AFPM Technical Session: RMC-14-80

PAYING ATTENTION TO THE LEADING INDICATORS OF TURNAROUND OUTCOMES

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What Does the Data Say?

Industry Continues to Struggle…

74 percent of all turnarounds failed to satisfy all performance goals[1]

… and 40 percent of all turnarounds grossly exceeded one or more success criteria and can be classified as a “train wreck”[2]

[1]Performance goals defined as +/-10% of budget, +/-10% of planned schedule, no trips after startup

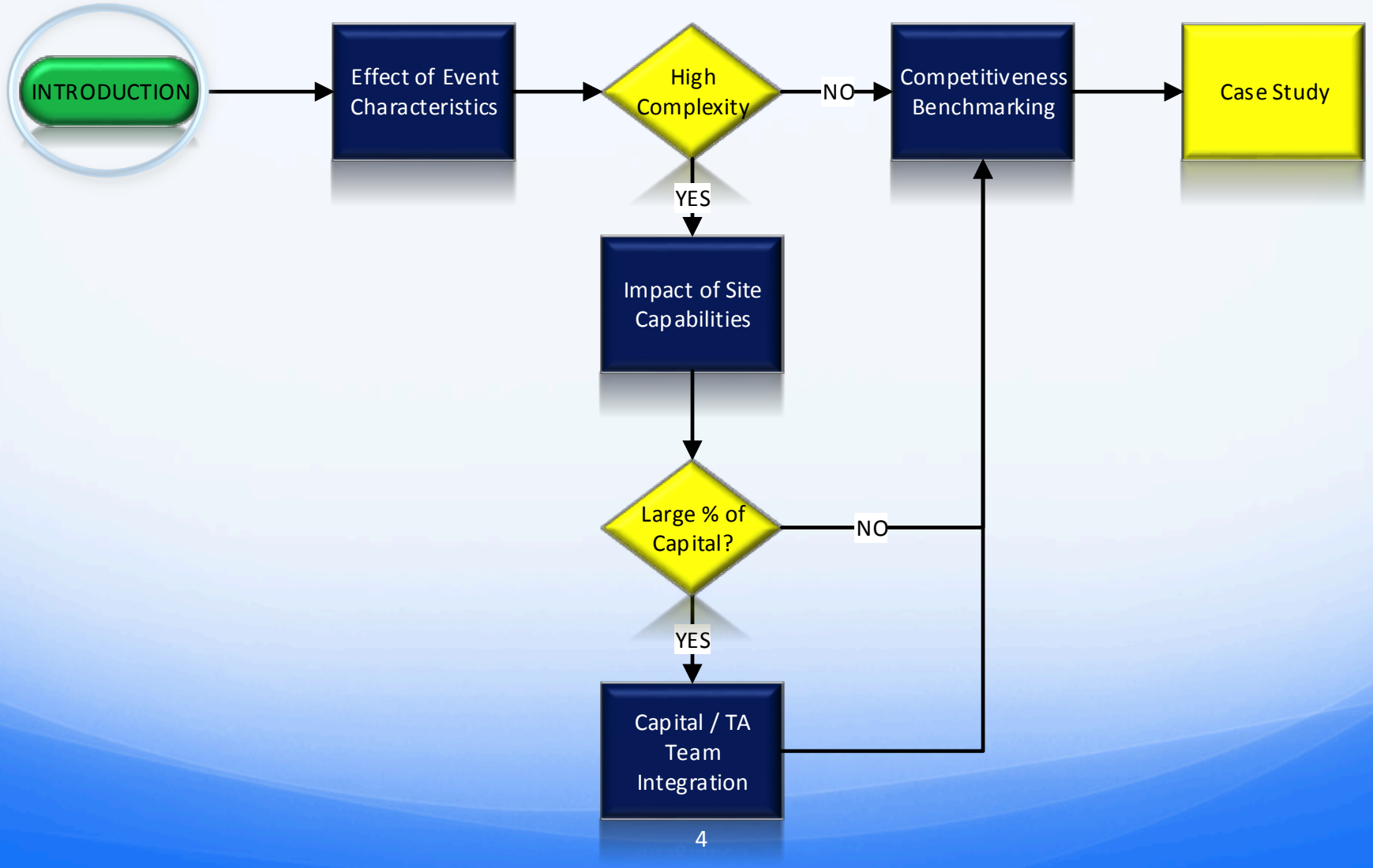
[2]Schedule and/or budget targets missed by 30% or more

From our database of Medium and High Complexity TAs executed since mid-2009

Ask this question…

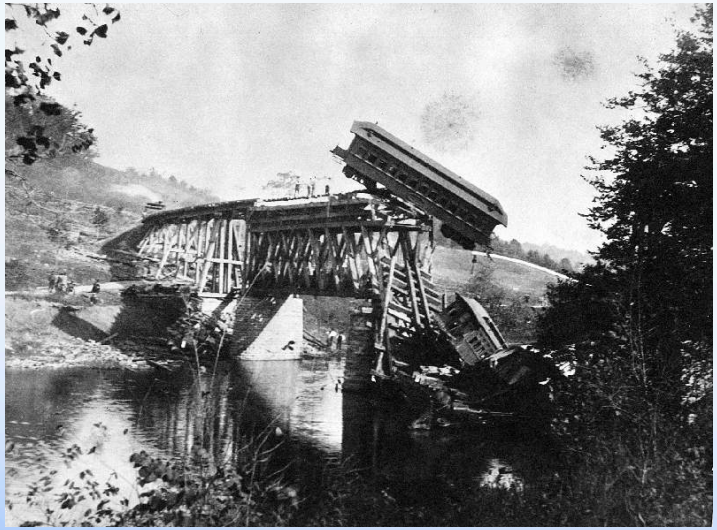
Would the engineer of that train have done something differently if he knew he was going to crash?

Presentation Format



Introduction

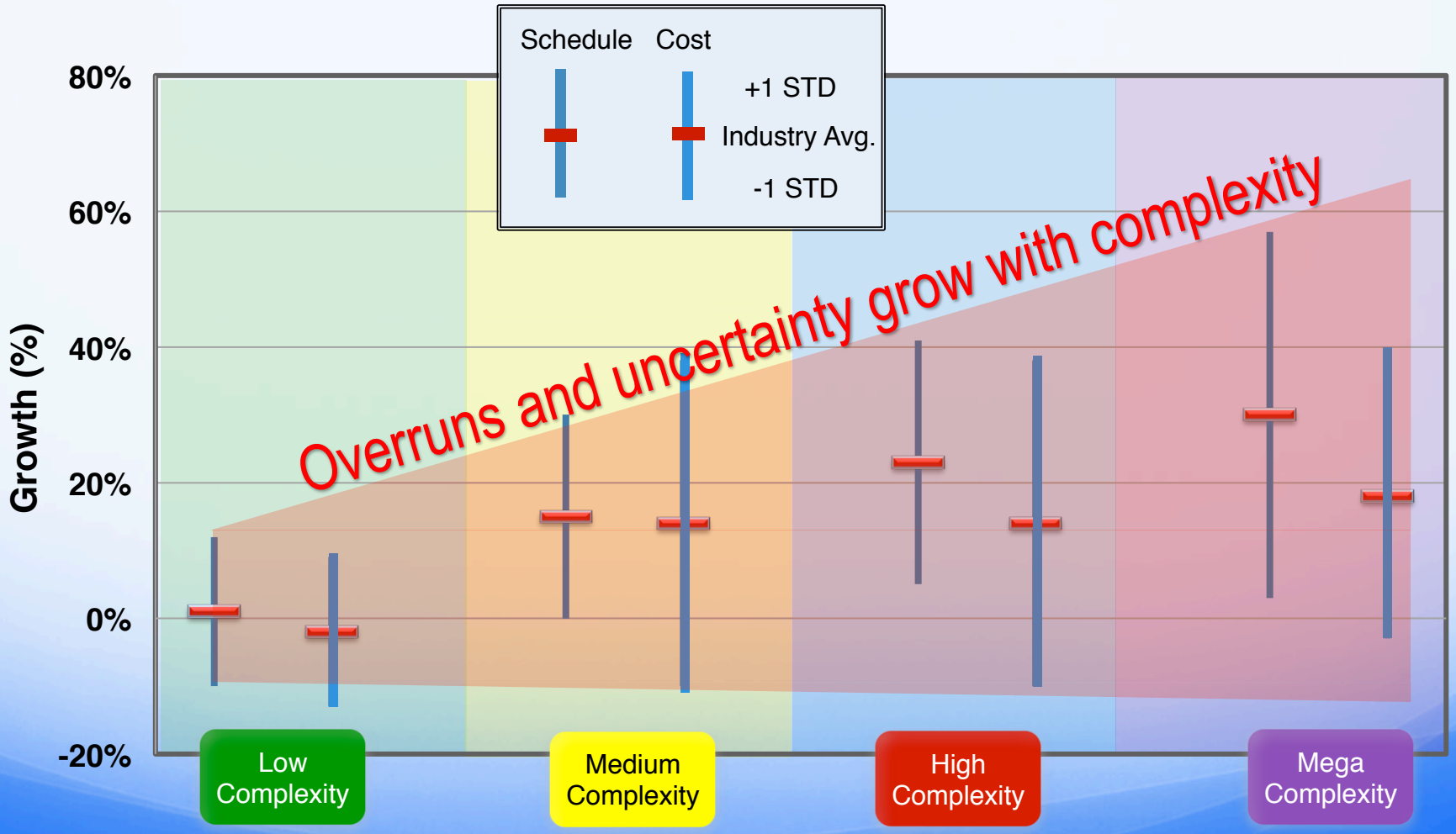
- Event results are often foreshadowed by conditions present before the event starts
- Predictors are quantifiable and measurable…



…if you see them.

