. Investment Requirements:** Both require upfront investments, but contingent capabilities often incur additional costs when activated. A backup generator requires initial purchase and maintenance, plus fuel and operational costs during actual use.
- 2. Supported Activities:** Operational capabilities support predictable, ongoing functions like daily dispatch operations or routine inspections. Contingent capabilities support unpredictable risk-mitigation activities like mass casualty response or evacuation coordination.
- 3. Benefit Timing:** Operational capabilities generate immediate, continuous benefits through regular use. Contingent capabilities provide benefits only when specific risk scenarios occur—potentially never, or catastrophically all at once.
- 4. Benefit Scale:** Operational capabilities generate predictable returns within expected ranges. Contingent capabilities may provide enormous benefits during major events or no benefits at all during quiet periods.
- 5. Benefit Likelihood:** Operational capabilities offer high certainty of returns. Contingent capabilities involve fundamental uncertainty about whether benefits will ever materialize. (Antikarov, 2021)

### Real-World Examples from Practice

Drawing from field experience, contingent capabilities take many forms:

- **Physical Infrastructure:** Building seawalls higher than current flood projections, constructing emergency operations centers with blast-resistant features, or maintaining helicopter landing zones that may never be needed.
- **Human Resources:** Cross-training personnel in multiple emergency functions, maintaining reserve staff pools, or developing specialized teams for low-probability, high-impact events.
- **Equipment and Supplies:** Stockpiling specialized rescue equipment, maintaining redundant communication systems, or pre-positioning resources in geographic areas based on risk modeling rather than current demand.
- **Information Systems:** Developing backup data centers, maintaining offline communication capabilities, or creating redundant command and control systems.

## THE VALUATION PROBLEM: WHY TRADITIONAL METHODS FAIL

### The Net Present Value Trap

Most government agencies rely on Net Present Value (NPV) type analysis for capital allocation decisions. For example, OMB's Circular A-4 has historically mandated this approach, requiring agencies to discount future benefits to present value using standardized rates (OMB, 2003).

For operational capabilities, NPV works reasonably well because benefits are predictable and continuous. However, contingent capabilities create several analytical challenges:

- 1. Deterministic Bias:** NPV assumes single-point estimates for future benefits, but contingent capabilities generate benefits across multiple risk scenarios with different probabilities and severities.
- 2. Discount Rate Rigidity:** Standard discount rates fail to capture the changing risk profile of contingent capabilities over time. A 20-year flood protection system may become more valuable as extreme weather events become more frequent.
- 3. Flexibility Blindness:** NPV cannot value the flexibility that contingent capabilities provide—the ability to adapt response based on how scenarios unfold.
- 4. Timing Misalignment:** NPV struggles to compare certain upfront costs with uncertain future benefits that may occur tomorrow or never.

### The Underinvestment Problem

These analytical limitations create systematic underinvestment in resilience. Consider a hypothetical analysis of hospital surge capacity:

- **Upfront Cost:** \$2 million for 20 additional beds
- **Annual Maintenance:** \$40,000 (2% of capital)
- **Opportunity Cost:** \$400,000 annually in foregone revenue
- **NPV over 20 years (7% discount):** -\$4.8 million

Traditional analysis suggests rejecting this investment. However, this calculation ignores the potential benefits: preventing healthcare system collapse during emergencies, maintaining community confidence, avoiding costly patient transfers, and reducing mortality rates during surge events.

## REAL OPTIONS ANALYSIS: A BREAKTHROUGH APPROACH

### Conceptual Foundation

Real Options Analysis (ROA) originated in financial markets, where options provide the "right but not the obligation" to buy or sell assets under specific conditions. A stock option has value

because it provides flexibility—the holder can exercise it if conditions are favorable or let it expire if not.

