Decisions in Motion

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Abstract

This paper introduces a practical approach to sensitivity analysis for **effective decision making**. Combining Monte Carlo Simulation and scenarios, decision-makers will highlight changes impacting financial metrics. A complete set of visualizations will support this process.

The approach uses **two use cases**: an economic project assessment and a budget model. This applied alternative generates easy-to-interpret outcomes and supports clear, actionable decisions. The visualization component also permits assessing the probability of achieving target outcomes. Additionally, it aids in evaluating trade-offs, and deviations, enabling more informed choices.

- The proposed methodology emphasizes **simplicity and flexibility**. It provides organizations with a structured way to apply sensitivity analysis and simulation. Finally, it offers practitioners a data-driven framework that helps build manageable insights.

Executive Summary

Objective

Introduce a practical framework for enhancing decision-making under uncertainty, combining **Monte Carlo Simulation**, **Scenario Design**, and **Sensitivity Analysis**.

Key Components

- Build clear scenarios reflecting plausible futures
- Analyze sensitivity to highlight critical drivers
- Use Monte Carlo Simulation to quantify uncertainty and probabilities

Use Cases

- **Budget Model**: Selecting among competing offers based on multi-criteria analysis
- **Economic Assessment**: Evaluating NPV dynamics under different development and market scenarios

Outcomes:

- Deliver actionable, easy-to-interpret insights
- Support strategic, data-driven decisions
- Build flexible and simple models that adapt to business needs

Agenda

- Decision-Making frameworks
- Scenario Design
- Sensitivity Analysis and Monte Carlo Simulation
- Decision Making Criteria
- Cases
- Conclusions

Typical Decision-Making Frameworks

SWOT Analysis:

- Identifies Strengths and Weaknesses, and external Opportunities and Threats to support strategic choices.

Cost-Benefit Analysis (CBA):

- Compares the total expected costs vs. benefits of a decision to determine its feasibility or value.

Decision Trees:

- Maps out possible decisions and outcomes in a tree-like structure, helping visualize risks, rewards, and paths.

Multi-Criteria Decision Analysis (MCDA):

- Evaluates options against multiple weighted criteria for more balanced, structured decisions.

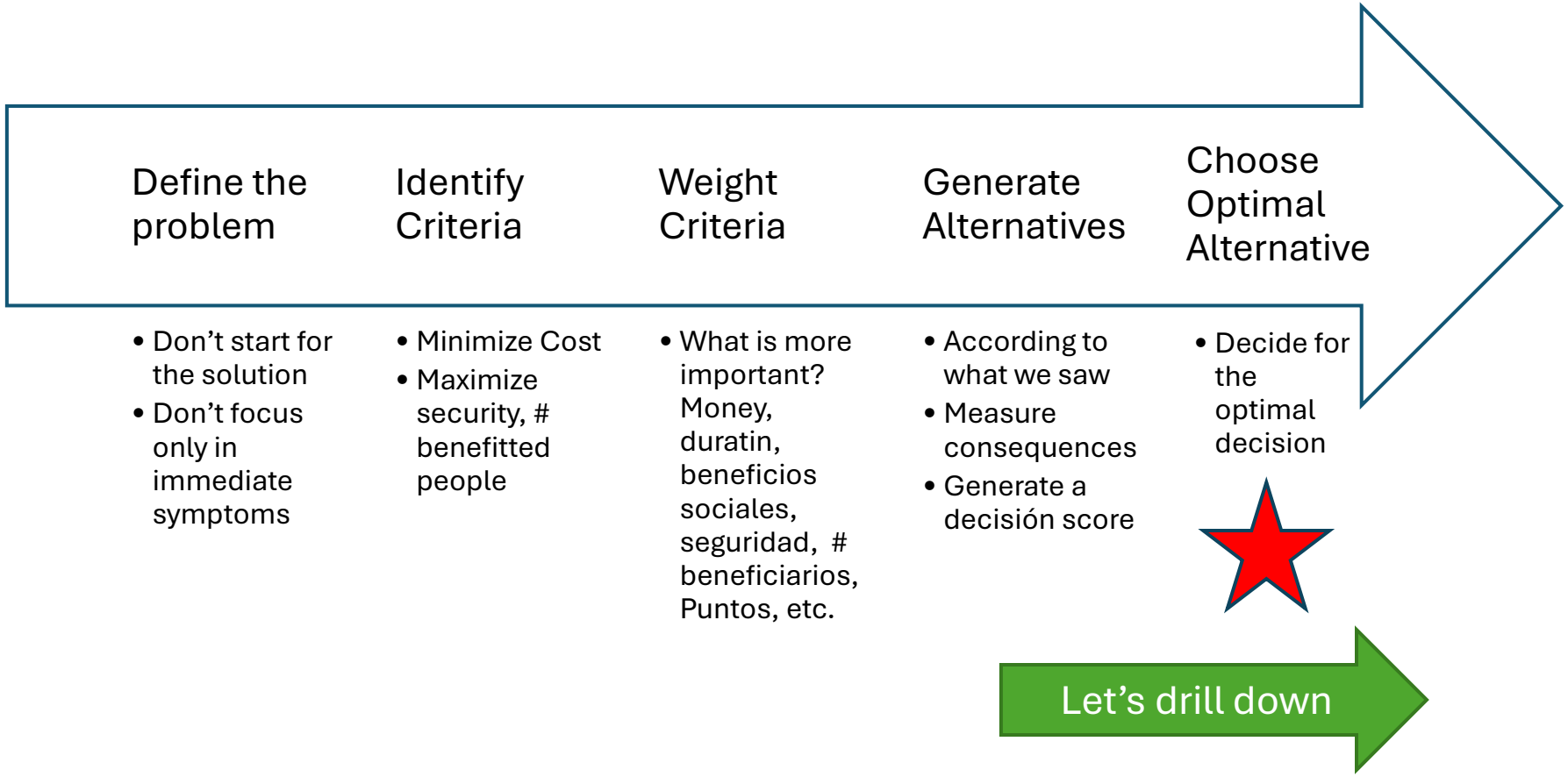
OODA Loop:

- A rapid, iterative cycle—Observe, Orient, Decide, Act—used in dynamic and fast-paced environments.

