LNG SUPPLY CHAIN RESILIENCE

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MIT Supply Chain MANAGEMENT

MIT Center for Transportation & Logistics

AGENDA

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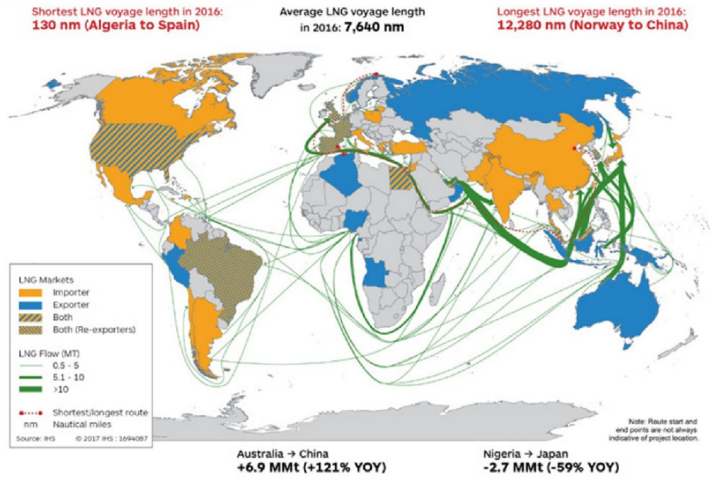
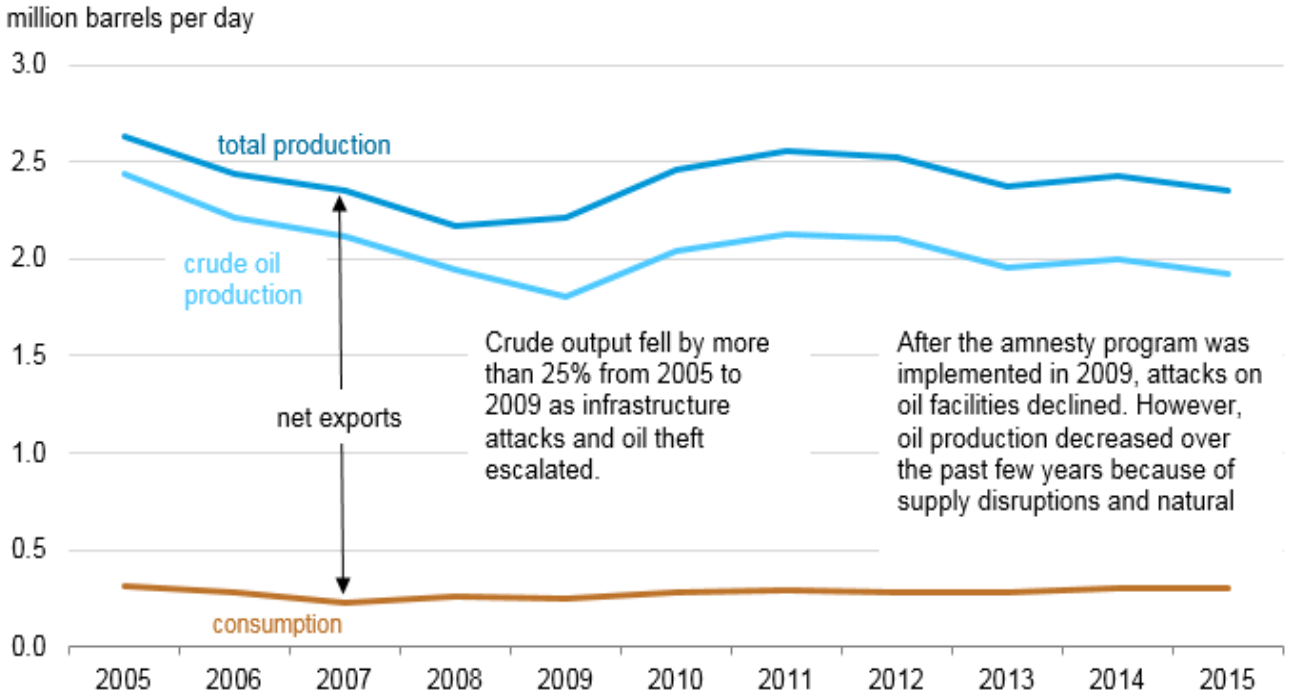
- Introduction
- Focus area and sponsor company
- Observations
- Research question
- LNG network
- Methodology
- Results
- Key insights



Introduction

- LNG demand are increasingly globally
- Exposure to disruptions and plant outages are on the increase
- Disruptions can be natural or man-made
- Man-made disruptions in Nigeria have huge economic costs