Turnarounds: What Does the Data Say?

Medium, High, and Mega Complexity Turnarounds Are Unpredictable



Source: AP-Networks Turnaround Database

What does this mean?

The odds are not in your favor…

- If I know nothing about your event, I can predict you will fail by some measure and I'll be correct the majority of the time

All is not lost…

- The outcome of each turnaround can be modeled and predicted outcomes can be quantified before the event starts
- Key elements that are more likely to drive the outcome in a negative direction can be identified, addressed, and mitigated

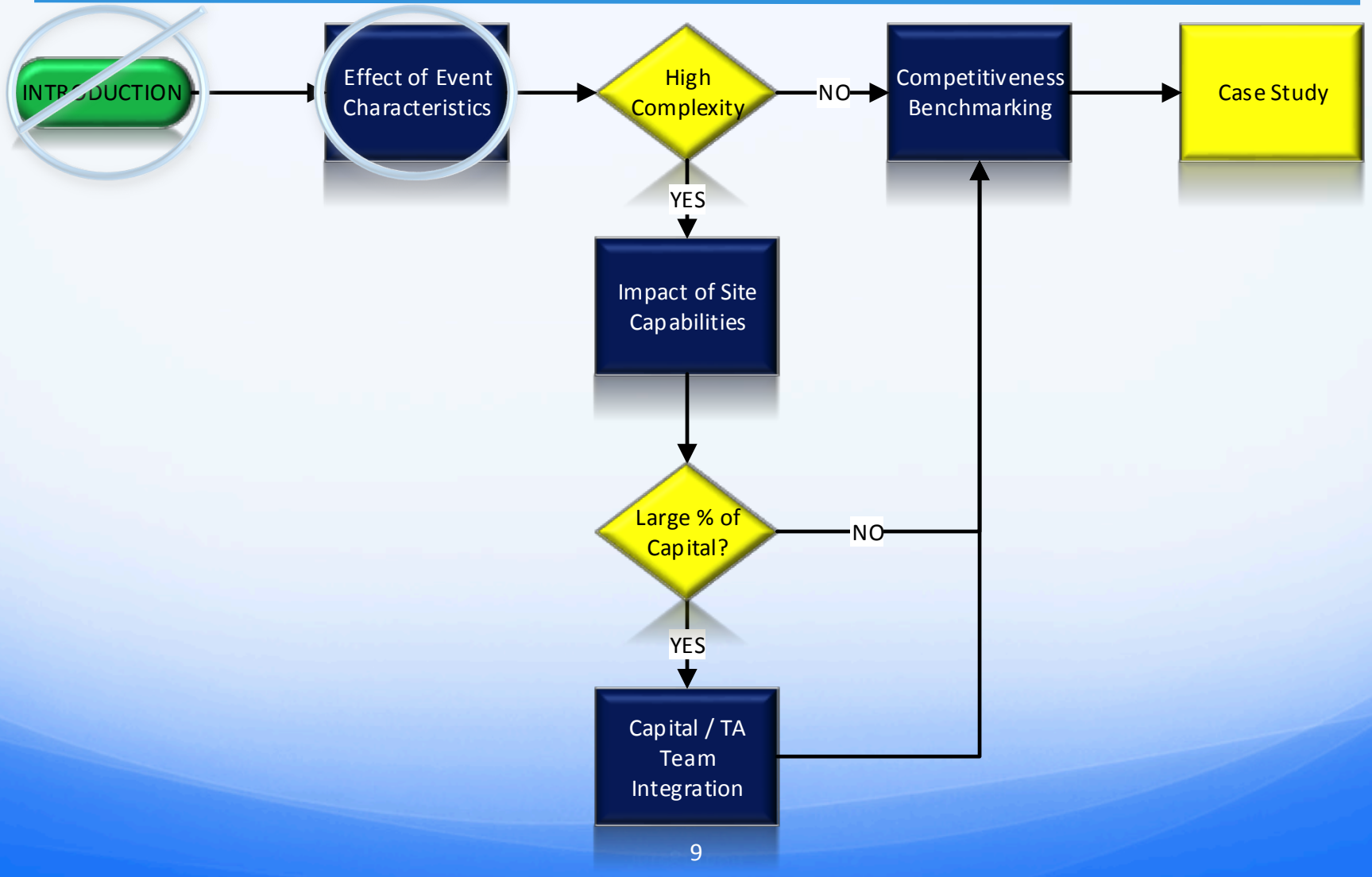
Remember this question?

leaders turnaround

Would the ~~engineer~~ of that ~~train~~ have done something differently if he knew he was going to ~~crash~~?

- Overrun cost by 30%
- Run long by 20%
- Have 2 recordables
- Etc.

Presentation Format



Events Can Be Modeled in a Predictive Fashion

Event Complexity Impacts Performance

- A turnaround's complexity is measured by three inherent properties:
  - *Size as measured in labor-hours*
  - *Percentage of the total turnaround execution labor-hours that are considered capital work*
  - *Turnaround interval*
- Using these three measures, AP-Networks categorizes the turnarounds in its database as Low, Medium, High, and Mega Complexity

Defining Complexity Levels

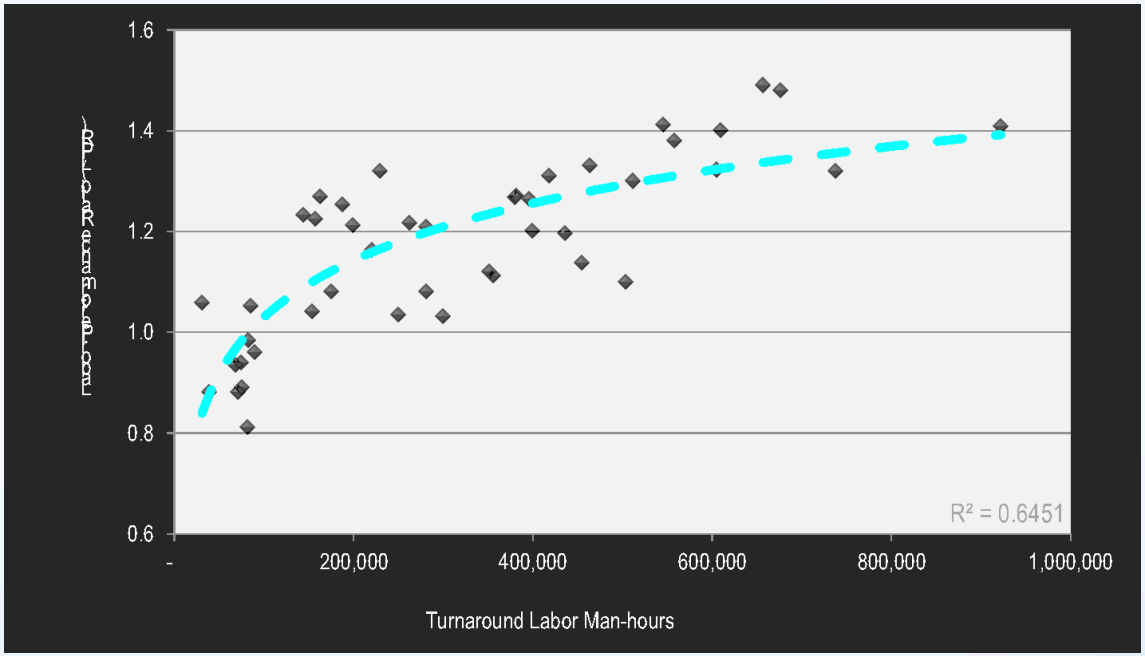
Key Characteristics

Example Complexity Level	Average Labor-Hours	% Average Capital Scope	Average Peak Labor
Low	43,563	8%	238
Medium	203,710	13%	901
High	693,960	23%	1,524
Mega	1,241,648	30%	2,518

Source: AP-Networks Turnaround Database

As Complexity Goes Up, Performance Goes Down

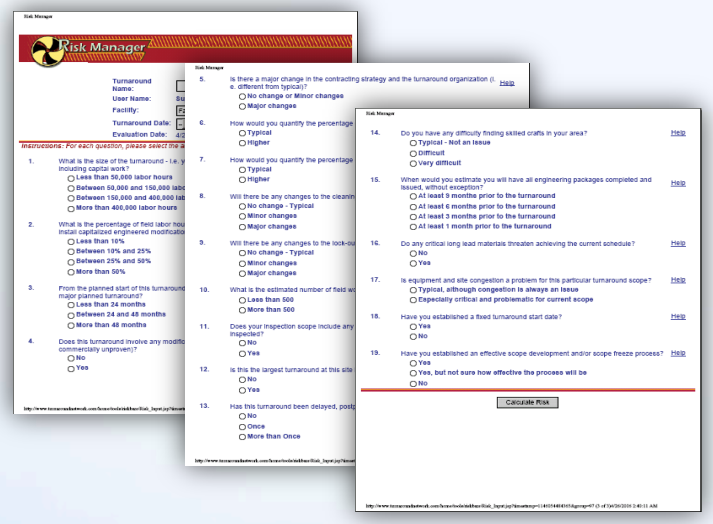
Labor performance deteriorates with increasing turnaround size



- Higher complexity events almost always…
  - *Stress the existing organization's ability to prepare and manage*
  - *Require organizational alignment and discipline that just isn't there*
  - *Rely on complex systems to manage information and work*
  - *Require longer preparation windows and greater efforts from the entire site*

Events Can Be Modeled in a Predictive Fashion

Profile the Risk Factors



- Build a Risk Profile
- Predicted outcomes are sensitive to several key factors:
  - *Peak labor force*
  - *Amount of piping work*
  - *First inspection on new equipment*
  - *Etc.*