Pros and Cons List:

- A simple yet effective method to weigh the positive and negative aspects of each option.

Decision-making Framework: Bazerman



** There are other decision making frameworks, which extend or consolidate stages*

Systems 1 and 2 – How do we decide

- According to Kahneman
  - There is an internal conflict between our internal systems during the decision-making process

System 1

- Rapid, automatic, intuitive, emotional
- Almost inconscious

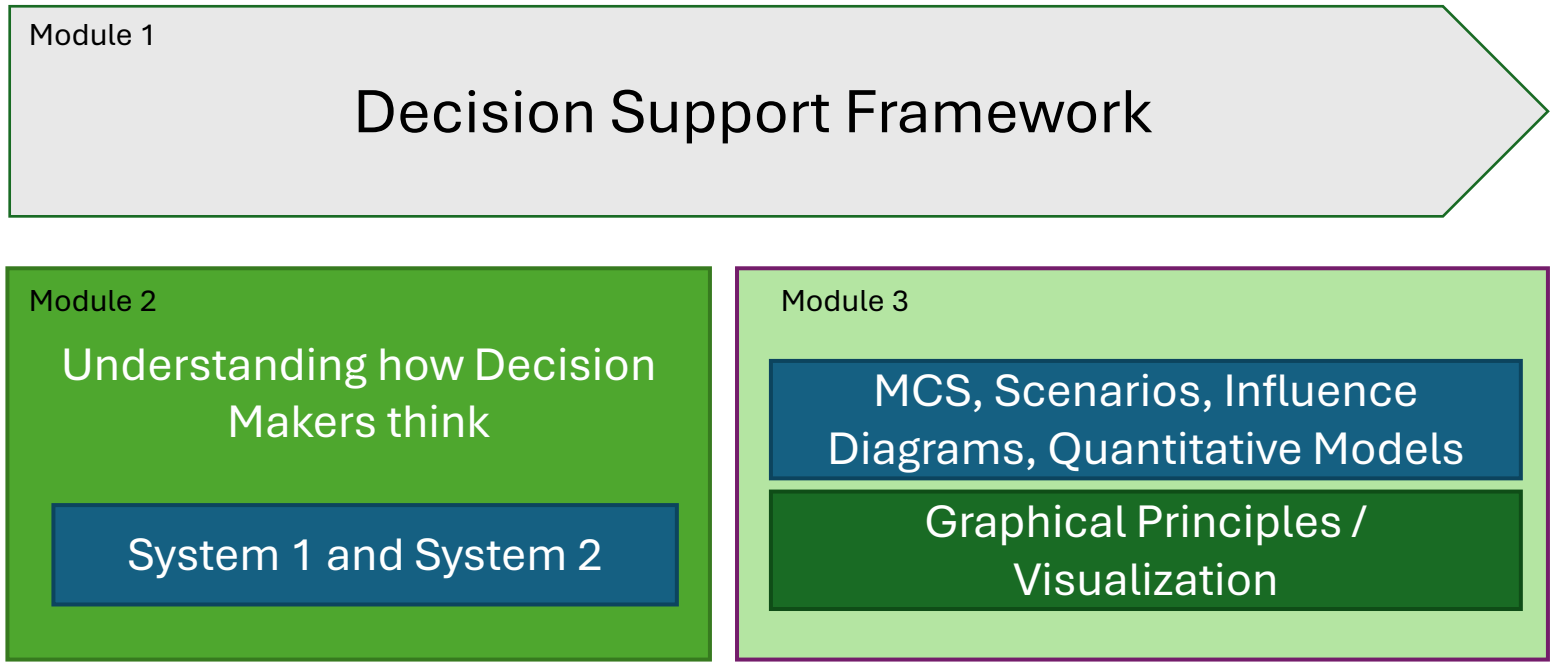
System 2

- Slower reasoning, conscious, explicit, logical

Preferable for most important decisions

X-Ray of a Decision

- Dissecting a decision: goals, options, uncertainty, risk, trade-offs.



The Decision-Making Challenge (1)

- Challenges in making effective decisions under uncertainty.

🔍 1. Uncertainty of Future Outcomes

- Market conditions, costs, or customer behavior can change unpredictably
- Limited visibility into long-term consequences
- Hard to estimate probabilities without proper data or models

⚖️ 2. Trade-offs Between Conflicting Objectives

- Maximizing ROI vs. minimizing risk
- Short-term performance vs. long-term growth
- Budget constraints vs. quality or innovation goals

The Decision-Making Challenge (2)

- Challenges in making effective decisions under uncertainty.

🧠 3. Cognitive Biases and Organizational Politics

- Anchoring, confirmation bias, overconfidence
- Decisions influenced by internal politics, egos, or departmental silos
- Difficulty in reaching consensus among stakeholdersy

📉 4. Lack of Structured Data-Driven Processes

- Decisions based on gut feeling or past experience alone
- Poor scenario design or oversimplified sensitivity analyses
- Limited integration of tools like simulations or models into the workflow

Designing Scenarios

Best Practices

Designing a Scenario (1)

1. Define the Objective

- ☐ What decision are we supporting?
- ☐ What is the key outcome or metric we want to evaluate (ROI, cost, time)?

2. Identify Key Variables

- ☐ What are the drivers of uncertainty? (e.g., demand, costs, regulations)
- ☐ Which variables have the highest impact on the outcome?

3. Establish Baseline Values

- ☐ What is the "business-as-usual" or expected case?
- ☐ Are historical data or expert estimates available?

Designing a Scenario (2)

4. Determine Plausible Ranges

- ☐ What are the minimum and maximum realistic values for each variable?
- ☐ Are these ranges based on evidence or assumptions?

5. Construct Scenarios

- ☐ Create 3–5 consistent, contrasting stories:
  - Best-case 🌞
  - Worst-case 🌩️
  - Likely case ☁️
  - Stress or Black Swan case 🧨
  - Policy or intervention scenario 🧭
- ☐ Ensure internal logic and realism in each scenario

6. Validate with Stakeholders

- ☐ Are the scenarios relevant and believable?
- ☐ Did we include perspectives from different functions or experts?