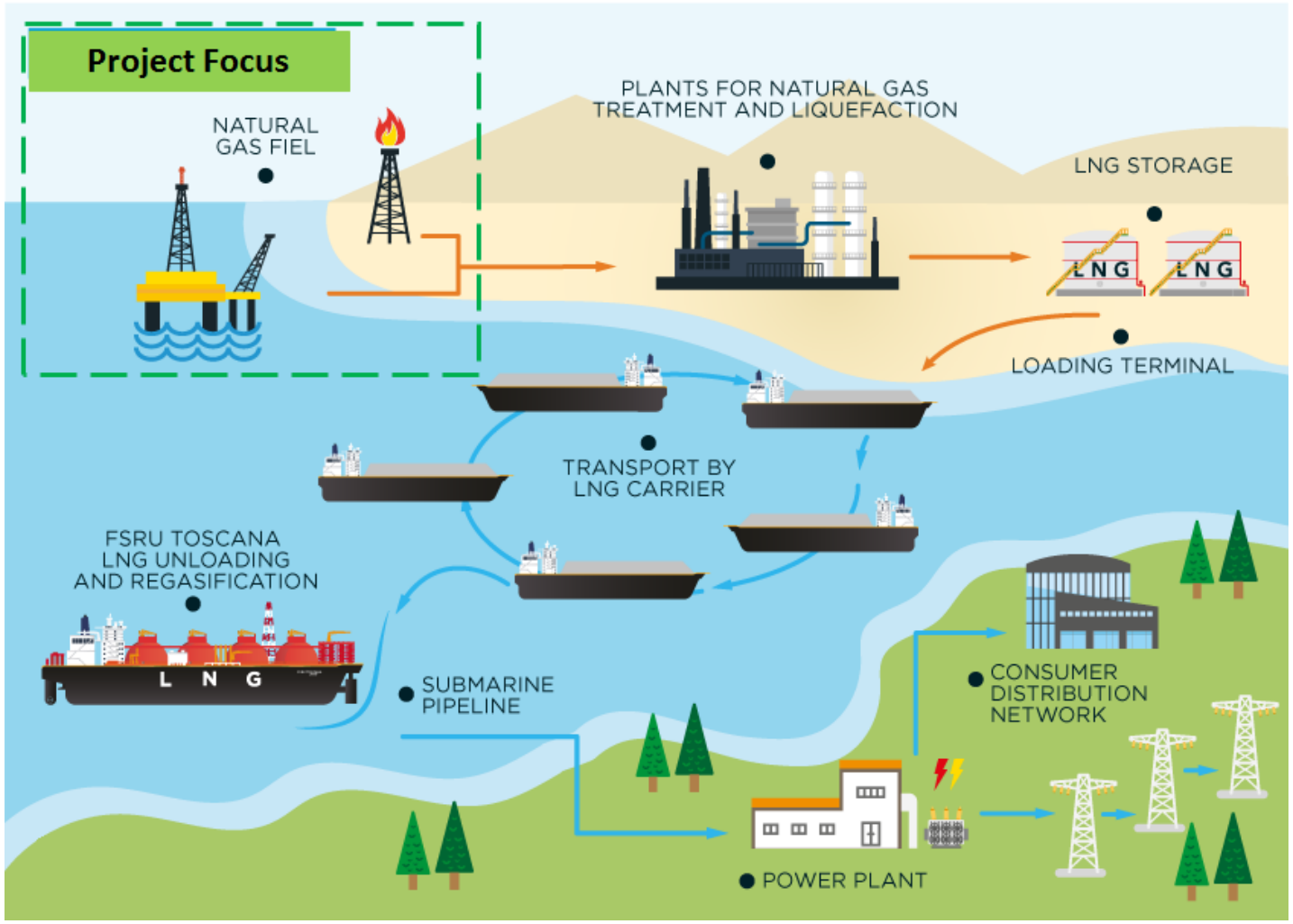


Sponsor company

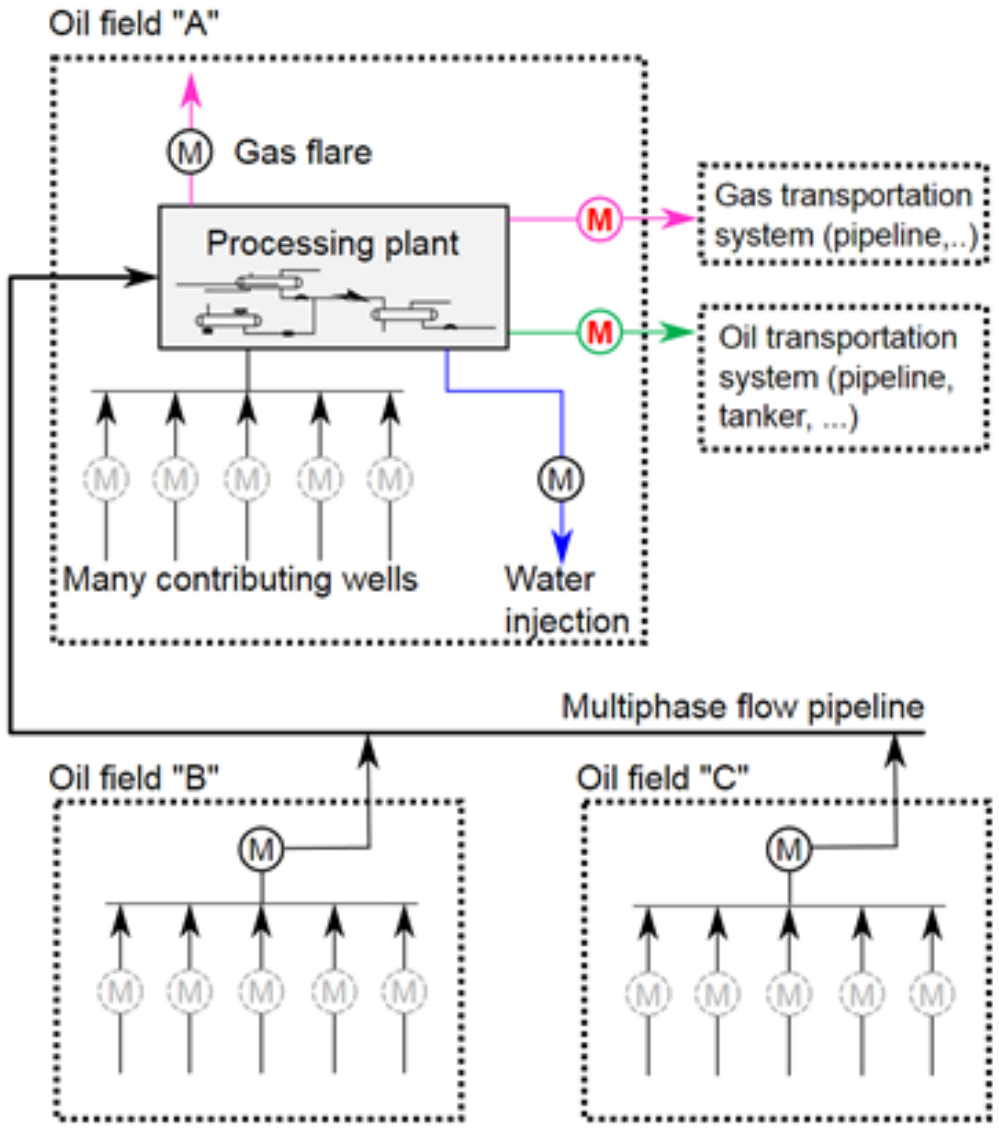
- An oil and gas pipeline infrastructure sub-contractor
- knowledge about disruptions in the Niger-delta region and pipeline restoration services
- Disruption and intervention data from SLA report
- Integrated pipeline response vs First-Down, First-Repair Approach