Events Can Be Modeled in a Predictive Fashion

Readiness and the Turnaround Readiness Pyramid

- Readiness relative to industry best practices can be measured and quantified

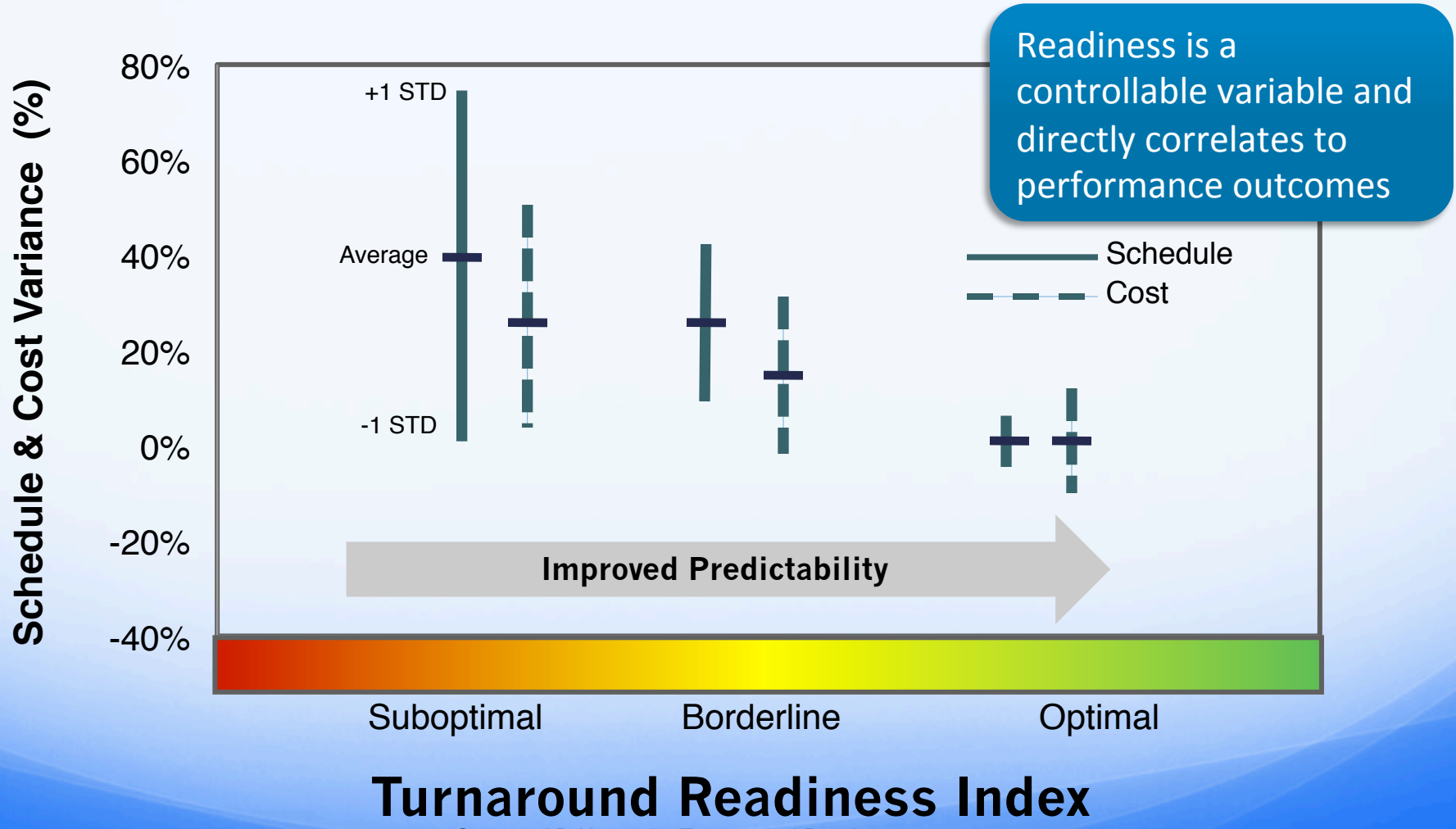
Turnaround Readiness Index

Planning Status [average]

Team Alignment [variance]

Readiness Drives Turnaround Performance

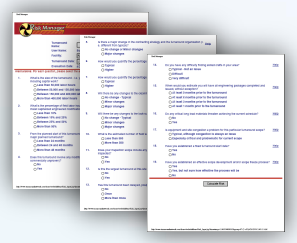
Industry Data Shows Strong and Consistent Correlation



Source: AP-Networks Turnaround Database

Statistical Modeling Can Predict Event Outcomes

Readiness



Risk Profile

Complexity Level	Average Labor Hours	% Average Capital Scope	Average Peak Labor
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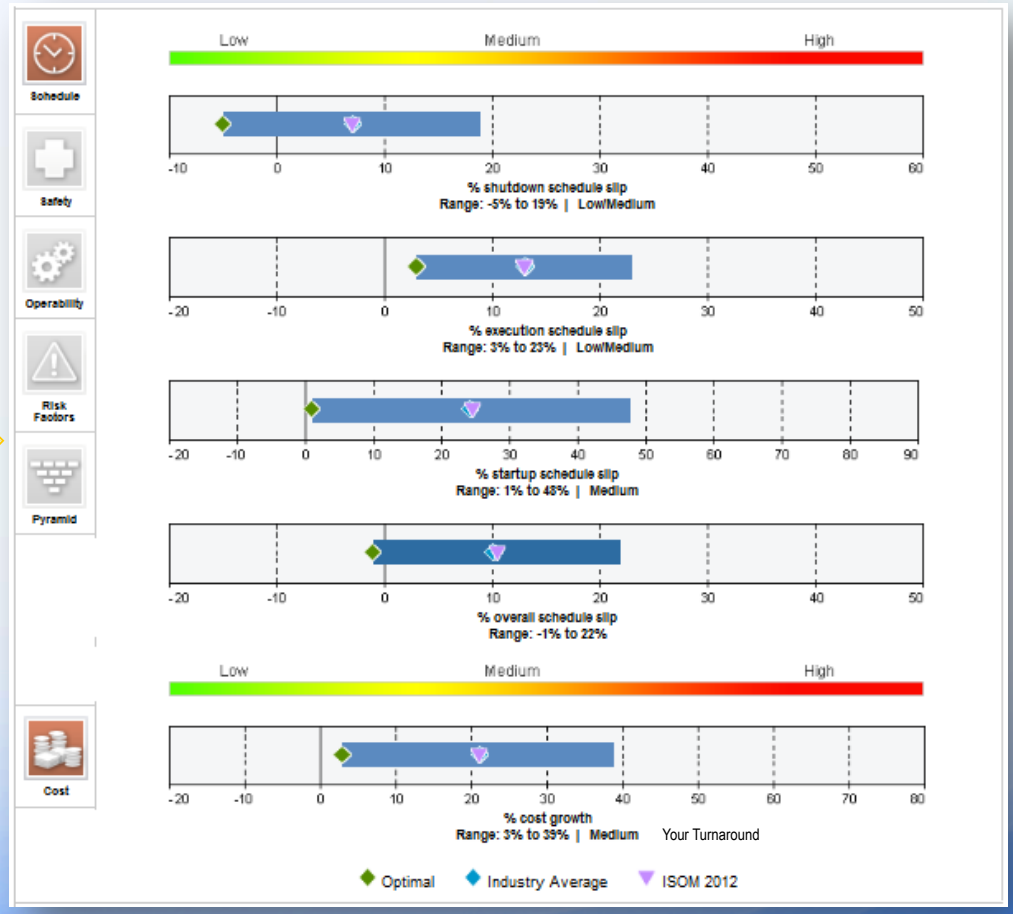
Complexity

Industry Database



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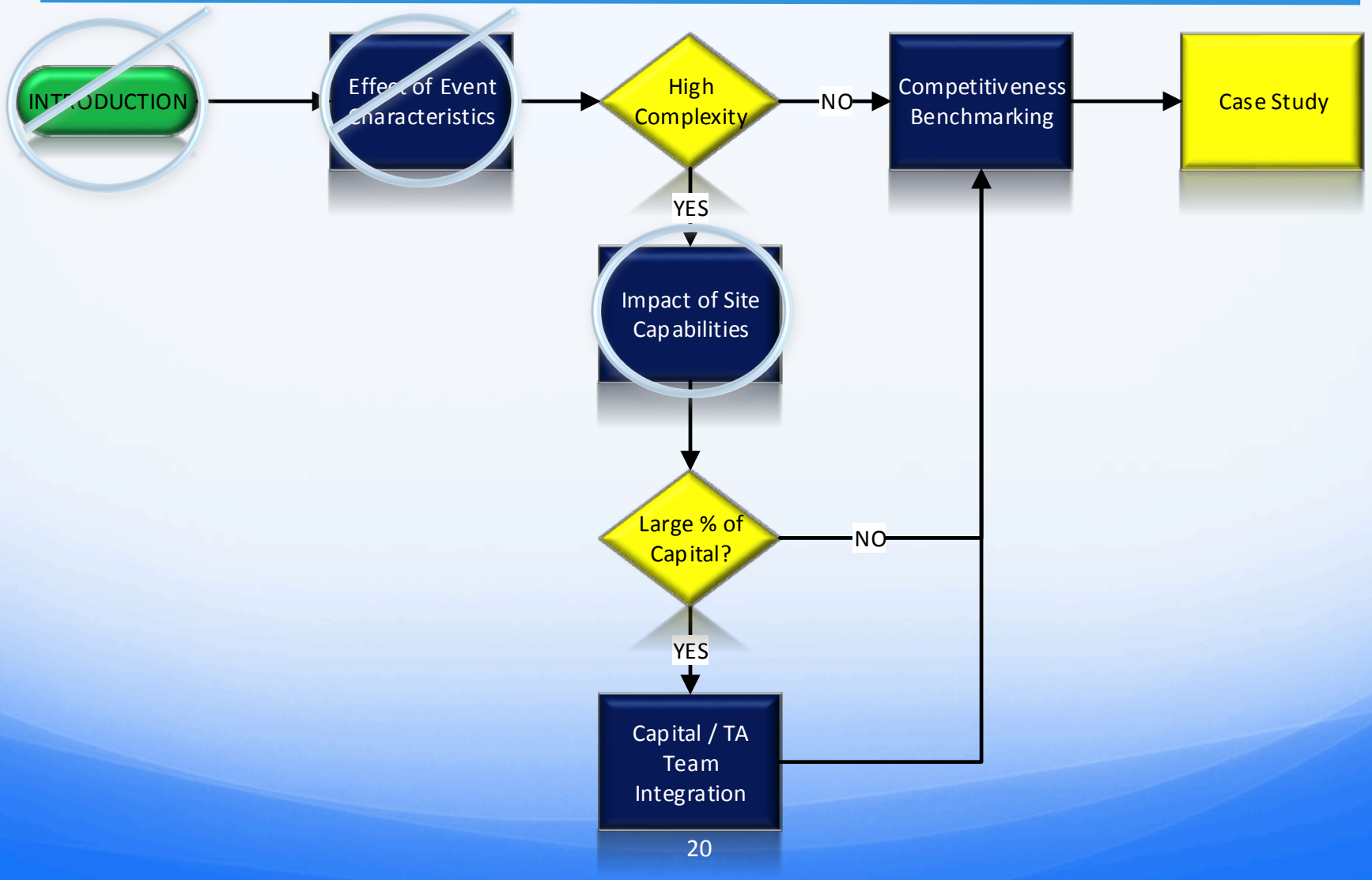