Designing a Scenario (3)

7. Simulate (if applicable)

- ☐ Run simulations (e.g., Monte Carlo) to assess scenario impacts
- ☐ Measure sensitivity of key outcomes

8. Document Assumptions

- ☐ Clearly state what assumptions are behind each scenario
- ☐ Mark any high-uncertainty inputs or data gaps

9. Evaluate Impact

- ☐ What decisions change based on scenario results?
- ☐ Are there dominant strategies that perform well across scenarios?

10. Update Regularly

- ☐ Are scenarios reviewed periodically?
- ☐ Is there a process to adjust them with new data or events?


SO FAR,
SO GOOD.

Sensitivity Analysis

And Monte Carlo Simulation

What is Sensitivity Analysis?

- ***A technique used to understand how changes in input variables impact the outcomes of a model or decision.***

- It helps reveal **which factors matter most**—and how much they affect the result.

⚙️ **Application Example**
Imagine you're planning a project with uncertain costs, timelines, and demand.

Sensitivity analysis shows you that **a small delay in delivery has a big impact on profit**, while material cost changes barely move the needle.

👉 Now you know **where to focus your attention**

Monte Carlo Simulation

Why?

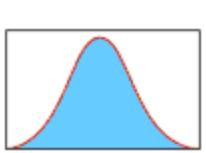
Evolve static (deterministic) models **From a single variable or static scenarios**

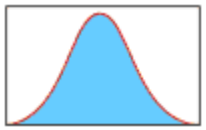
- Where one arrives at "The Number"

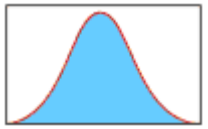
Generate probabilistic results that reinforce risk analysis

- Instead of one variable, a **probabilistic distribution** with the results is analyzed
- Using Monte Carlo Simulation
  - *Different tools to do it*

Monte Carlo Simulation in a Nutshell







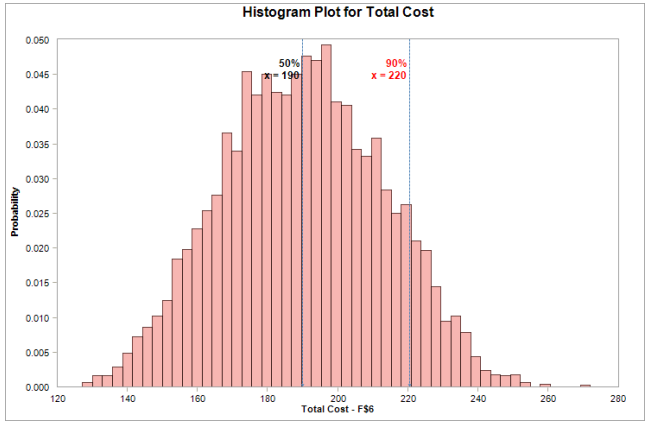
Variable A

Variable B

Variable C

Model Logic (Estimation Model, Cashflow, NPV)

Result (Total Cost, NPV, Cashflow)