Contingent capabilities function similarly and have option-like characteristics. They provide organizations with the "right but not the obligation" to respond effectively when risks materialize. Like financial options, their value depends on:

- **Underlying volatility:** Higher risk variability increases option value
- **Time to expiration:** Longer time horizons generally increase value
- **Exercise price:** Lower activation costs increase value
- **Risk-free rate:** Affects the present value calculation
- **Dividend yield:** Ongoing costs that reduce net value

This optionality can be correctly valued with the same valuation methods used to price financial options (Myers, 1977).

### **OMB Recognition and Legitimacy**

The 2023 update to OMB Circular A-4 represents an important moment for ROA in government decision-making. The updated guidance explicitly states: "In some situations, it may be useful to analyze a regulation with uncertain effects as an option (referred to as 'real options' analysis)" (OMB, 2023).

This endorsement acknowledges that traditional NPV analysis is insufficient for valuing investments with uncertain, contingent benefits—exactly the challenge emergency managers face daily.

### **Practical Advantages for Practitioners**

ROA offers several benefits over traditional valuation methods:

1. **Uncertainty Recognition:** Rather than forcing single-point estimates, ROA explicitly models multiple scenarios with different probabilities and outcomes.
2. **Flexibility Valuation:** ROA quantifies the value of maintaining response options, critical for emergency management, where conditions change rapidly.
3. **Risk Integration:** The methodology naturally incorporates risk levels into value calculations, making high-risk scenarios appropriately influential in investment decisions.
4. **Stakeholder Communication:** ROA provides clear metrics that help practitioners explain resilience investments to elected officials, budget analysts, and community leaders.
5. **Decision Timing:** ROA can optimize not just whether to invest, but when and how much to invest as conditions evolve. (Copeland, T., Antikarov, V. 2003)

## IMPLEMENTING ROA IN EMERGENCY MANAGEMENT PRACTICE

### Step-by-Step Application

Implementing ROA requires adapting financial option pricing models to emergency management contexts:

**Step 1: Define the Contingent Capability:** Clearly specify what capability is being valued, its activation conditions, and expected lifespan. For example: "20-bed hospital surge capacity activated when regional occupancy exceeds 85%."

**Step 2: Identify Risk Scenarios:** Develop realistic scenarios where the capability would provide value. Include probability estimates based on historical data, climate projections, or expert judgment.

**Step 3: Quantify Benefits by Scenario:** Estimate the economic value provided in each scenario, including avoided costs, preserved economic activity, and reduced consequences.

**Step 4: Calculate Option Value:** Apply modified Black-Scholes or binomial option pricing models, adjusting parameters for the specific risk and capability characteristics.

**Step 5: Compare Alternatives:** Evaluate different capability configurations, timing options, or alternative approaches using consistent ROA methodology.

### Case Study: Regional Communication Redundancy (Illustrative)

Consider valuing a backup communication system for a multi-county region:

#### Traditional NPV Analysis:

- Capital cost: \$1.2 million
- Annual maintenance: \$60,000
- 15-year lifespan
- NPV (7% discount): -\$1.7 million (rejected)

#### ROA Analysis:

- Scenarios: Major hurricane (15% annual probability), cyber attack (8% probability), equipment failure (25% probability)
- Benefits: Maintained coordination (\$2M value), faster recovery (\$5M value), reduced casualties (\$10M value)
- Option value calculation: +\$2.3 million (approved)

The ROA approach reveals positive value by properly accounting for the catastrophic costs of communication failure during emergencies.

## OVERCOMING IMPLEMENTATION CHALLENGES

### Data and Modeling Requirements

ROA requires more sophisticated analysis than traditional NPV, creating potential barriers:

- **Historical Data:** Practitioners need probability estimates for various risk scenarios. Where data is limited, expert elicitation and Monte Carlo simulation can supplement historical analysis.
- **Benefit Quantification:** Valuing avoided casualties, preserved economic activity, or maintained public confidence requires careful methodology. Existing literature on the Value of Statistical Life and economic impact modeling provides starting points.
- **Technical Expertise:** ROA implementation may require collaboration with economists, financial analysts, or academic researchers to ensure proper model specification.
- **Organizational Adaptation**
- Successfully implementing ROA requires organizational changes:
- **Training and Education:** Staff need to understand ROA concepts and applications. Professional development programs should include financial modeling and risk analysis components.
- **Process Integration:** ROA should complement, not replace, existing capital planning processes. Integration with hazard mitigation planning, emergency operations planning, and budget development is essential.
- **Performance Measurement:** Organizations need metrics to track the actual performance of contingent capabilities, validate ROA predictions, and improve future analyses.