Organizational Tipping Points

Key Questions Posed by the Analysis

1. Is this turnaround too large for the site?
2. Is this turnaround too large for this turnaround department?

What Does the Data Say?

Industry Continues to Struggle…

85 Mega

74 percent of all turnarounds failed to satisfy all performance goals[1]

60 Mega

… and 40 percent of all turnarounds grossly exceeded one or more success criteria and can be classified as a "train wreck"[2]

[1]Performance goals defined as +/-10% of budget, +/-10% of planned schedule, no trips after startup

[2]Schedule and/or budget targets missed by 30% or more

From our database of Medium and High Complexity TAs executed since mid-2009

Capability Index

Primary Components

Risk Factors

+

Organizational Capability

+

Organizational Readiness

Key Factors Rated

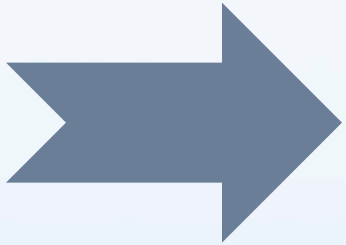
Largest TA at Site?
Interval Length
Peak Labor

# of Plant Personnel

TA Department Staff

Supervisors Ratio

Team Alignment
Steering Team Effectiveness



Capability Index

Capability Index

Higher Score Reduces Overrun Risk

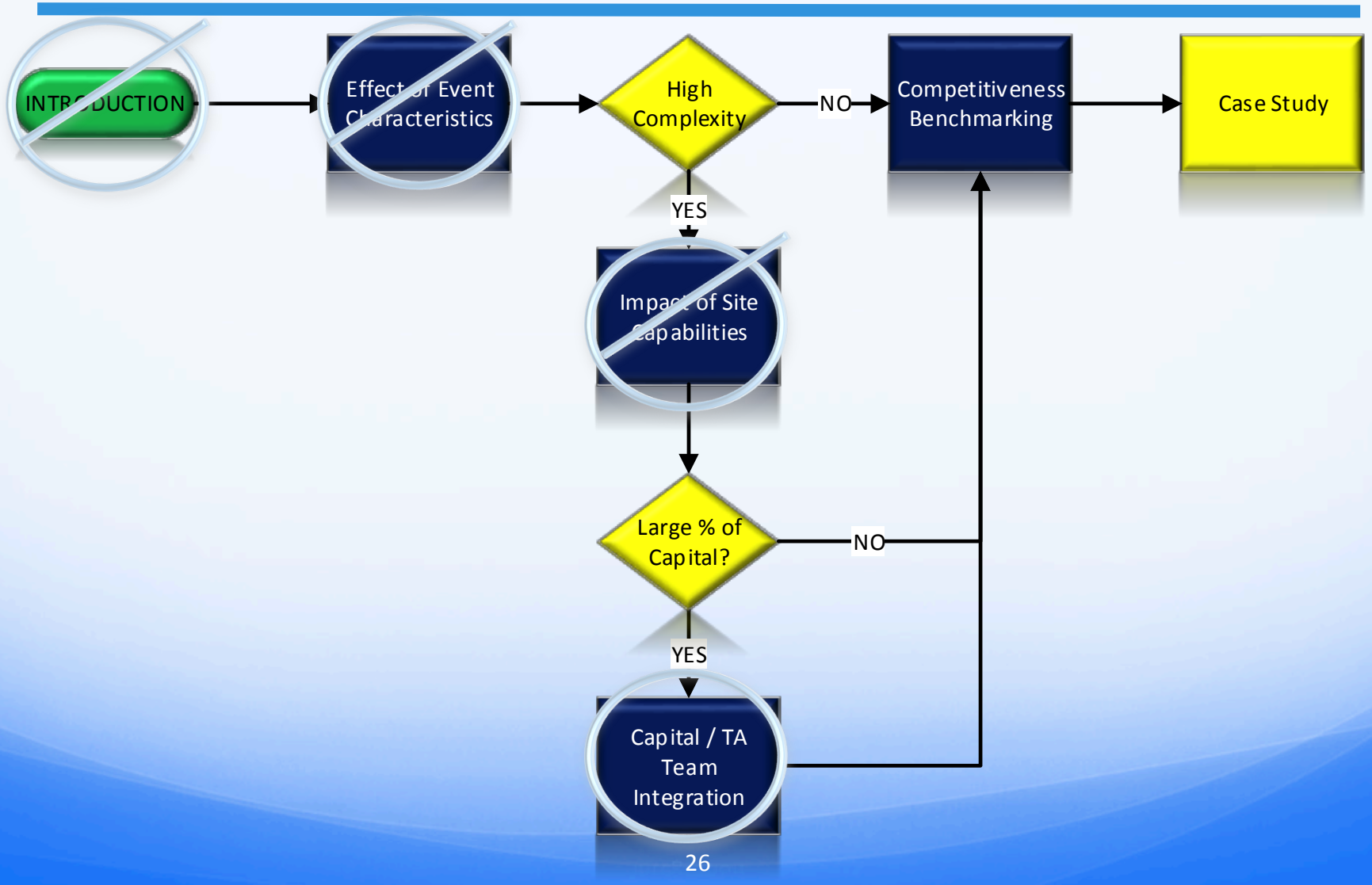
Site Capability Index

Source: AP-Networks Turnaround Database

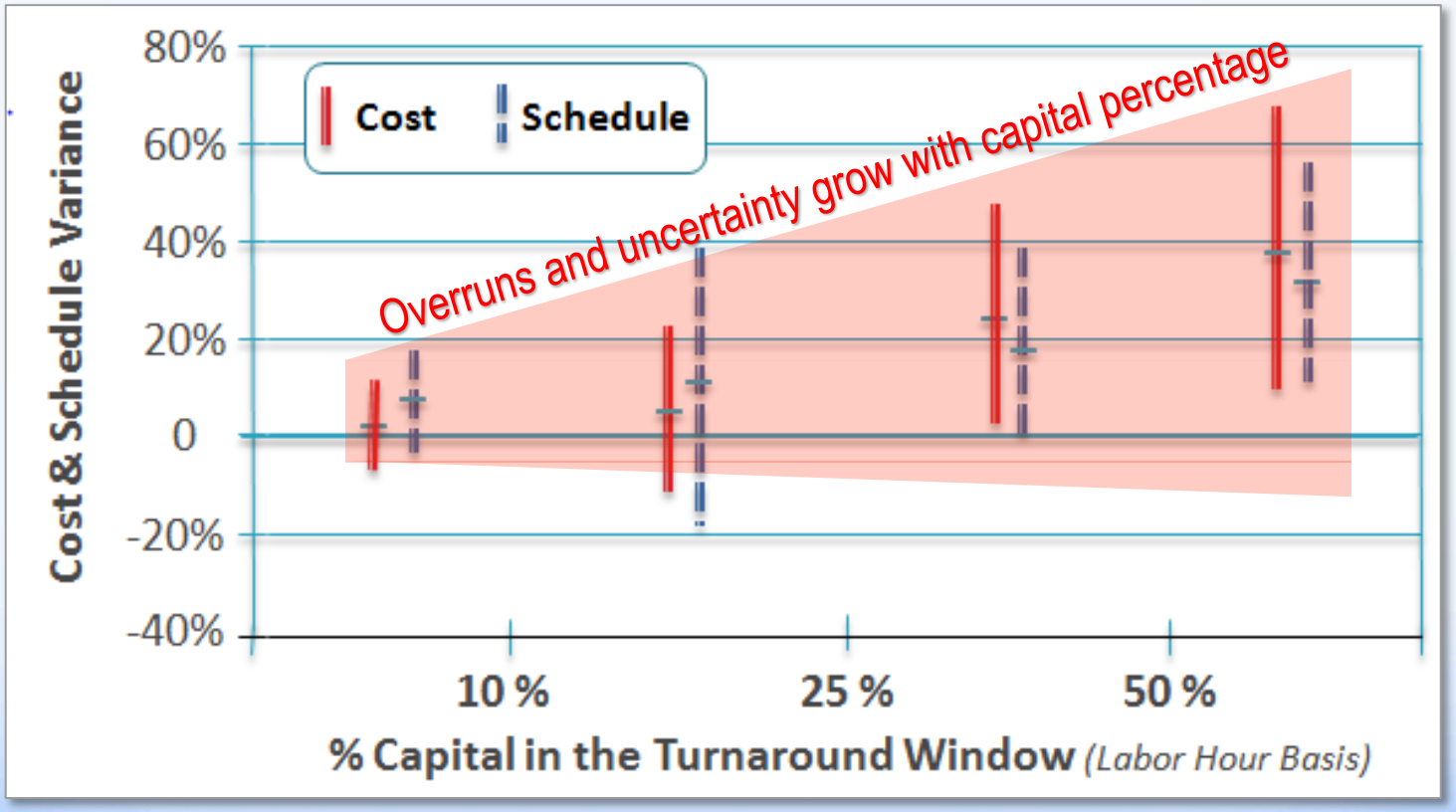
Organizational Capability Takeaway

- The ability to successfully manage a Mega Turnaround is highly dependent on several key factors:
  - *Leadership's role in either galvanizing or splintering the organization*
  - *Properly staffed organization with no shortages or turnover in key positions*
  - *Aligned long-range plan*
  - *Well-developed plan that can be used to manage work and keep work force productive*
  - *The ability of the site to manage the sheer scope of activities*
  - *Disciplined approach to turnaround preparations by the entire site*
  - *Disciplined scope control*