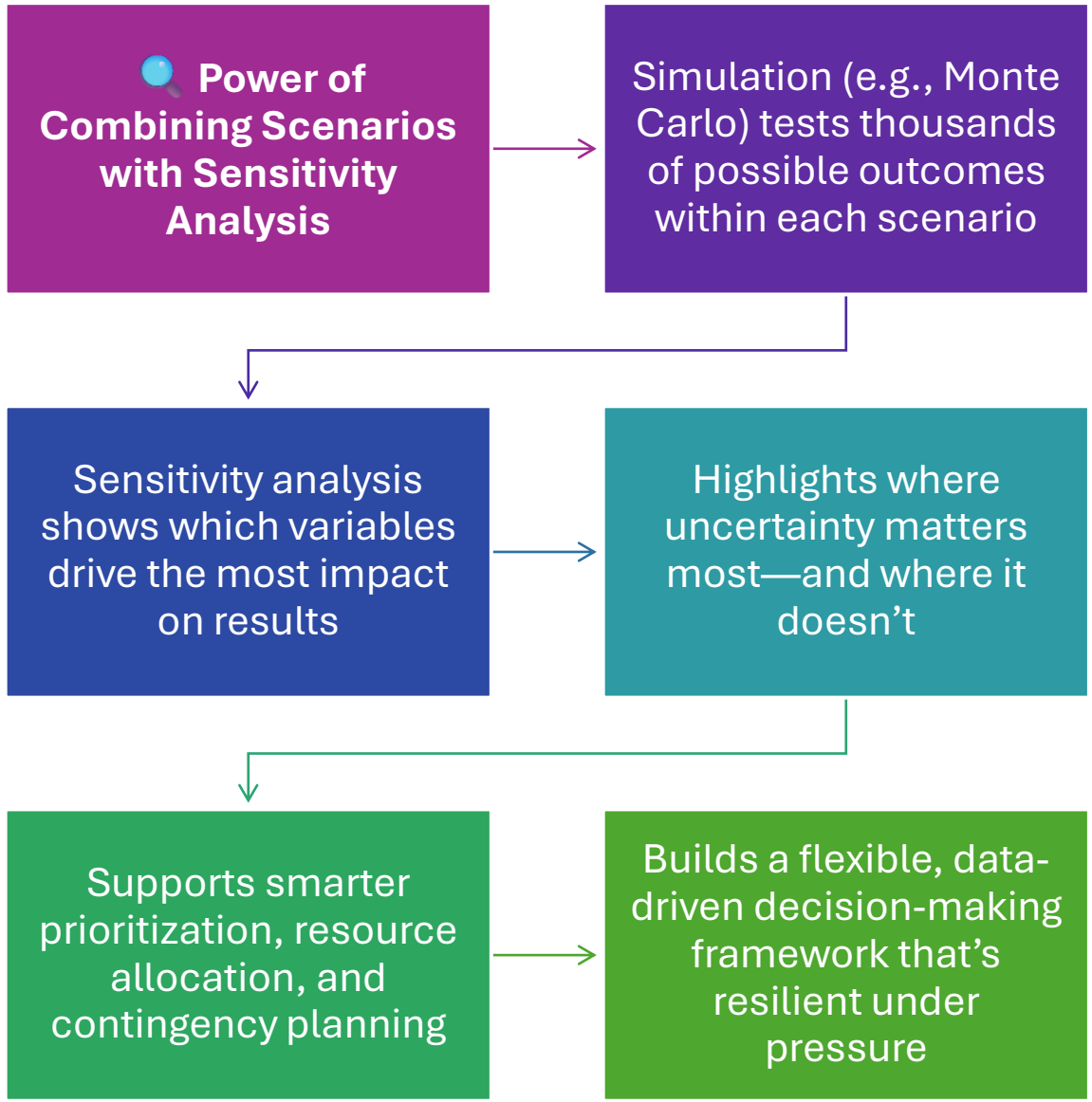
Results
145
130
120
150
143
151
220
240

The Power of Scenarios

🎯 **Why Scenario Design is Critical for Decision Making**

- Helps organizations explore a range of plausible futures, not just one prediction
- Supports strategic thinking by considering best-case, worst-case, and stress scenarios
- Reveals risks, opportunities, and blind spots that fixed forecasts often miss
- Encourages creativity, adaptability, and preparedness in uncertain environments
- Enhances alignment and communication across teams and stakeholders

Merging Scenarios + Simulation



The Decision-Making Challenge

Continued…

- Challenges in making effective decisions under uncertainty.
  - A method to understand how **uncertainty in key inputs** affects the outcomes of a decision.
    Combined with **simulation** (like Monte Carlo), it shows not just what *could* happen, but *how likely* different outcomes are—turning unknowns into insight.

The Decision-Making Challenge

Example

⚙️ **Application in Decision Making Under Uncertainty**

Let's say you're evaluating a new product launch, but market demand, production cost, and delivery time are all uncertain.

With simulation, you generate **thousands of possible futures**.
With sensitivity analysis, you discover that **uncertainty in market demand drives 80% of the profit variability**.

- 👉 Now you know where to reduce risk, where to build flexibility, and how to **make confident, data-driven decisions**.

Decision Criteria Examples

Our Approach

- Overview of the practical methodology introduced
- Application in 2 use cases
- Simplified scenarios for easy understanding

Use Case 1: Budget Model

- **Cost Estimation Model**
- Level 1 granularity
- Tender offer process, 3 participants
- I want to understand the differences in their offerings
- Differences principally lie in the cost offerings

Criteria for Decision Making – **Use Case 1**

- Base Case: $18.50 MM USD
- Different criteria

Base Case	Max Budget	Risk as % of Total Cost
• How far from the base case $4,500 K USD	• $7 MM USD • If it is more tan this total is should not be considered	• 5% Max

Relative Weights

50%	30%	20%
Base Case	Max Budget	Risk as % Total Cost
• How far from the base case $4,500 MM USD	• $7 MM USD • If it is more tan this total is should not be considered	• 5% Max

* Weights are defined by the business. They could be subjective, use AHP or any other ranking system that is later translated into weights

Use Case 1: Budget Model

Cost Estimation

	Deterministic	Uncertainty Ranges		Scenario		
Item	**Most Likely**	**Min**	**Max**	**Uncertainty Only**	**Inherent Risk**	**Residual Risk**
Design	$ 500	$ 450	$ 700	$ 458		
Preliminar Engineering	$ 400	$ 350	$ 600	$ 422		
Implementation of pipeline	$ 2,000	$ 1,500	$ 4,000	$ 1,696		
Testing	$ 450	$ 400	$ 700	$ 429		
Refinements and details	$ 400	$ 350	$ 500	$ 268		
Final Delivery	$ 150	$ 100	$ 300	$ 86		
Documentation	$ 300	$ 270	$ 450	$ 315		
Total	**$ 4,200**	**$ 3,420**	**$ 7,250**	**$ 3,673**	$ 3,673	$ 3,673
Risk	*$ 250*				$ 456	$ -
Control Cost	$ 50					$ 217
Total Cost + Risk	**$ 4,500**				**$ 4,129**	**$ 3,890**

Risk Register

	Inherent Risks							
				Impact				
Risk	**Type**	**Prob / Freq**	**Prob Distribution**	**Min**	**ML**	**Max**	**Impact Dist**	**Aggregate**
Problems with Community	Multiple	2	4	100	150	350	209.70	838.8
Resource Scarcity	Multiple	4	3	10	15	40	22.08	66.2
Exchange Rate exposure	Single	0.08	0	250	300	450	342.00	0.0
Project Management issues	Single	0.1	0	150	250	450	237.96	0.0
Environmental Impact Approval	Single	0.05	0	20	40	85	71.39	0.0

- The model includes uncertainty and a risk register to properly manage risks.
- It also includes Inherent and Residual risks to estimate exposure in both scenarios.
- **Agreed to use the Residual scenario.**

Mitigation		Residual							
					Impact				
Control	**Control Cost**	**Type**	**Prob / Freq**	**Prob Distribution**	**Min**	**ML**	**Max**	**Impact Dist**	**Aggregate**
Conflict Expert	40	Multiple	1	1	50	70	90	70.22	70.2
Redundancy HR Agency	7	Multiple	1	1	10	15	40	26.05	26.0
FX Hedge	80	Single	0.08	0	100	200	250	154.87	0.0
PMO Expert	50	Single	0.03	0	150	250	300	217.20	0.0
EnviroTech Agency	40	Single	0.04	1	20	40	50	36.22	36.2