LNG SUPPLY CHAIN

$20B Market in 2025
258 MT Global traded in 2016
439 Vessels January 2017



Upstream of the LNG Supply chain



Observations

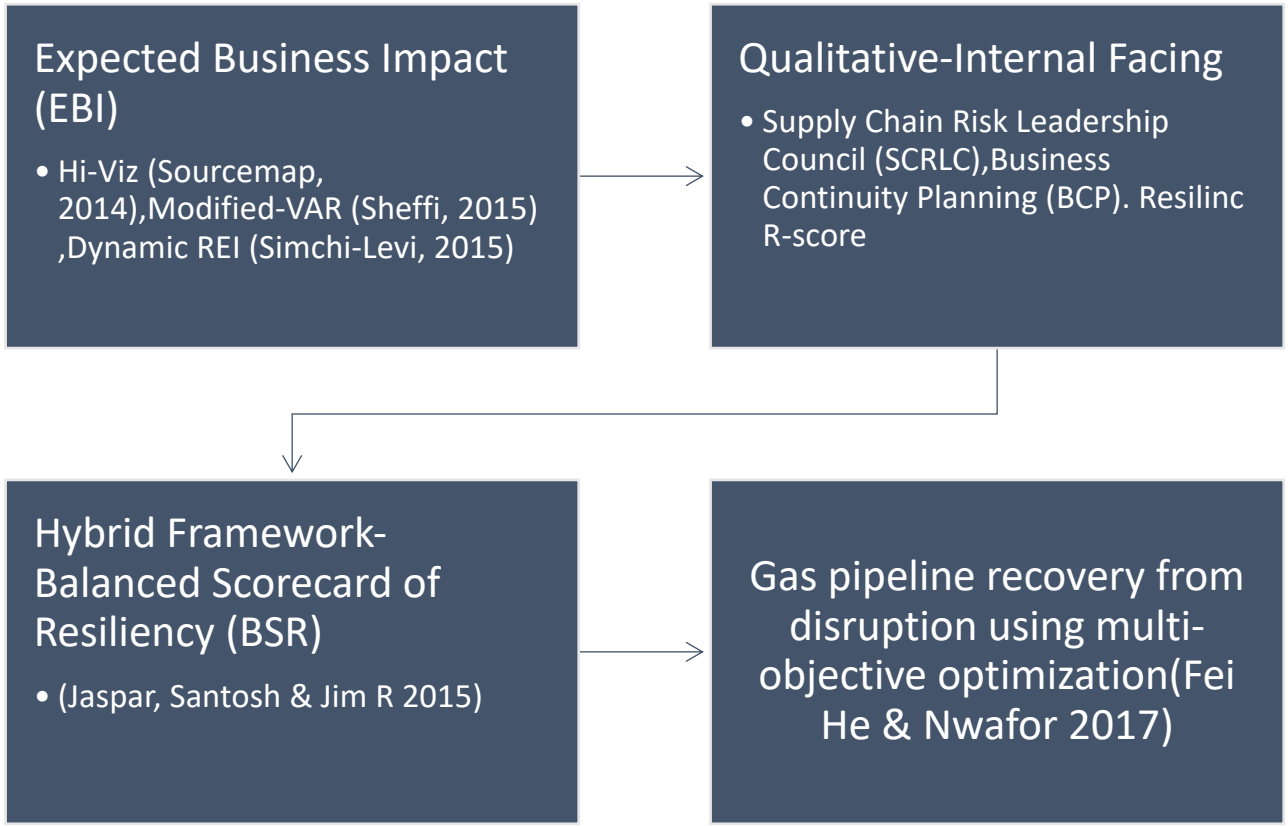
Multiple pipeline disruption occurs across facilities

Route replacement and flowline repair is facility driven based on budget

No integrated framework for prioritizing flowline repair and response to disruption

Lack adequate process for after action evaluation on resilience improvement

Work already done?



Research Question.