Presentation Format



Turnarounds Become More Unpredictable as Capital Increases



Capital Project Hours ↑ **TA Predictability** ↓

Source: AP-Networks Turnaround Database

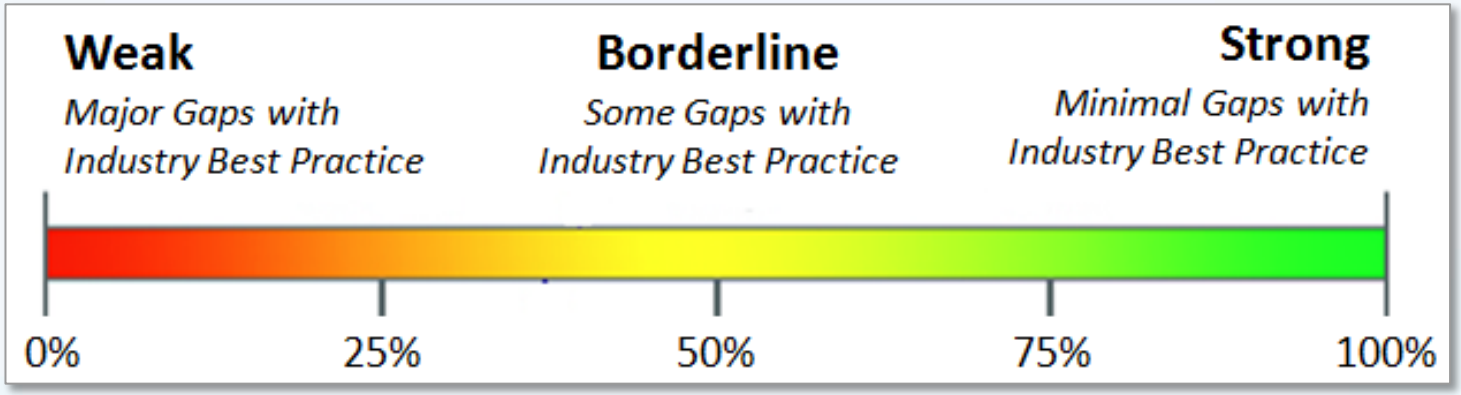
Capital/TA Integration Can Be Problematic

- Repeatability:
  - *Turnarounds have practical (repeatable) experience doing their work*
  - *Projects are typically "one-off" without repeatability*
  - *Project costs are probabilistic in nature, whereas turnaround costs are informed by historical data and outcomes*
- Systemic and cultural issues impede teams from exchanging information
  - *Schedule integration is difficult*
  - *Goals and contractual terms are often misaligned*
  - *Conflicting team reporting structures and decision authorities*
  - *Physical interfaces are not well understood*
- Project quality problems that are not resolved prior to installation compound when they are found during execution

Capital Projects
Evaluations

- There are several ways to evaluate a capital project:
  - *Project Assessments*
  - *Risk Workshops*
  - *Monte Carlo Assessment*
- There are two tools to quantify the status and predict the outcome:
  - *Projects Integration Index – How well are my project and turnaround teams integrated?*
  - *Project Readiness Index (PRI) – How well-prepared is my project for execution?*

Integration Index



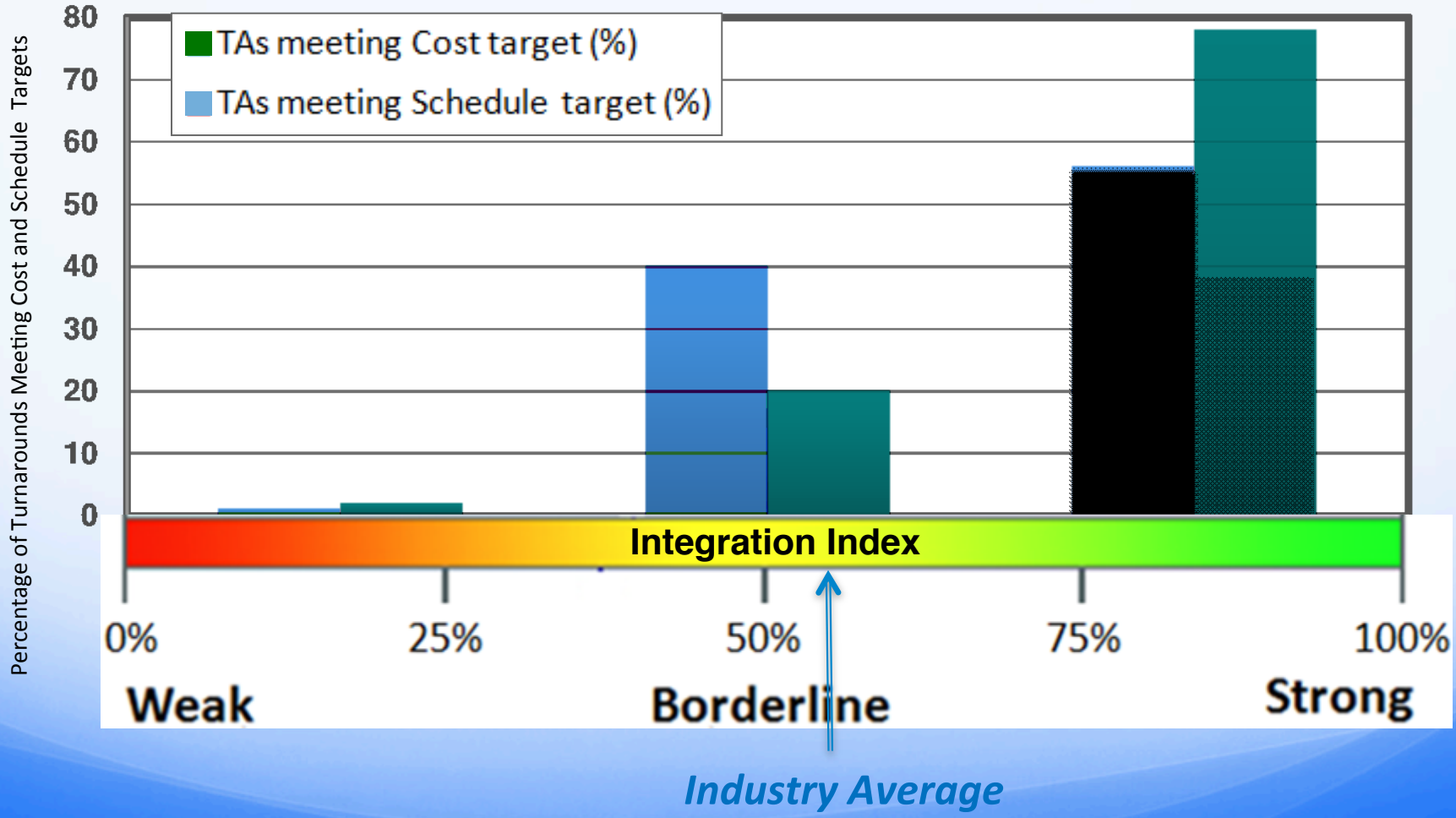
- Measures the quality of organizational and planning integration between the capital project and turnaround organizations
- Measured on a scale of 0% to 100%
- Effectively pinpoints gaps between project and turnaround teams
- Indicator of Turnaround Performance outcomes

Integration Index

Drivers are organized into three areas to quantify the level of project and turnaround integration