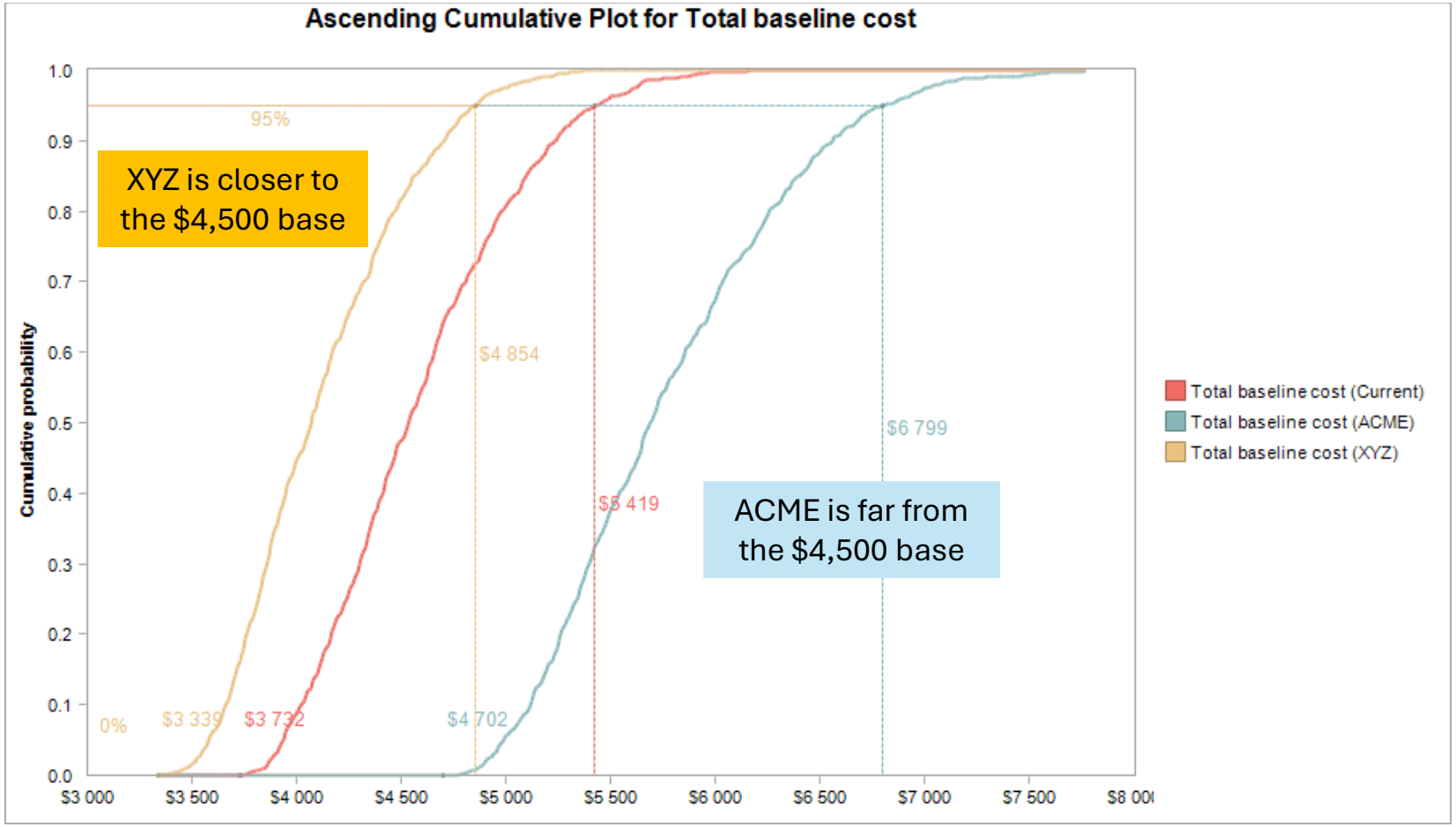
Use Case 1- Scenario Design Examples

- Provider Comparison
  - The current provider is used as a reference.
  - The other 2 providers have factors multiplied for each distribution sample of the Current definition.
  - For scenario 2, the *Testing* item, it will cost 1.4 times the original value.

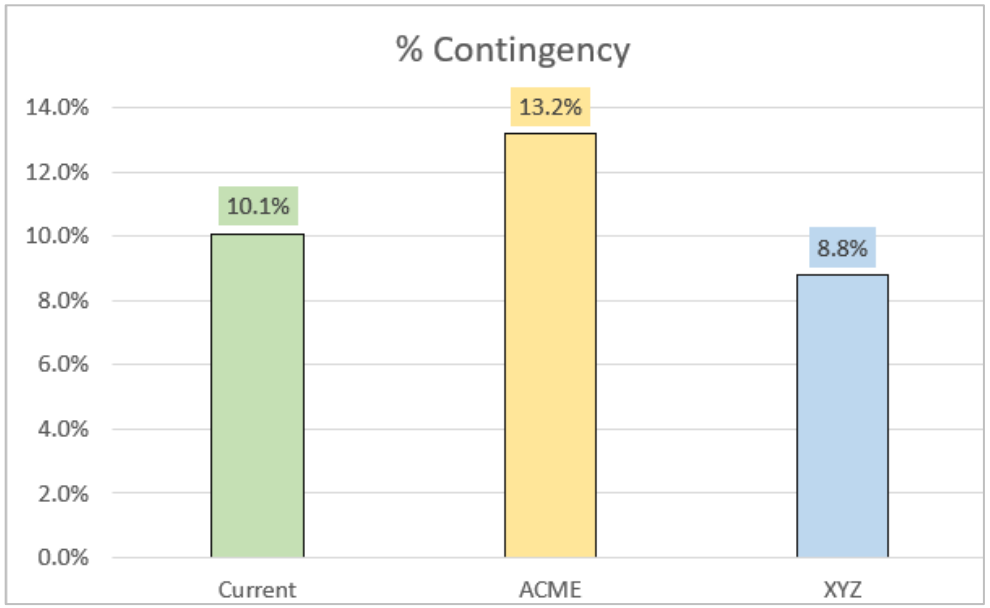
	Factor to be multiplied		
	Current	ACME	XYZ
Simulation #	**1**	**2**	**3**
Design	1	1.2	0.95
Preliminar Engineering	1	0.9	0.98
Implementation of pipeline	1	1.3	0.87
Testing	1	1.4	1.05
Refinements and details	1	1.5	0.75
Final Delivery	1	1.2	0.65
Documentation	1	1.2	1.05

Visualizing **Use Case 1**

Charts showing sensitivity and probability of outcomes.