How can resilience framework improve response to multiple oil and gas pipeline supply chain disruption?

How can the Balance Scorecard of Resilience(BSR) form a framework for prioritizing response to multiple disruption?

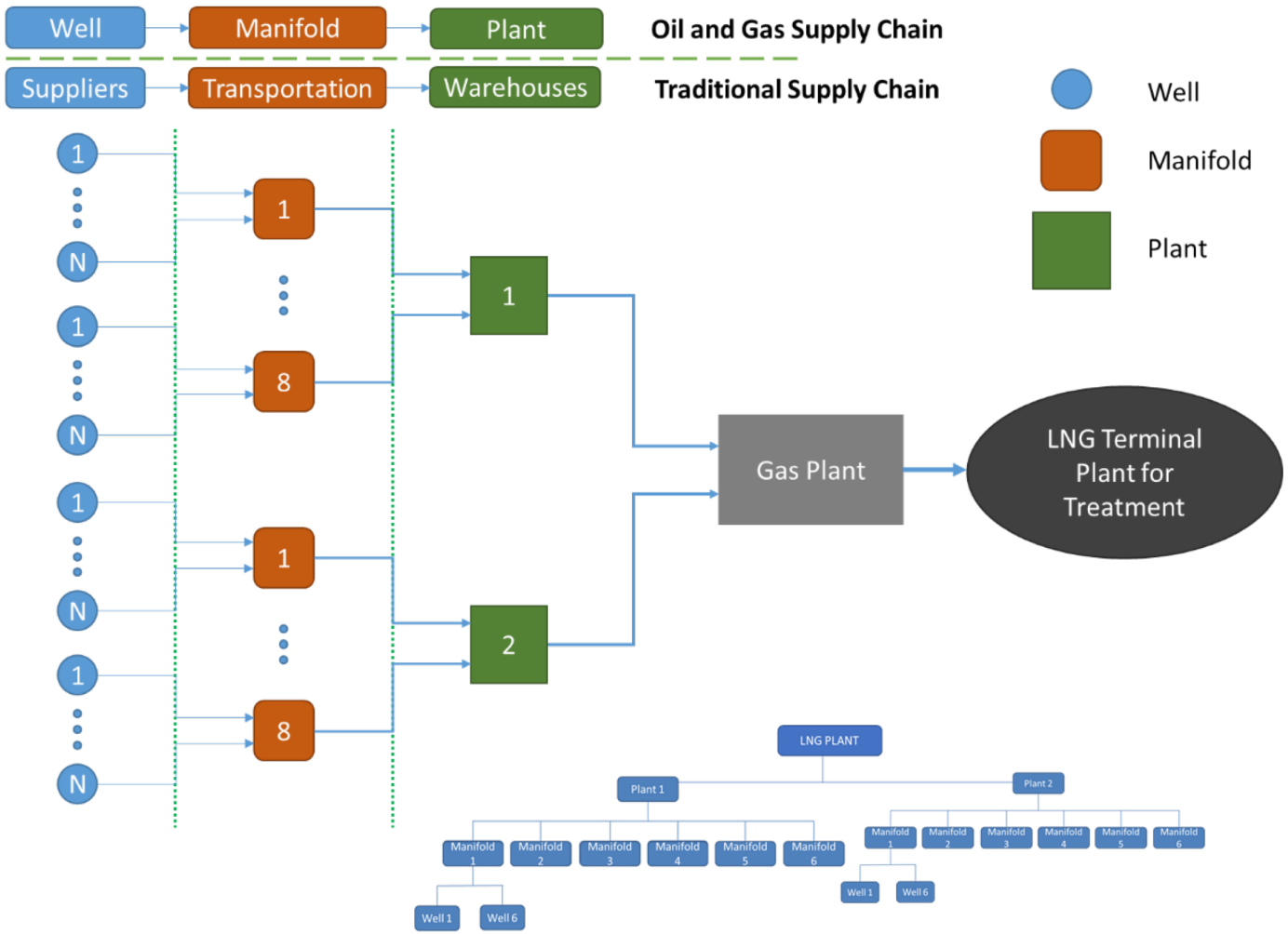
What is done differently?

An integrated risk based approach to prioritizing response to pipeline disruption