Integration Index

Probability of Success is Low Without a Strong Integration Index

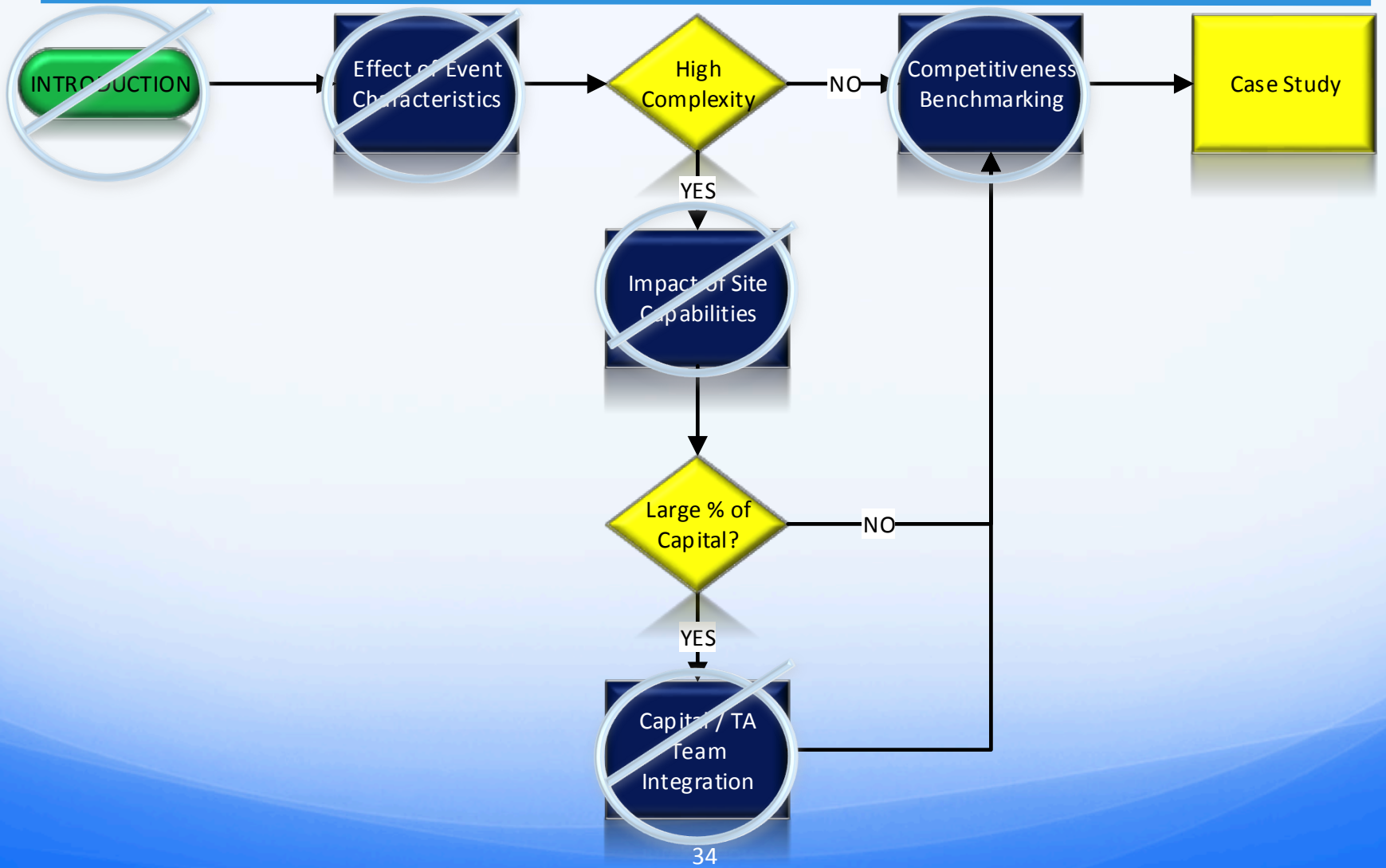


Project Readiness Index

PRI is measured and quantified across 21 key elements

Potential execution concerns and gaps from best practices are identified

Presentation Format



Competitiveness Benchmarks

How did industry perform under similar circumstances?

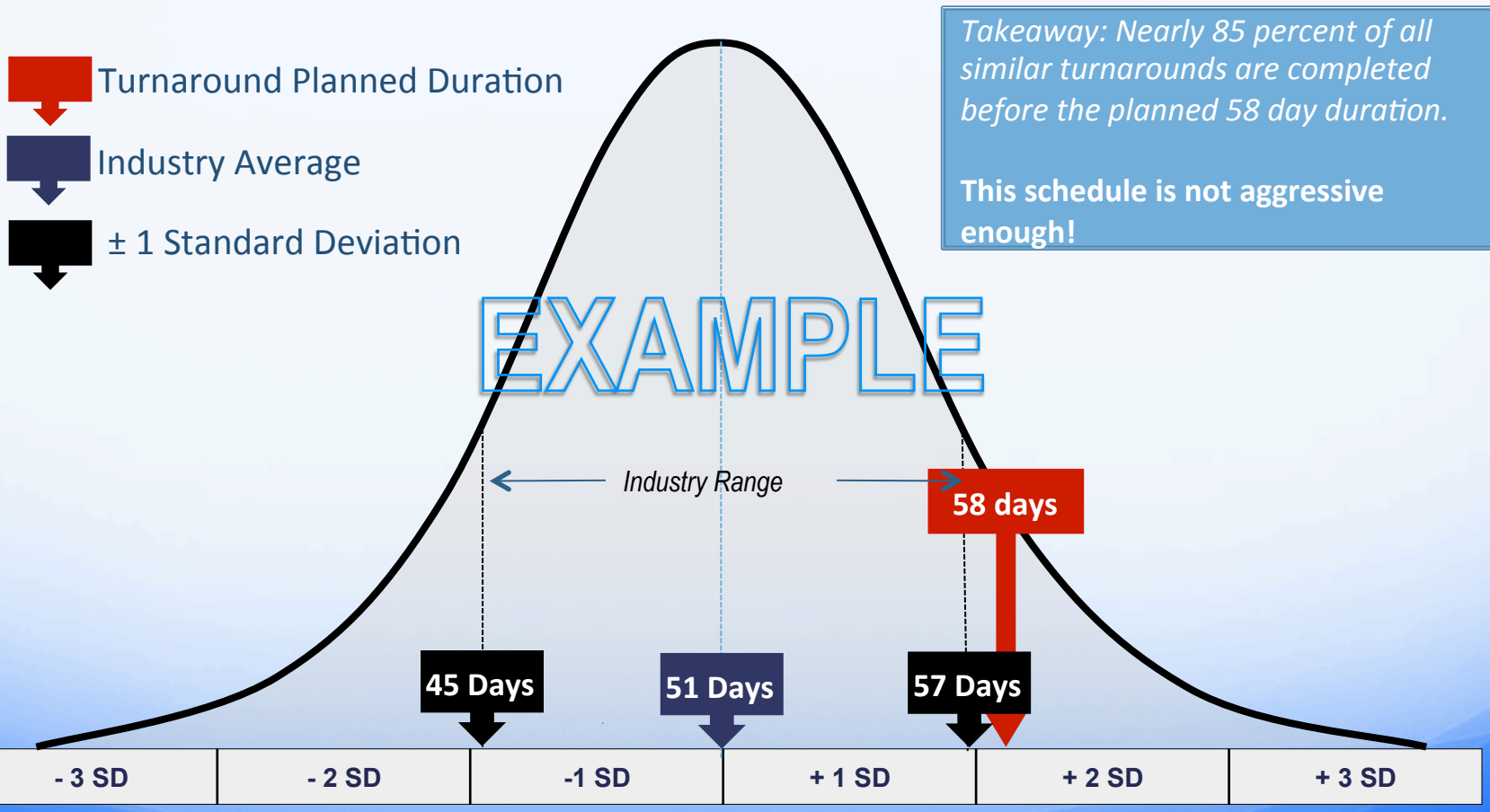
Addresses the questions…

- Is my schedule too aggressive or too conservative?
- Is my budget too aggressive or too conservative?

Schedule Duration Benchmark

Schedule is Conservative Relative to Industry

Based on units with similar characteristics, # of units, labor-hours, complexity, etc.



Takeaway: Nearly 85 percent of all similar turnarounds are completed before the planned 58 day duration.

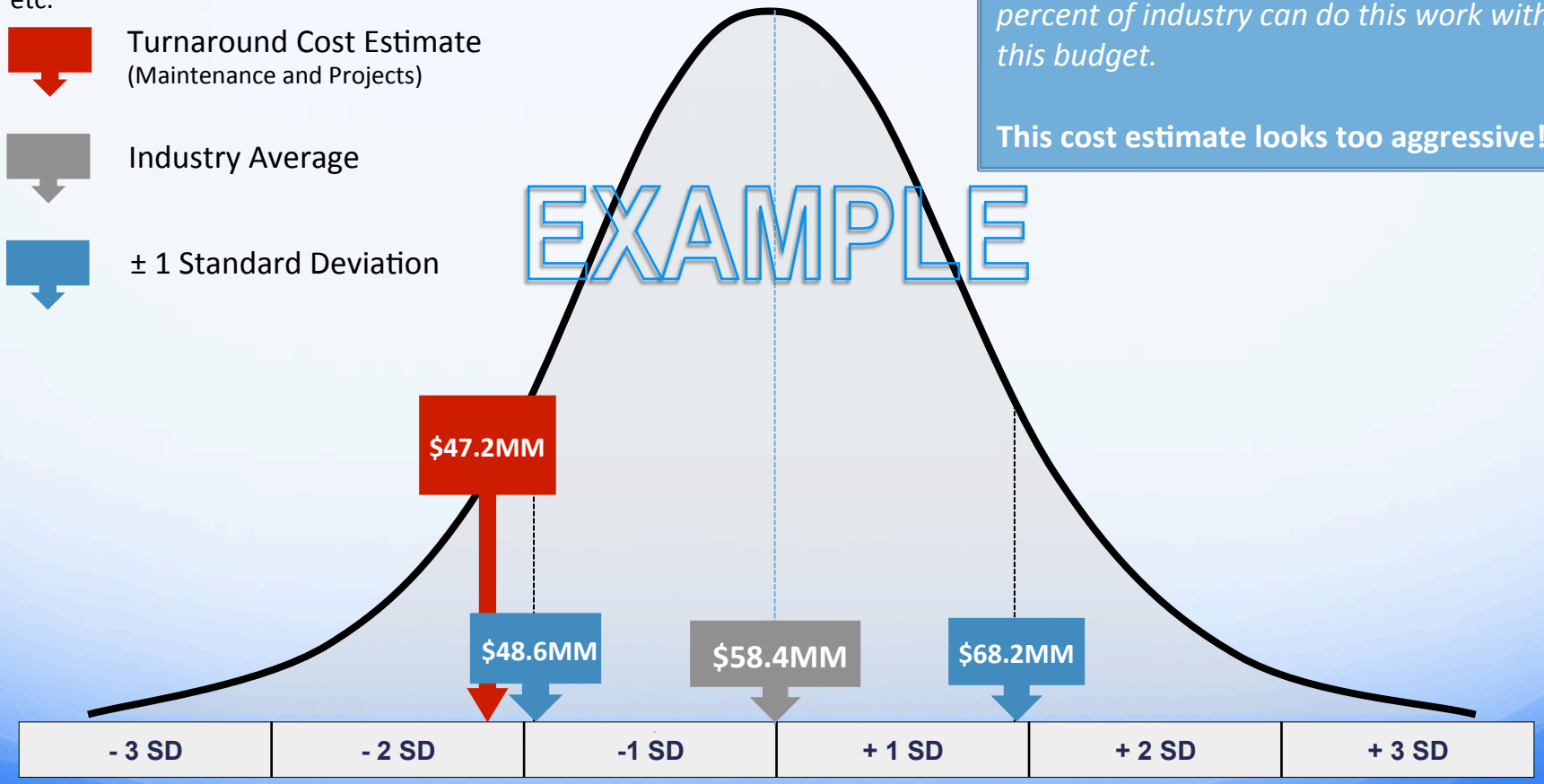
This schedule is not aggressive enough!