Visualizing **Use Case 1**



Lower Contingency

Scenario Report	Current	ACME	XYZ
P50	$ 4,558	$ 5,842	$ 4,155
P80	$ 4,991	$ 6,409	$ 4,532
Contingency	$ 433	$ 566	$ 377
% Contingency	10.1%	13.2%	8.8%

A lower contingency means its percentage as part of global risk will be smaller

Decision Criteria - **Use Case 1**

Criteria	Relative Weight			Current	ACME	XYZ
General Statistics		Min	$	4,194	$ 5,169	$ 3,946
		Max	$	6,803	$ 8,108	$ 5,739
Deviation from Base Case	50%	Prob > 4500		91.2%	99.6%	60.3%
		Score		**4.4%**	**0.2%**	**19.9%**
Max Limit of $7 MM	30%	Score		**0.85%**	**-4.75%**	**5.41%**
Risks as % of Total	20%	Risks / Deterministic		3.85%	3.96%	3.73%
		Risks < 5%		**4.6%**	**4.1%**	**5.1%**
Criteria Score	**100%**			**9.83%**	**-0.40%**	**30.36%**

Recommended Option

Use Case 2: Economic Project Assessment

- Understand the dynamics of the market of an NPV model
- **Three options possible**
  - go with base plan
  - spend extra $2.5M in development to access increased market of 25%
  - spend additional $1 MM to increase market share in 10%

Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Sales Activity										
Sales Price			$6,028	$6,205	$6,390	$6,621	$6,892	$7,200	$7,546	$7,934
Sales Volume			3,339	3,861	3,349	3,098	2,986	3,453	3,993	4,618
Production Expense										
Product Development	$ 3,156,120	$ 3,161,390	$ 3,172,297	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Expenses	$ 125,000	$ 145,000	$ 55,000	$ 35,000	$ -	$ -	$ -	$ -	$ -	$ -
Overhead	$ -	$ 10,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 25,000	$ 25,000	$ 25,000
Total Expenses	$ 3,281,120	$ 3,316,390	$ 3,247,297	$ 55,000	$ 20,000	$ 20,000	$ 20,000	$ 25,000	$ 25,000	$ 25,000
Cash Flow										
Total Revenue	$ -	$ -	$ 20,126,282	$ 23,956,114	$ 21,400,194	$ 20,510,780	$ 20,580,787	$ 24,861,729	$ 30,133,081	$ 36,641,210
Cost of Goods Sold	$ -	$ -	$ 7,867,706	$ 9,364,852	$ 8,365,699	$ 8,018,012	$ 8,045,379	$ 9,718,872	$ 11,779,533	$ 14,323,671
Gross Margin	$ -	$ -	$ 12,258,577	$ 14,591,262	$ 13,034,494	$ 12,492,768	$ 12,535,408	$ 15,142,857	$ 18,353,548	$ 22,317,539
Operating Expenses	$ 3,281,120	$ 3,316,390	$ 3,247,297	$ 55,000	$ 20,000	$ 20,000	$ 20,000	$ 25,000	$ 25,000	$ 25,000
Earnings Before Taxes	$ (3,281,120)	$ (3,316,390)	$ 9,011,280	$ 14,536,262	$ 13,014,494	$ 12,472,768	$ 12,515,408	$ 15,117,857	$ 18,328,548	$ 22,292,539
Tax Basis	$ (3,281,120)	$ (6,597,510)	$ 2,413,770	$ 14,536,262	$ 13,014,494	$ 12,472,768	$ 12,515,408	$ 15,117,857	$ 18,328,548	$ 22,292,539
Income Tax	$ -	$ -	$ 844,819	$ 5,087,692	$ 4,555,073	$ 4,365,469	$ 4,380,393	$ 5,291,250	$ 6,414,992	$ 7,802,389

Criteria for Decision Making – **Use Case 2**

- Base Case: $4.13 MM USD NPV
- Rate of Return: 10%

Base Case	Max Cost	Net Income / Revenue Average
• How far from NPV = 0	• $11 MM USD • If greater, total is should not be considered	• At least 35% (P5)

Relative Weights – Use Case 2

40%	30%	30%
Base Case	Max Cost	Net Income / Revenue Average
• How far from NPV = 0	• $11 MM USD • If it is more tan this total is should not be considered	• At least 35% (P5)

* Weights are defined by the business. They could be subjective, use AHP or any other ranking system that is later translated into weights

