

This Week

Monday

- Project Risk Analysis



Wednesday

- Lab Exercise: Risk Analysis for Liquair-Pro

Topics

- **Risk and Uncertainty**
- **Risk Analysis Methods**
- **Choosing the “Best” Alternative**

A Problem Solving Framework

- 1. Define the Problem*
- 2. Collect and Organize Data*
- 3. Characterize Uncertainty and Data Relationships*
- 4. Build an Evaluation Model*
- 5. Formulate a Solution Approach*
-  *6. Evaluate Potential Solutions*
-  *7. Recommend a Course of Action*

Risk And Uncertainty

In the context of projects:

- **Uncertainty** exists when the value of one or more parameters affecting a project's economic and/or operating characteristics are unknown.
- **Risk** is the potential for loss arising from uncertainty.
- The goal of **risk analysis** is to identify the magnitude and likelihood of potential loss associated with various decision alternatives.

Recall: Decision Making With Well-Defined Outcomes

Given:

- The set of *decision alternatives*
- The possible *outcomes* of the sources of uncertainty
- The associated *probabilities* of each outcome

We need to determine:

- What are the *consequences* for each possible combination of decision alternative and outcome?
- How should we *measure* the decision alternatives?
- What is the *best* decision alternative?

Can we apply this framework to Liquair-Pro?

Risk Analysis Methods

- **Sensitivity Analysis**
- **Break-Even Analysis**
- **Scenario Analysis**
- **Probabilistic Risk Analysis**

Sensitivity Analysis

- Measures how variations in individual parameters (usually one or two) affect a project's NPW.
 - + **Good for determining which individual factors impact the NPW most profoundly.**
 - **Does not evaluate the likelihood of realizing specific parameter values.**
 - **May not provide a good assessment of realistic outcomes since interactions among variables are ignored.**

Break-Even Analysis

- For a particular parameter, determines the value that makes the decision-maker indifferent to accepting or rejecting a project.
 - + **Good for determining the individual parameter levels at which “good” projects become “bad” projects.**
 - **Does not evaluate the likelihood of realizing specific parameter values.**
 - **May not provide a good assessment of realistic outcomes since interactions among variables are ignored.**

Scenario Analysis

- Evaluates and compares several possible collections of parameters that are representative in some meaningful way (e.g., base case, worst case, best case scenarios)
 - + Provides an assessment of a subset of realistic outcomes, variable interactions captured within the scenario.
 - Does not evaluate the likelihood of realizing the evaluated scenarios or intermediate scenarios.

Probabilistic Risk Analysis

- Uses individual or joint probability distributions for key uncertain parameters to determine a probability distribution for the project's NPW.
 - + Takes into account the likelihood of realizing specific parameter values
 - Must establish these likelihoods
 - Can become very complicated as the number of uncertain parameters (and/or the number of possible values) increases. Independence is frequently assumed for tractability.

Dealing With Scale

- Suppose that a project has **2 unknown parameters** and **each parameter has 30 possible values**. How do we analyze $2^{30} > 1$ billion scenarios?
- A **Monte Carlo Simulation** approach:
 1. **Define probability distributions** for each unknown parameter (and/or joint distributions for each group of dependent unknown parameters).
 2. **Generate random values** for each unknown parameter according to their respective distributions and compute the resulting cash flows and NPW. Repeat this many times.
 3. **Use the realizations to establish an approximate probability distribution for the NPW** and other metrics of interest that may affect the project decision.

Monte Carlo Simulation

- How does **tank size = LA-1** and **price/Kgallons = \$594.132** perform if the two primary sources of uncertainty are projected demand and annual growth rate?