The schedule distribution is based on a statistical regression model that includes a number of independent variables and leading indicators. The independent variables and model coefficients are proprietary to AP-Networks and are not shared.

Cost Benchmark

Cost Estimate is Aggressive Compared to Industry

Based on units with similar characteristics, # of units, labor-hours, complexity, etc.

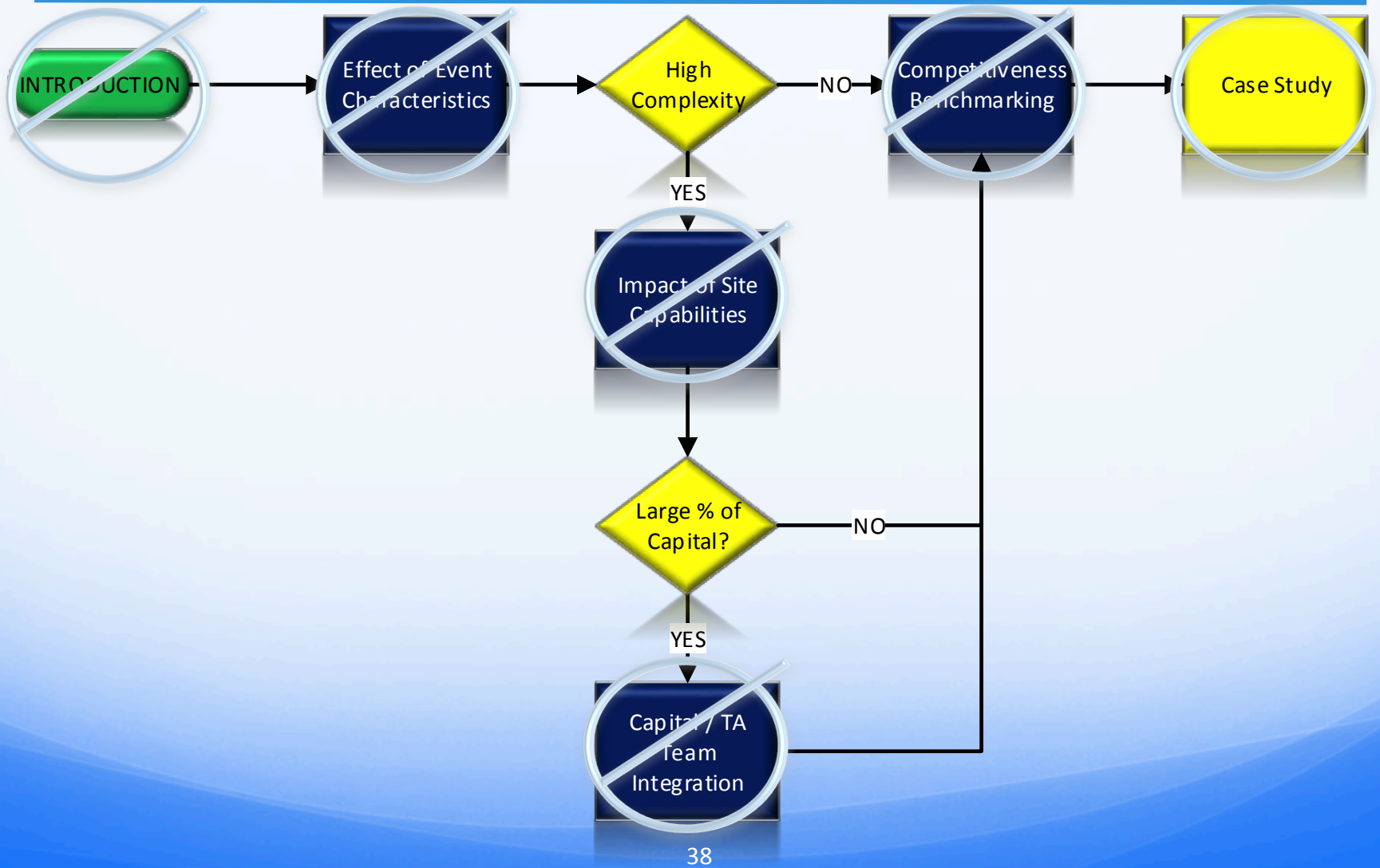


Take-away: Only approximately 14 percent of industry can do this work with this budget.

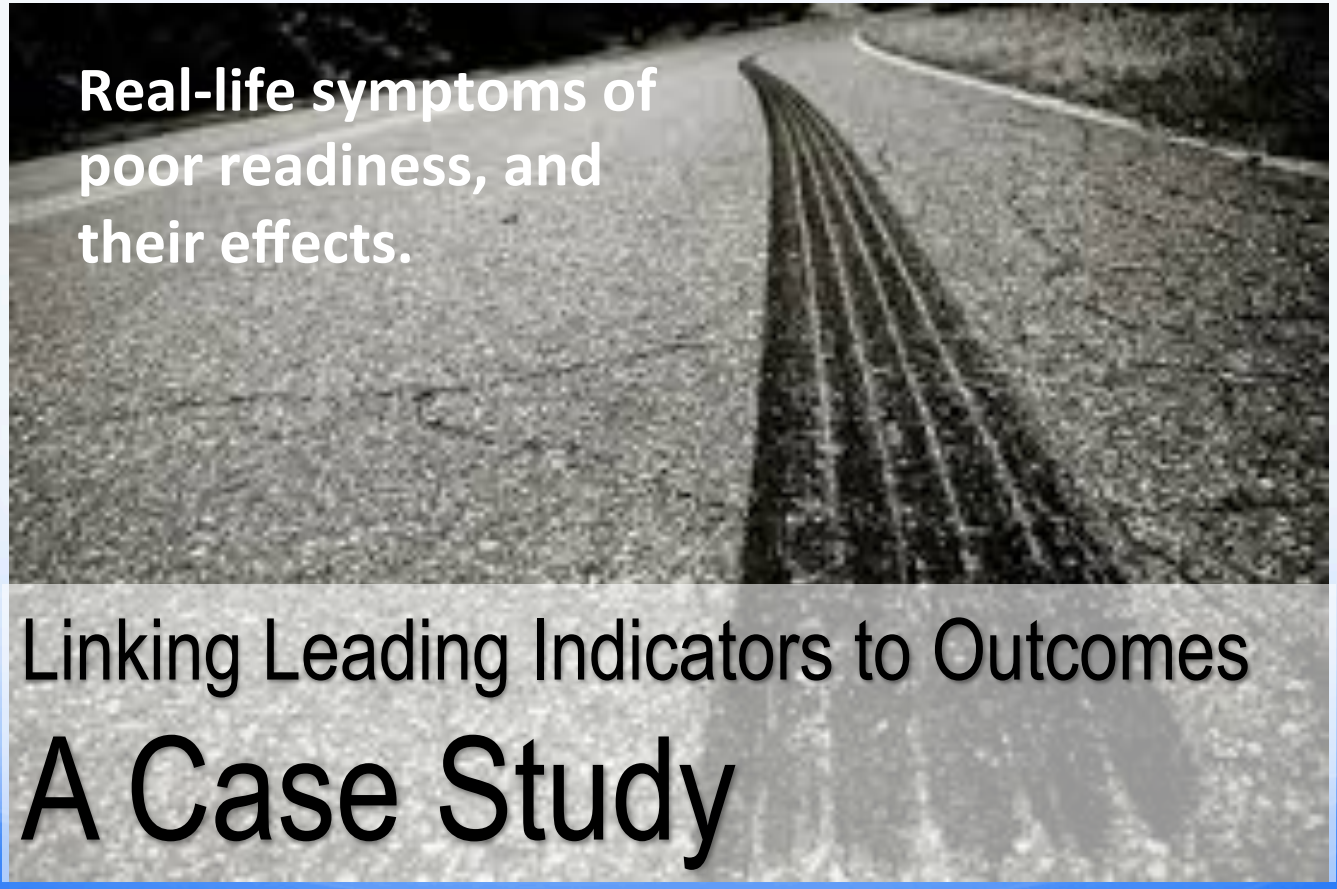
This cost estimate looks too aggressive!

The cost distribution is based on a statistical regression model that includes a number of independent variables and leading indicators. The Benchmarks are not a validation of submitted labor-hours. The Benchmark is not a validation of the estimated/actual labor-hours.