Use Case 2: Model Preparation

- The model uses 2 main components

Cash Flow

Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Sales Activity										
Sales Price			$5 635	$5 858	$6 101	$6 330	$6 558	$6 790	$7 034	$7 304
Sales Volume			3 810	3 132	2 746	2 508	2 749	3 012	3 302	3 618
Production Expense										
Product Development	$ 3 094 826	$ 3 097 444	$ 13 095 697	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Expenses	$ 200 000	$ 165 000	$ 55 000	$ 35 000	$ -	$ -	$ -	$ -	$ -	$ -
Overhead	$ -	$ 50 000	$ 70 000	$ 70 000	$ 70 000	$ 70 000	$ 90 000	$ 90 000	$ 90 000	$ 90 000
Additional Cost Scenarios				$ 1 428 571	$ 1 428 571	$ 1 428 571	$ 1 428 571	$ 1 428 571	$ 1 428 571	$ 1 428 571
Total Expenses	$ 3 294 826	$ 3 312 444	$ 13 220 697	$ 1 533 571	$ 1 498 571	$ 1 498 571	$ 1 518 571	$ 1 518 571	$ 1 518 571	$ 1 518 571
Cash Flow										
Total Revenue	$ -	$ -	$ 21 469 379	$ 18 345 953	$ 16 753 150	$ 15 875 704	$ 18 029 089	$ 20 452 544	$ 23 226 193	$ 26 424 902
Cost of Goods Sold	$ -	$ -	$ 8 890 217	$ 7 596 843	$ 6 937 282	$ 6 573 942	$ 7 465 633	$ 8 469 157	$ 9 617 693	$ 10 942 240
Gross Margin	**$ -**	**$ -**	**$ 12 579 162**	**$ 10 749 110**	**$ 9 815 868**	**$ 9 301 762**	**$ 10 563 456**	**$ 11 983 386**	**$ 13 608 500**	**$ 15 482 661**
Operating Expenses	$ 3 294 826	$ 3 312 444	$ 13 220 697	$ 1 533 571	$ 1 498 571	$ 1 498 571	$ 1 518 571	$ 1 518 571	$ 1 518 571	$ 1 518 571
Earnings Before Taxes	$ (3 294 826)	$ (3 312 444)	$ (641 535)	$ 9 215 539	$ 8 317 296	$ 7 803 190	$ 9 044 884	$ 10 464 815	$ 12 089 929	$ 13 964 090
Tax Basis	$ (3 294 826)	$ (6 607 271)	$ (7 248 805)	$ 1 966 733	$ 8 317 296	$ 7 803 190	$ 9 044 884	$ 10 464 815	$ 12 089 929	$ 13 964 090
Income Tax	$ -	$ -	$ -	$ 688 357	$ 2 911 054	$ 2 731 117	$ 3 165 709	$ 3 662 685	$ 4 231 475	$ 4 887 431
Net Income	**$ (3 294 826)**	**$ (3 312 444)**	**$ (641 535)**	**$ 8 527 182**	**$ 5 406 243**	**$ 5 072 074**	**$ 5 879 175**	**$ 6 802 130**	**$ 7 858 454**	**$ 9 076 658**

Revenue, COGS, Dev Cost, OPEX, EBITDA, Taxes

Market Conditions

Market Conditions								
Year	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Inflation Rate	3 %	4 %	4 %	4 %	4 %	4 %	4 %	4 %
Tax Rate	35 %	35 %	35 %	35 %	35 %	35 %	35 %	35 %
Market volume			3 810	4 176	4 577	5 016	5 497	6 025
Number of Competitors	0	0	0	1	1	1	1	1
Unit Cost			$2 333	$2 426	$2 526	$2 621	$2 716	$2 812

Inflation and Tax Rate, Market Volume # of competitors and Unit Cost

Use Case 2 - Scenario Design Examples

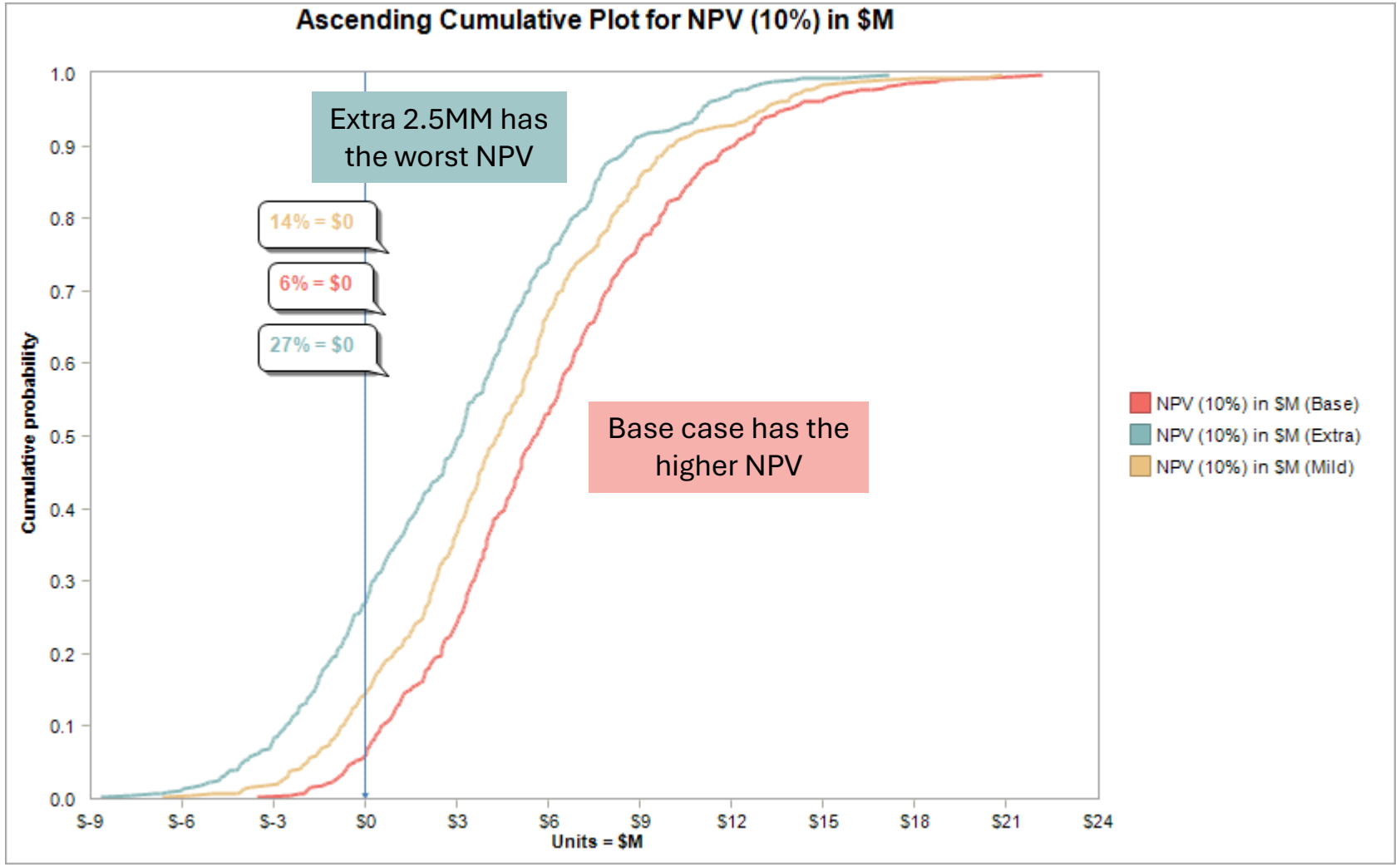
- Scenarios Comparison
  - Two variables included
  - Extra money for Development Cost
  - Additional Market Share
  - Max Price