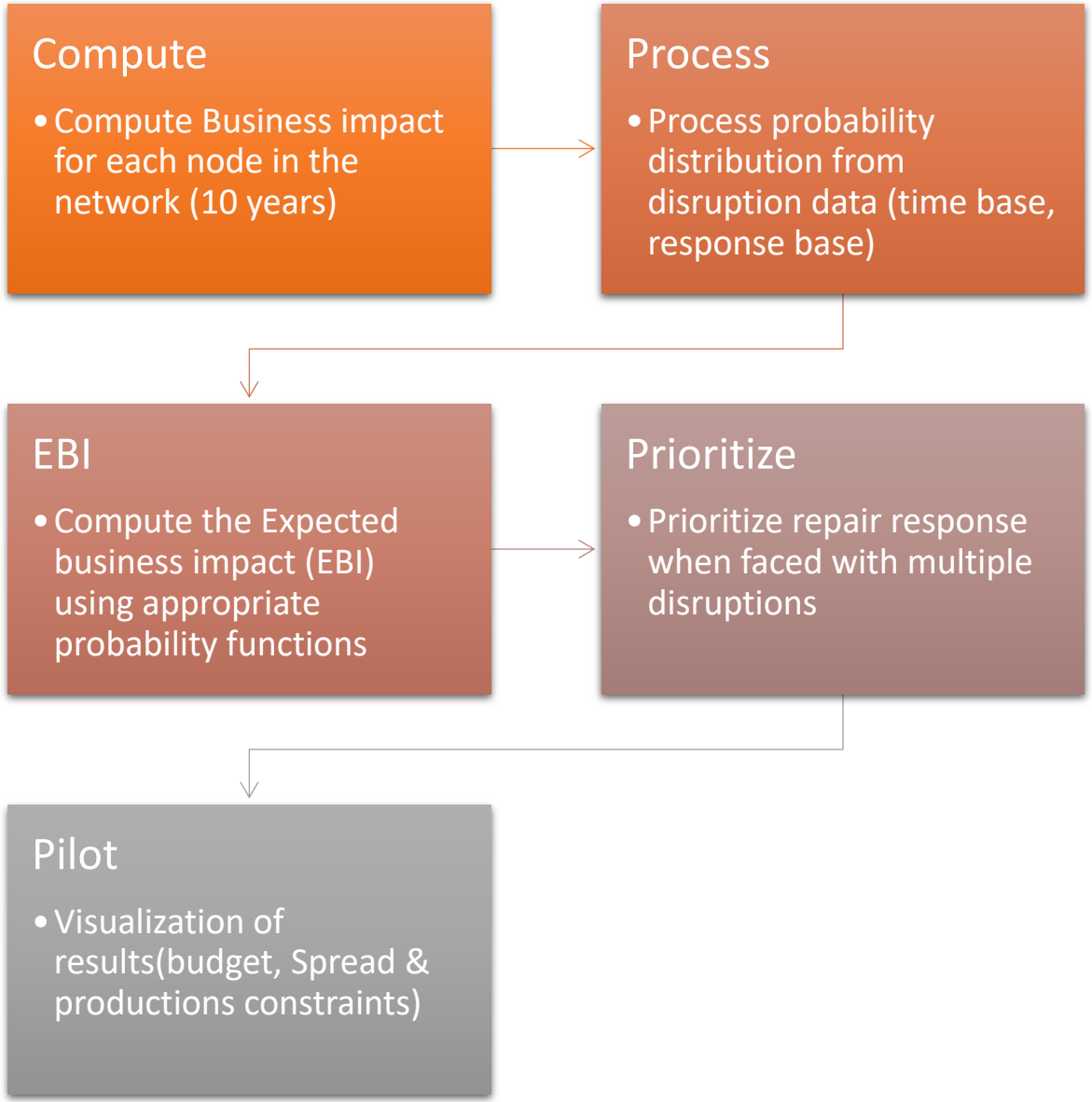
Reducing overall impact of disruption on the business

Modeling the LNG Supply chain

- Similarities between LNG Supply Chain and Traditional Product Supply Chain
- Existing Resilience Frameworks can be updated and applied to the LNG Supply Chain



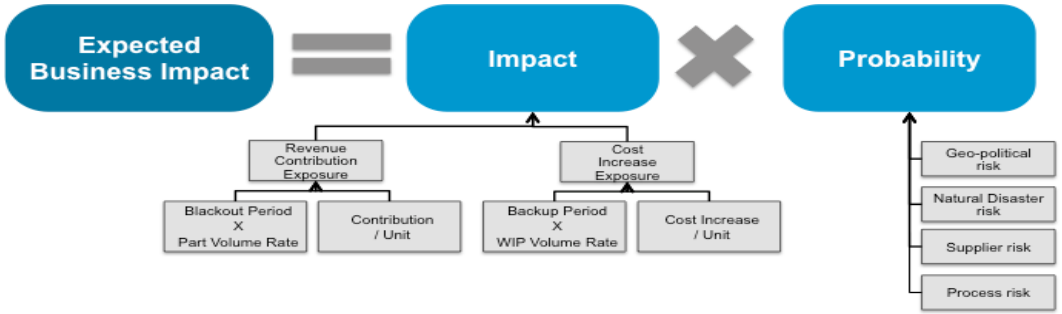
Methodology



BSR Base Case

- $Business\ Impact = Value\ at\ Risk + Cost\ to\ Repair$
  - $Value\ at\ Risk = Revenue\ Loss/day * Profit\ Margin$
  - $Cost\ to\ Repair = Mobilization\ Cost + Repair\ Cost + Variable\ Cost$