Factor 1** = Projected Year 1 Demand									
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Standard Deviation:	<input type="text" value="5,000"/>	<input type="button" value="▲"/>							
		<input type="button" value="▼"/>							
Factor 2** = Projected Annual Growth Rate									
Mean:	<input type="text" value="5.00%"/>	from Price Quote sheet	<table><tr><td>Standard Deviation:</td><td><input type="text" value="0.50%"/></td><td><input type="button" value="▲"/></td></tr><tr><td></td><td></td><td><input type="button" value="▼"/></td></tr></table>	Standard Deviation:	<input type="text" value="0.50%"/>	<input type="button" value="▲"/>			<input type="button" value="▼"/>
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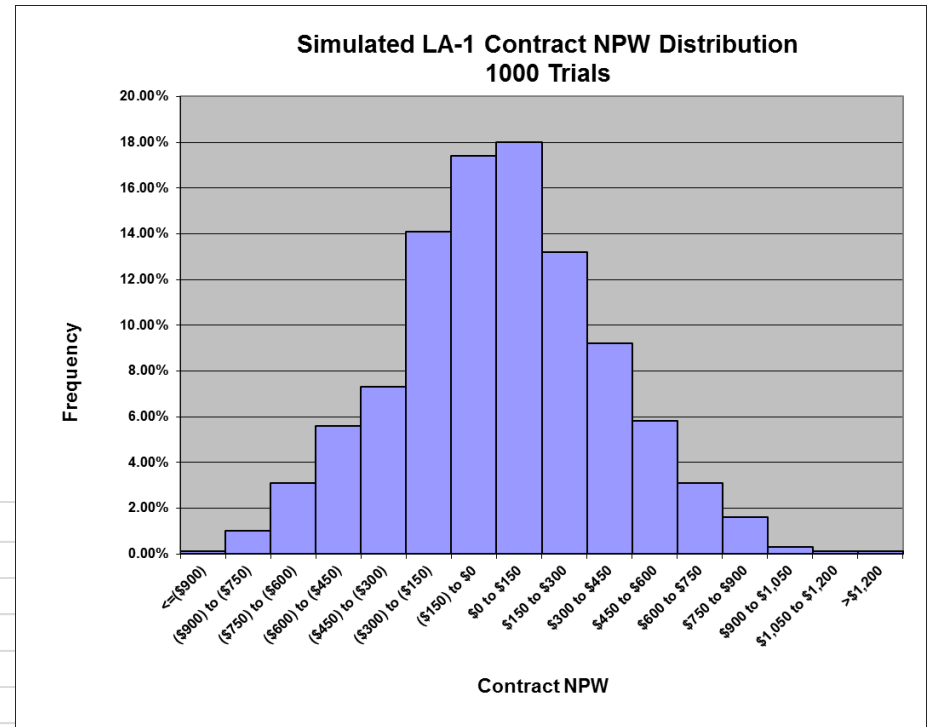
Example Statistical Results

	LA-1
Price per KGallons for Simulation:	\$594.132

	Contract NPW
Average:	\$16.39
Std Dev:	\$347.25

Contract NPW Range	Frequency	As %	Cumulative %
<=(\$900)	1	0.10%	0.10%
(\$900) to (\$750)	10	1.00%	1.10%
(\$750) to (\$600)	31	3.10%	4.20%
(\$600) to (\$450)	56	5.60%	9.80%
(\$450) to (\$300)	73	7.30%	17.10%
(\$300) to (\$150)	141	14.10%	31.20%
(\$150) to \$0	174	17.40%	48.60%
\$0 to \$150	180	18.00%	66.60%
\$150 to \$300	132	13.20%	79.80%
\$300 to \$450	92	9.20%	89.00%
\$450 to \$600	58	5.80%	94.80%
\$600 to \$750	31	3.10%	97.90%
\$750 to \$900	16	1.60%	99.50%
\$900 to \$1,050	3	0.30%	99.80%
\$1,050 to \$1,200	1	0.10%	99.90%
>\$1,200	1	0.10%	100.00%
	1000	100.00%	

<== Loss Probability



Choosing the “Best” Alternative

Questions to Consider:

- *How should this tank/price combination be compared against other alternatives?*
- *What other information should be captured for each simulation trial besides the Contract NPW?*
- *If parameter likelihoods cannot be established with accuracy, what other methods can be employed to hedge against uncertainty?*