## LESSONS LEARNED FROM EARLY ADOPTERS

### Success Factors

Organizations successfully implementing ROA share several characteristics:

- **Leadership Support:** Senior executives who understand and champion the approach enable staff to invest time in learning and applying ROA methods.
- **Analytical Capacity:** Either developing internal expertise or partnering with academic institutions or consulting firms provides the necessary technical capabilities.
- **Stakeholder Engagement:** Involving budget offices, elected officials, and community partners in ROA education builds understanding and acceptance.
- **Iterative Approach:** Starting with simple applications and gradually increasing sophistication allows organizations to build competence and confidence.

### Common Pitfalls

Early implementation efforts reveal several potential problems:

**Over-Complexity:** Attempting overly sophisticated models initially can create analysis paralysis and stakeholder confusion.

**Data Perfectionism:** Waiting for perfect data prevents progress. ROA provides value even with imperfect inputs by making uncertainty explicit.

**Stand-Alone Application:** Using ROA in isolation rather than integrating it with existing planning processes reduces acceptance and effectiveness.

**Neglecting Communication:** Focusing solely on technical accuracy while ignoring stakeholder understanding limits implementation success.

## FUTURE DIRECTIONS AND RECOMMENDATIONS

### Research Opportunities

The intersection of ROA and emergency management offers rich research opportunities:

- **Standardization:** Developing standardized ROA approaches for common emergency management investments could reduce implementation barriers and improve consistency.
- **Empirical Validation:** Longitudinal studies comparing ROA predictions with actual performance during disasters would strengthen the methodology's credibility.
- **Integration Methods:** Research on incorporating ROA into existing planning frameworks (hazard mitigation, emergency operations, capital improvement) could improve adoption.
- **Decision Support Tools:** Developing user-friendly software tools could make ROA accessible to smaller organizations with limited analytical resources.

### Policy Implications

Broader adoption of ROA could influence policy at multiple levels:

- **Federal Guidance:** Expanding OMB's recognition of ROA specifically for emergency management and homeland security investments.
- **Grant Programs:** Incorporating ROA into federal grant evaluation criteria could incentivize resilience investments and improve resource allocation.
- **Professional Standards:** Professional organizations like the International Association of Emergency Managers could develop ROA competency standards and training programs.
- **Academic Integration:** Emergency management degree programs should incorporate ROA concepts into their curricula to prepare future practitioners with these analytical skills.

## CONCLUSION

The gap between the value practitioners know contingent capabilities provide and their ability to demonstrate that value through traditional analysis has long frustrated the emergency management community. Real Options Analysis offers a bridge across this gap, providing a theoretically sound and practically applicable method for valuing investments in resilience.

The OMB's 2023 endorsement of ROA in Circular A-4 creates an unprecedented opportunity for emergency managers to move beyond intuition-based arguments for preparedness investments and toward data-driven business cases that speak the language of budget analysts and elected officials.

However, ROA is not a panacea. Its successful implementation requires organizational commitment, analytical capabilities, and stakeholder engagement. The methodology demands more sophisticated analysis than traditional approaches but offers correspondingly richer insights into the true value of resilience investments.

As we face an increasingly uncertain future marked by climate change, technological vulnerabilities, and evolving threats, our ability to accurately value and prioritize resilience investments becomes ever more critical. ROA provides emergency management practitioners with a powerful tool to ensure that the invisible shield of preparedness receives the investment it deserves.

The question is not whether uncertainty will test our communities—it will. The question is whether we will be prepared with the analytical tools and contingent capabilities necessary to protect what matters most. Real Options Analysis helps ensure the answer is yes.

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