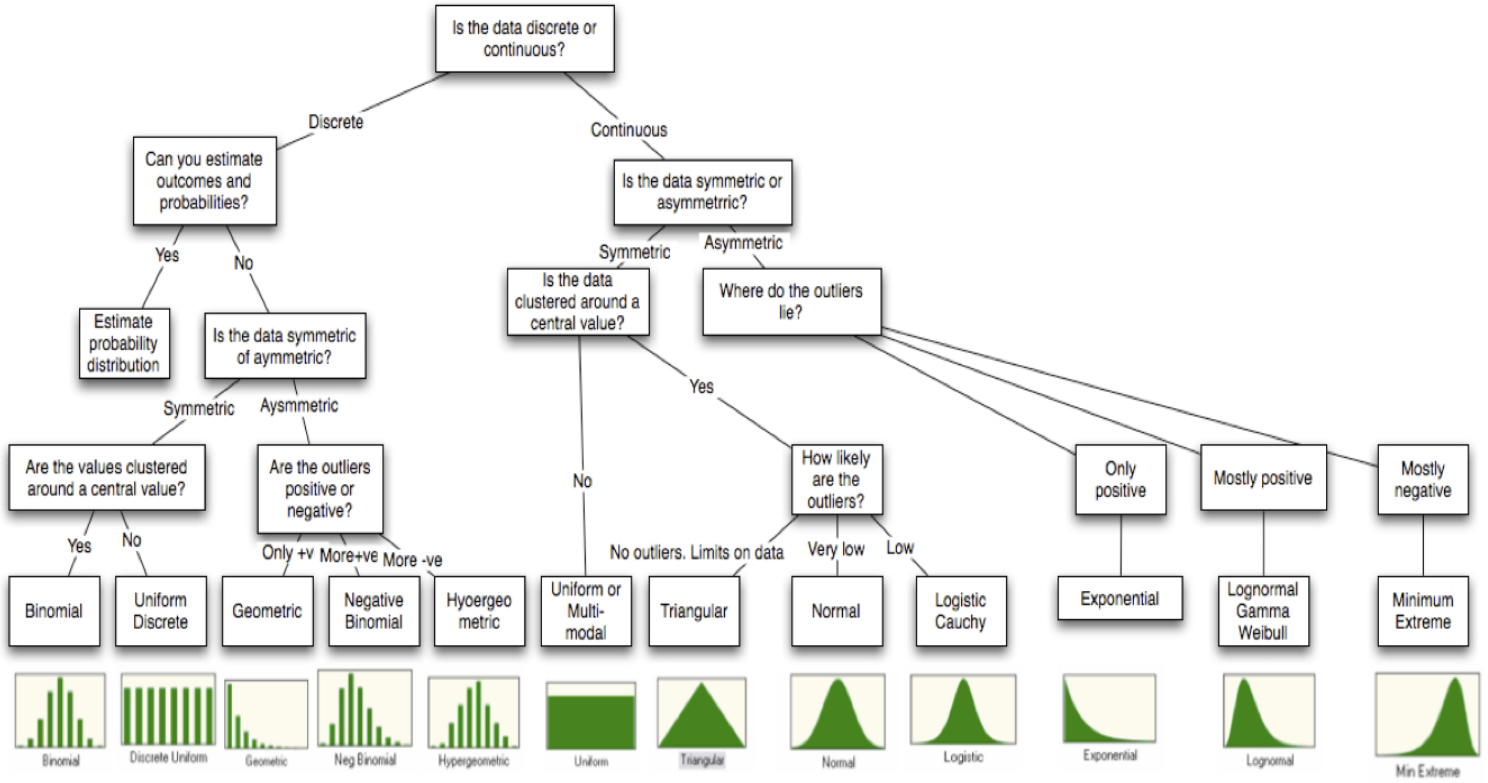
- Other risk factor not considered: Impact on People, Environment & Reputation