Presentation Format



Where the “Rubber Hits the Road”



Risk Manager Profiles High Risk Areas

RISK MANAGER

- Largest turnaround at this site in the past 15 years
- More than 500 estimated field laborers
- More than 400,000 labor-hours

Site Capabilities

- Higher than typical amount of piping work
- Critical long lead materials threaten achieving the current schedule
- Equipment and site congestion issues are especially critical and problematic for the current scope

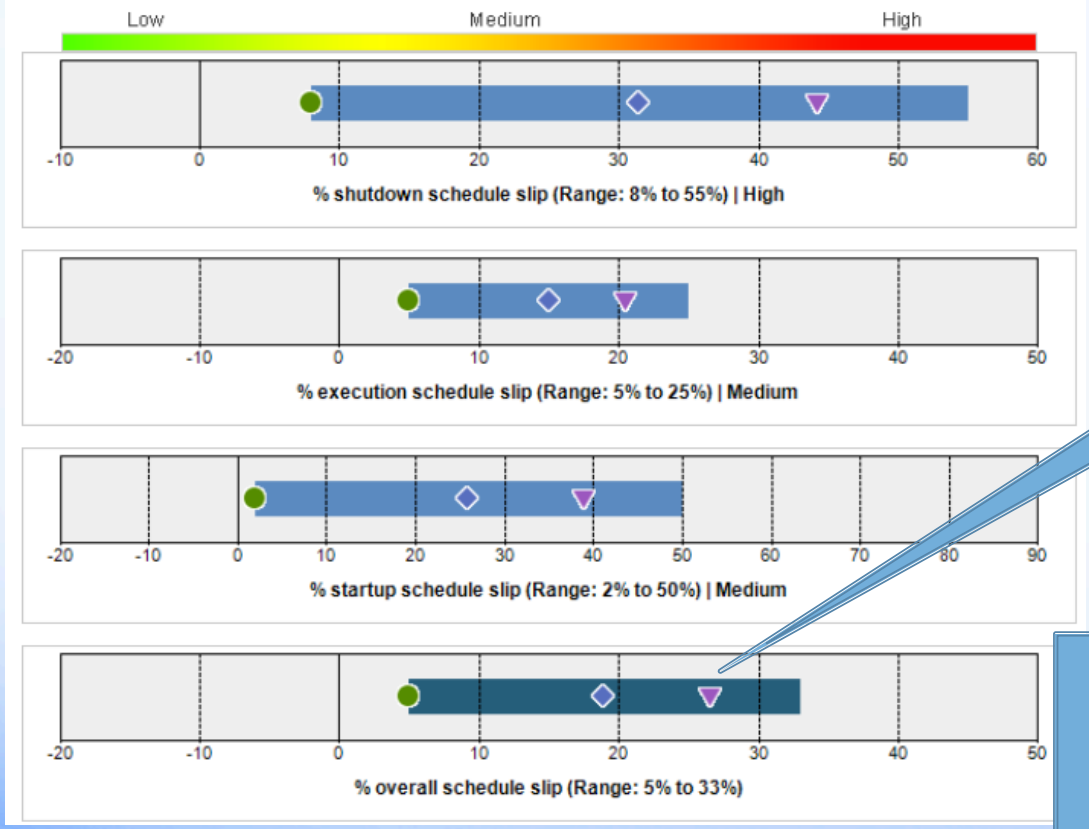
Event Characteristics

- All engineering packages will be issued at least 1 month prior to the turnaround start
- Between 25% and 50% projects work

Capital Projects Integration

Schedule and Cost Predictions

TRI was 2.1, Industry Average TRI was 2.7



Predicted Schedule Slip was 26%

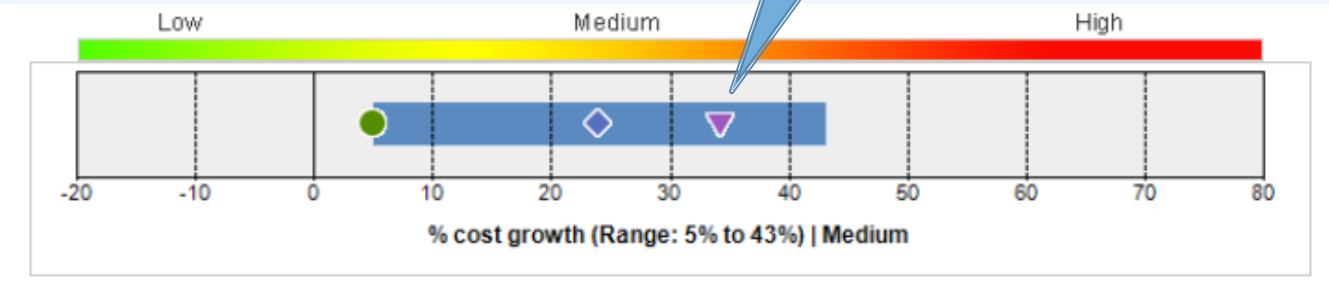
Actual Schedule Slip was 42%

- Optimally Prepared Turnaround
- Average Prepared Turnaround
- Turnaround with a TRI of 2.1

Schedule and Cost Predictions

TRI was 2.1, Industry Average TRI was 2.7

Predicted Cost Slip was 34%



- Optimally Prepared Turnaround
- Average Prepared Turnaround
- Turnaround with a TRI of 2.1

Actual Cost Slip was 33%

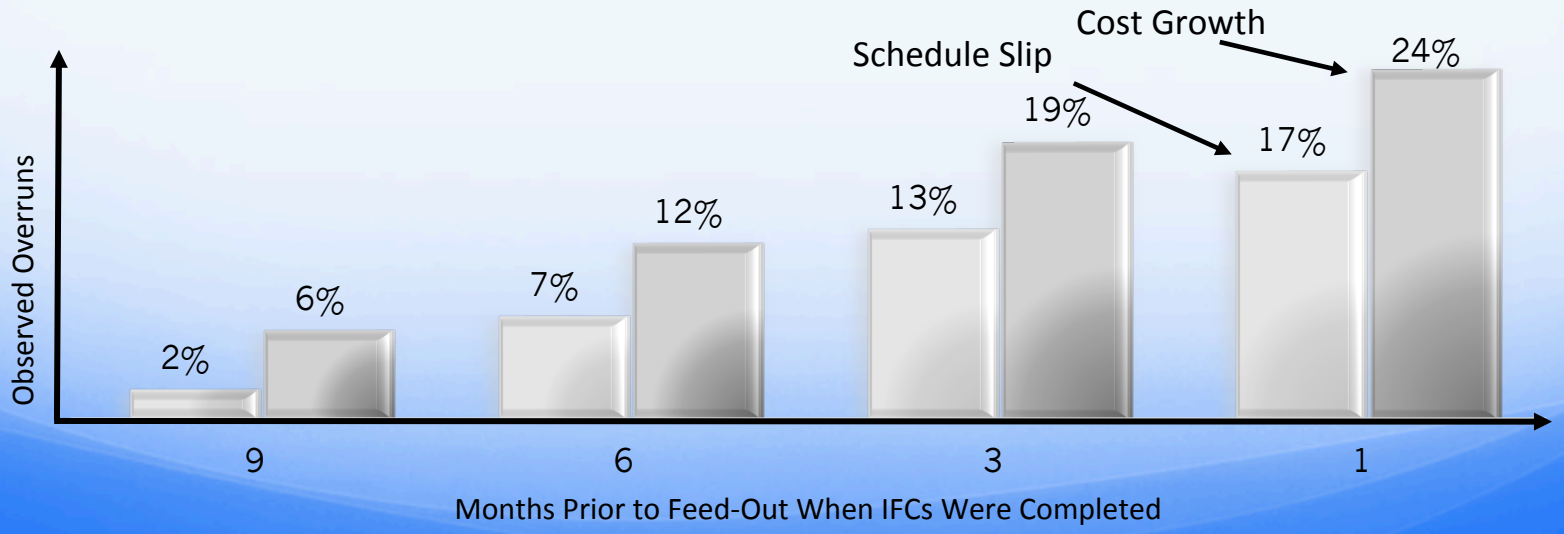
Lookback Workshop Key Contributors

Leading Indicator: *Late and High Volume of Capital Projects*

Impact to Execution:

- *Inaccurate Staff Levels*
- *Stressed Logistics*
- *Engineering Errors*
- *Incomplete Schedule*
- *Fabrication and Fit-Up Errors*
- *Late Materials*

The Timing of Engineering Packages Greatly Impacts Observed Overruns!



Lookback Workshop Key Contributors

Leading Indicator: *Poor Integration Between TA and Capital*

Impact to Execution:

- *Two Separate, Inaccurate Schedules*
- *Two Separate QA Systems*
- *Resource Conflicts*
- *Equipment Access Conflicts*

Leading Indicator: *Poor Scope Control and Late Scope Growth*

Impact to Execution:

- *Late Scope Not Added to Schedule*
- *Look-Ahead Not Functional*
- *Contributed to Inaccurate Staff Levels*
- *Late Arriving Materials*
- *Pre-Work Slip into Execution Window*

Lookback Workshop Key Contributors

Leading Indicator: *Late Safety Policy Changes*

Impact to Execution:

- *Operational Aspects Not Detailed*
- *Field Supervisors Distracted Resolving Functional Details During Execution*
- *Compounded Congestion and Schedule Problems*

Conclusion

- The outcome of each turnaround can be modeled, and predicted outcomes can be quantified before the event starts
- Key elements that are more likely to drive the outcome in a negative direction can be identified, addressed, and mitigated
- Collecting the right information for both the turnaround and capital projects can help you:
  - *Pinpoint areas of opportunity*
  - *Quantify likely overages*
- Each event's unique overages can be minimized if the organization is capable and ready to take the necessary steps
- You have to know where to start!