Scenarios Design

Index	Name	Extra $	Δ market	Max Price
1	Base	$ -	0 %	$ 80
2	Extra	$ 2 500 000	25 %	$ 70
3	Mild	$ 1 000 000	10 %	$ 75

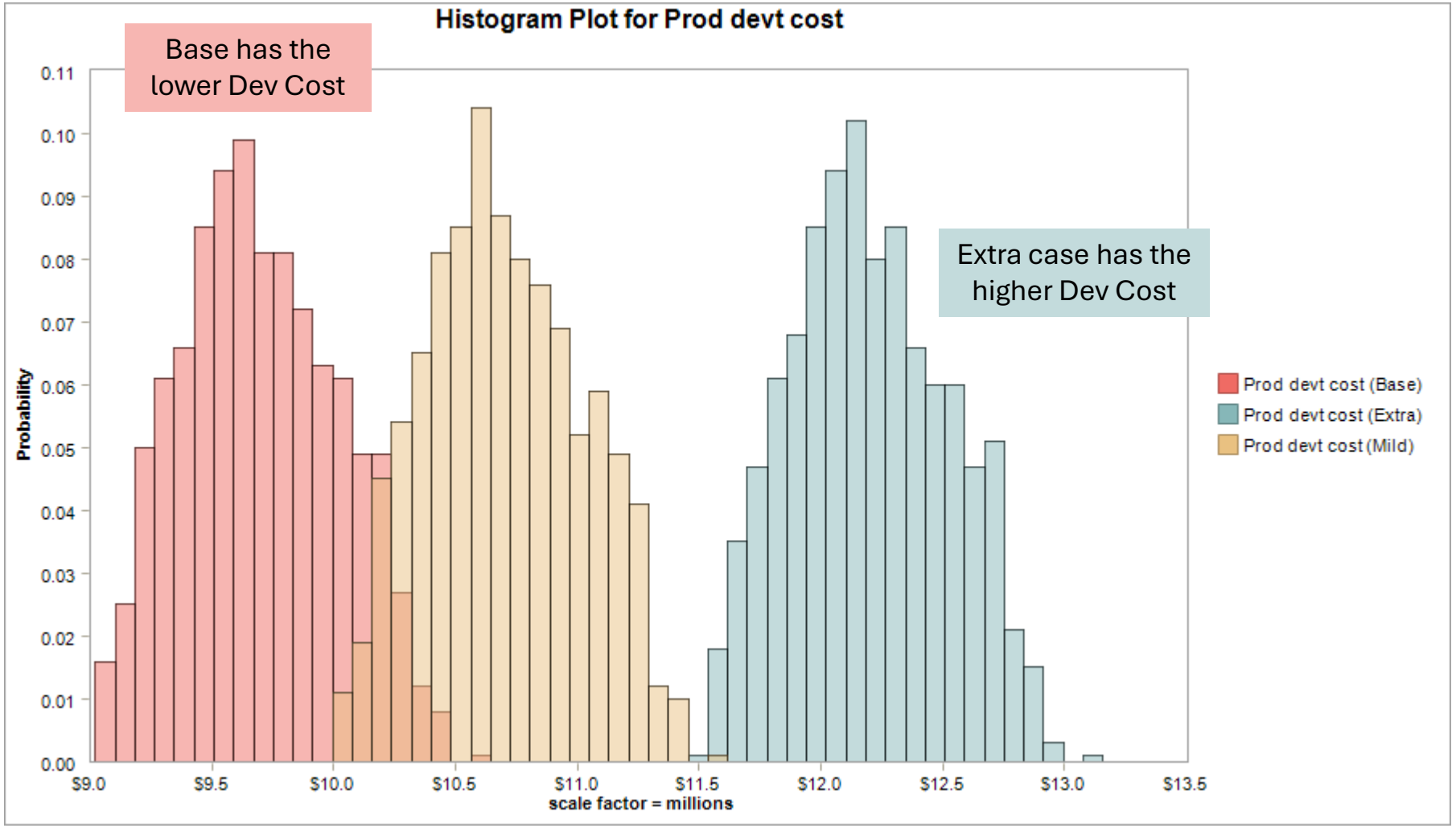
Use Case 2 - Visualizing NPV

- NPV Comparison



Visualizing Product Cost – **Use Case 2**

- Charts showing sensitivity and NPV comparison



Use Case 2 – Decision Criteria

Criteria	Relative Weight	Operation	Base	Extra	Mild	Base	Extra	Mild
Probability of NPV < 0	40 %	Prob > 0	6 %	27 %	14 %			
		Score	94 %	73 %	86 %	38 %	29 %	34 %
Prod Dev Cost of $11 MM	30 %	Min	$ 9 022 424	$ 11 522 424	$ 10 022 424			
		Max	$ 10 429 947	$ 12 929 947	$ 11 429 947			
		Score	0.20 %	100.00 %	18.36 %	29.94 %	0.00 %	24.49 %
EBITDA as % of Revenue	30 %	EBITDA / Revenue	42.23 %	39.86 %	41.20 %			
		Range 35% - 45%	35.00 %	45.00 %				
		Score	72.31 %	48.61 %	61.96 %	21.69 %	14.58 %	18.59 %
						89.24 %	**43.81 %**	**77.41 %**

Recommended Option

Conclusions

Final Thoughts

Framework for Practitioners

- How to apply the methodology in real settings
- How can we adopt this methodology?
  - Use of MCS
  - Support for decision-making

Conclusions

- Each model requires its own measures, the ones that make sense
  - Business should be **definitely** included
- Applying a framework for decision making is necessary
- Calibrating the weights is something that takes time
  - Ideally these weights reflect the company's priorities for each analysis

Final summary and open floor for questions.

Q&A + Closing Thoughts

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