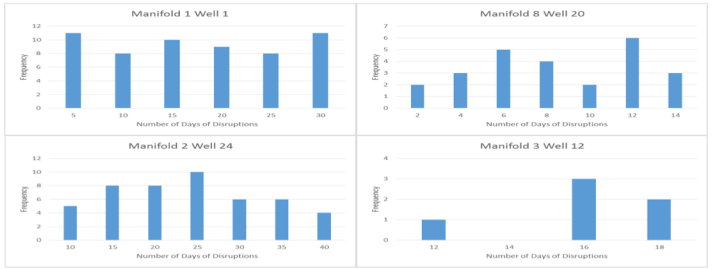


Expected Business Impact

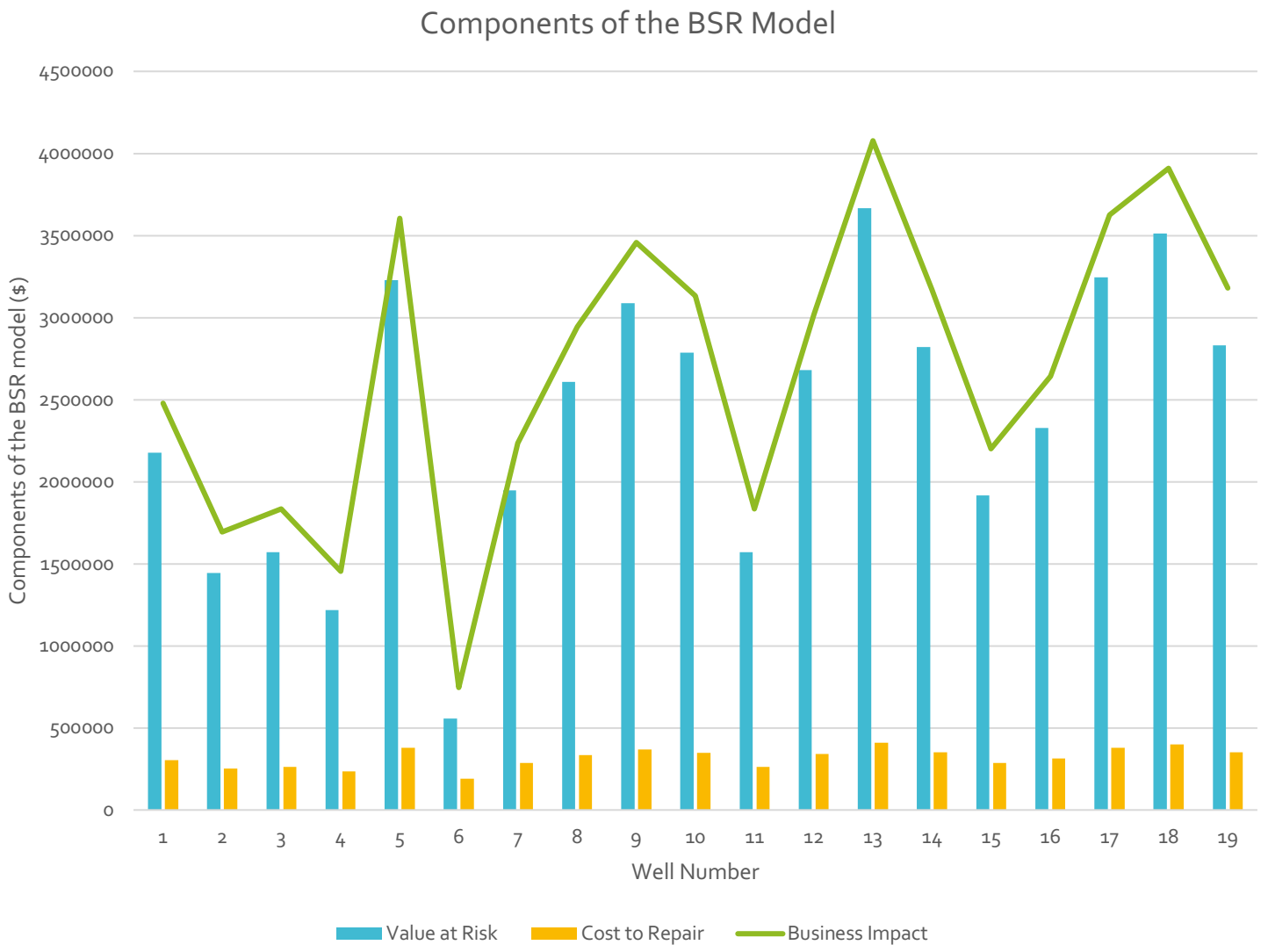
- Probability function should not be applied to every term
- $Expected\ Business\ Impact = Expected\ Value\ at\ Risk + Expected\ Cost\ to\ Repair$
  - $E[Value\ at\ Risk] = P(Disruption\ ) * Value\ at\ Risk$
  - $E[Cost\ to\ Repair] = Material\ Cost + Mobilization\ Cost + E[Variable\ Cost]$
  - $E[Variable\ Cost] = P(Disruption) * Variable\ Cost/Day$
- Two different Probability Functions
  - Normal Distribution
  - Discrete Uniform Distribution

Probability Distribution





VaR
CtR
EBI


Components of the BSR Model
Components of the BSR model ($)
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4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1
2
3
4
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6
7
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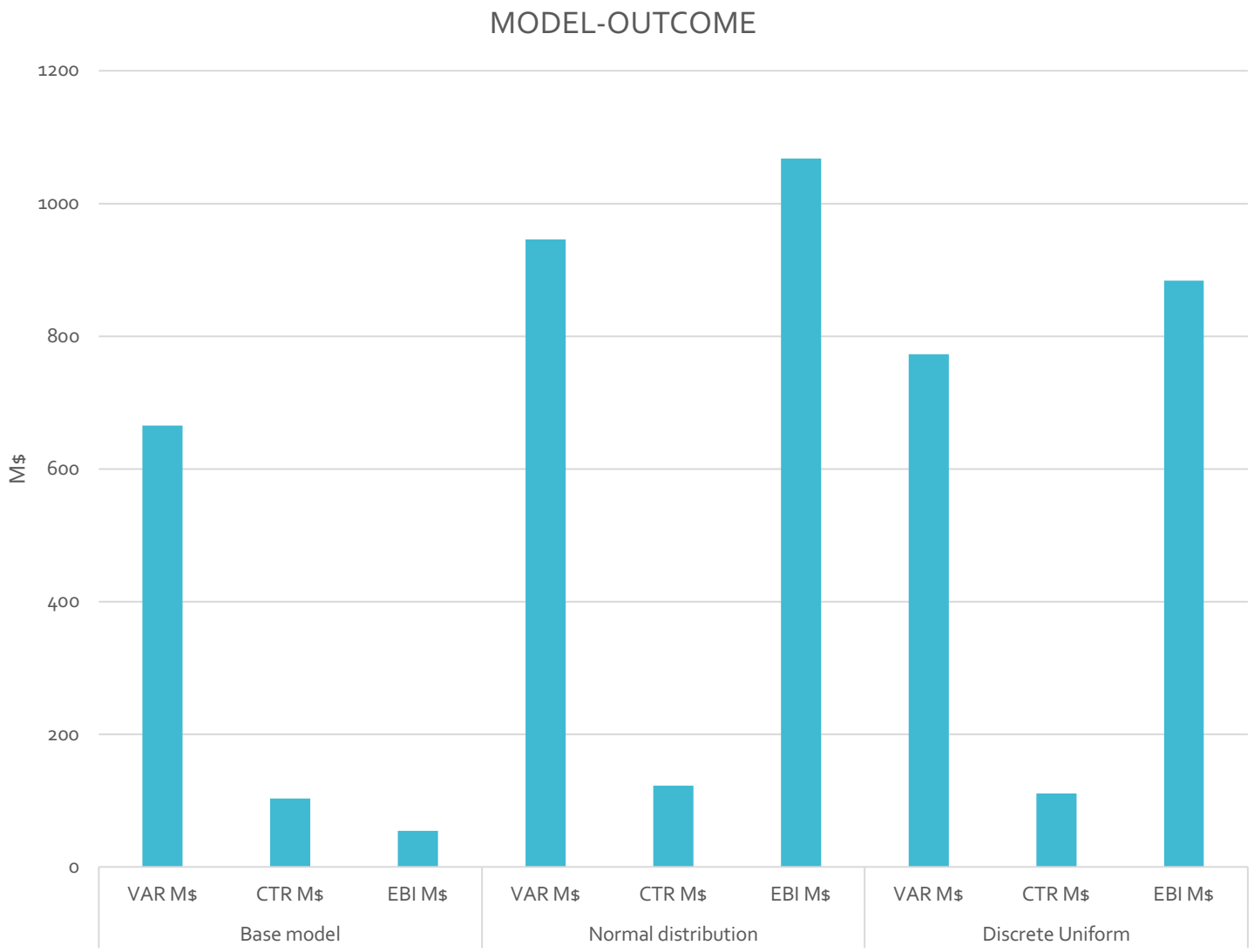
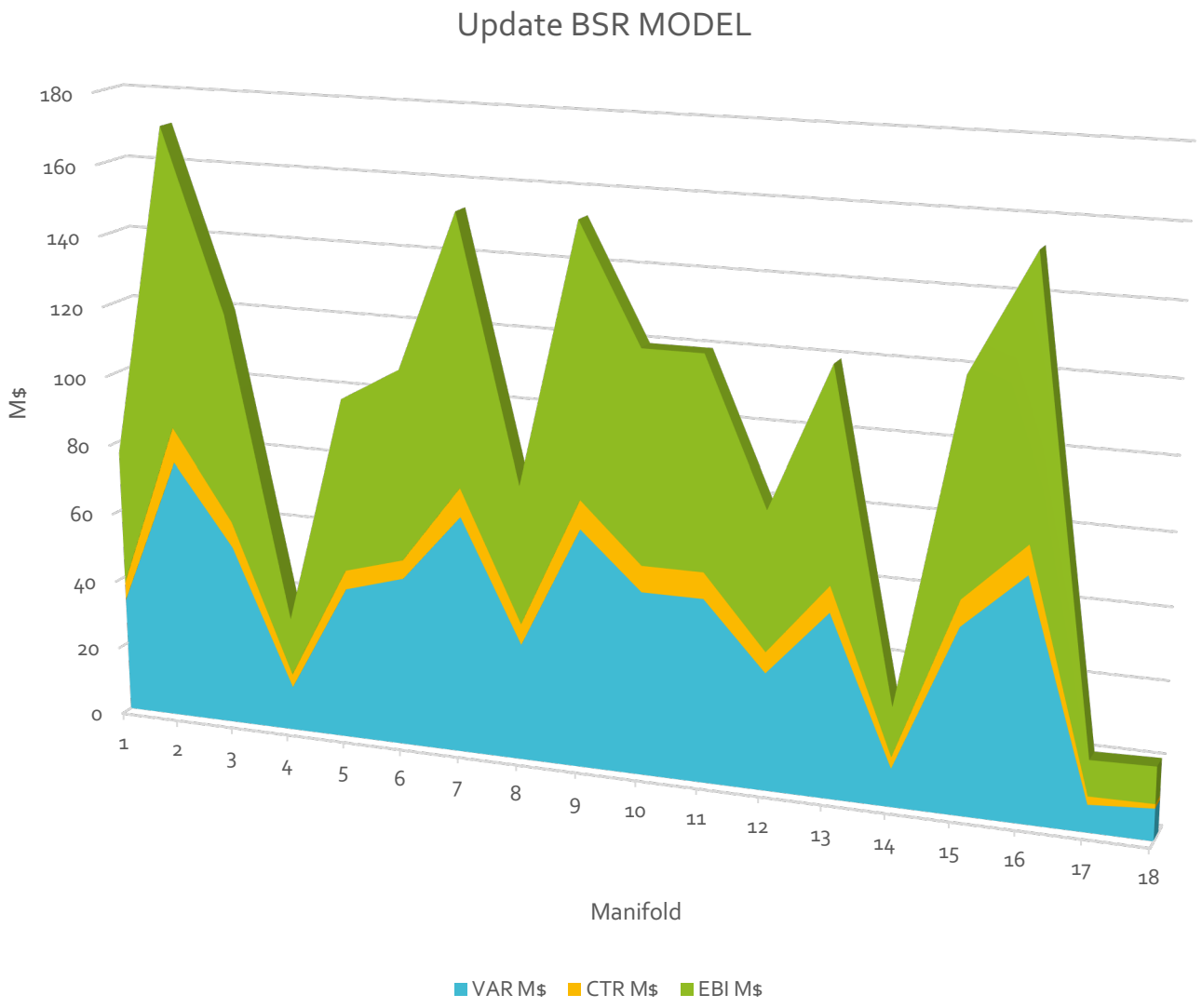
Well Number
Value at Risk
Cost to Repair
Business Impact

Base Model
Normal distribution
Discrete Uniform distribution



Update BSR Model



KEY INSIGHTS

Quantitative assessment of resilience across a supply chain network allows a company to make an objective business case for mitigation and disruption restoration planning

Expected business Impact from multiple pipeline disruption can be reduced by designing business metric that captures value at risk and cost to repair for disruption scenarios

The ranking of mitigation option and extent of restorative investment depends on the additional improvement to baseline business impact

Q&A

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