



کنترل پروژه پیشرفته و ارزیابی عملکرد در پروژه‌های پیچیده (بر اساس اسناد CII)

فصل ششم:
ابزار PCI و بهبود ارزیابی عملکرد پروژه

ارائه دهنده:

سید محمدرضا علوی پور

(PhD, PMP, CMIT)

CMAA Authorized Trainer

دانشگاه Illinois Tech آمریکا



What we will learn?

- ☐ What is the Issue?
- ☐ What is the Solution?
- ☐ Overview of PCI Tool
- ☐ PCI Tool Structure and Components
- ☐ Core Metrics Directory
- ☐ Reliability Improvement Checklist
- ☐ User Guide
- ☐ Use Cases

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What is the Issue?

What is the issue?

Construction projects are suffering from significant performance inefficiencies



Only
ONE
in twenty projects
is under budget and on time



Source: Construction Industry Institute, 2012

What is the issue?

Performance issues cause major cost and schedule deviations, particularly in bigger projects

98

98% of megaprojects
incur cost overruns
and schedule delays.

80

The average **cost**
increase is 80% of
the original budget.

20

The average **slippage**
is 20 months behind
original schedule.

Source: McKinsey & Co, 2015



What is the issue?

Adverse effects of low project performance is crippling the industry



\$100 million
of every \$1 billion
invested in projects is wasted

Only
TWO
out of five
projects
are profitable for contractors

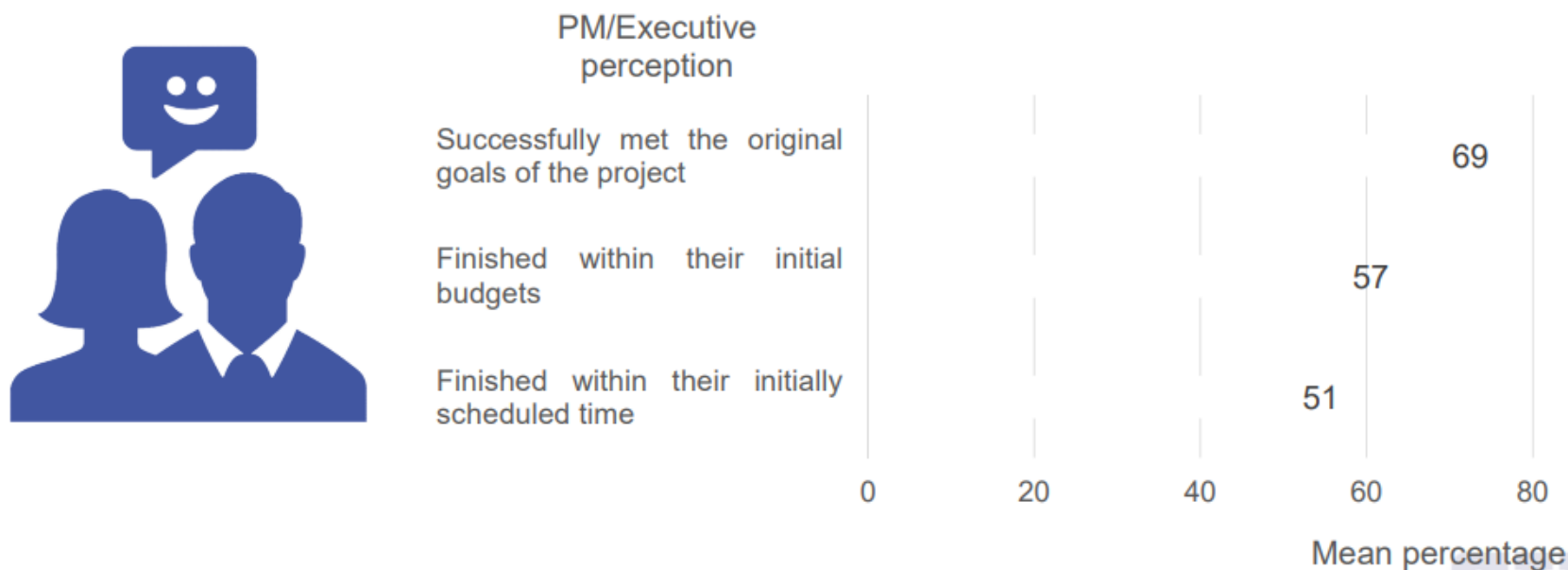


Sources: Project Management Institute, 2017; Construction Industry Institute, 2014



What is the issue?

Majority of project managers believe most of their projects are performing well and meeting targets



Source: A.T. Kearney, 2012; Project Management Institute, 2017

What is the Solution?

What is the solution?

Main objective is to improve project control systems for assessment of current and future performance



Objective #1

Develop a systematic project controls framework



Objective #2

Identify the core project control metrics



Objective #3

Generate guidelines for improving the reliability



Project controls improvement (PCI) tool

❑ **CII Research Team 322 (RT-322)** developed the Project Controls Improvement (PCI) Tool to

1. **address** these industry-wide questions and
2. **identify** potential gaps in **current in-flight** project control practices.

❑ Based on surveys, case studies, and review by a panel of experts with more than **350 years of experience**, as owners and contractors,

RT-322 crafted a tool that contains valuable information on

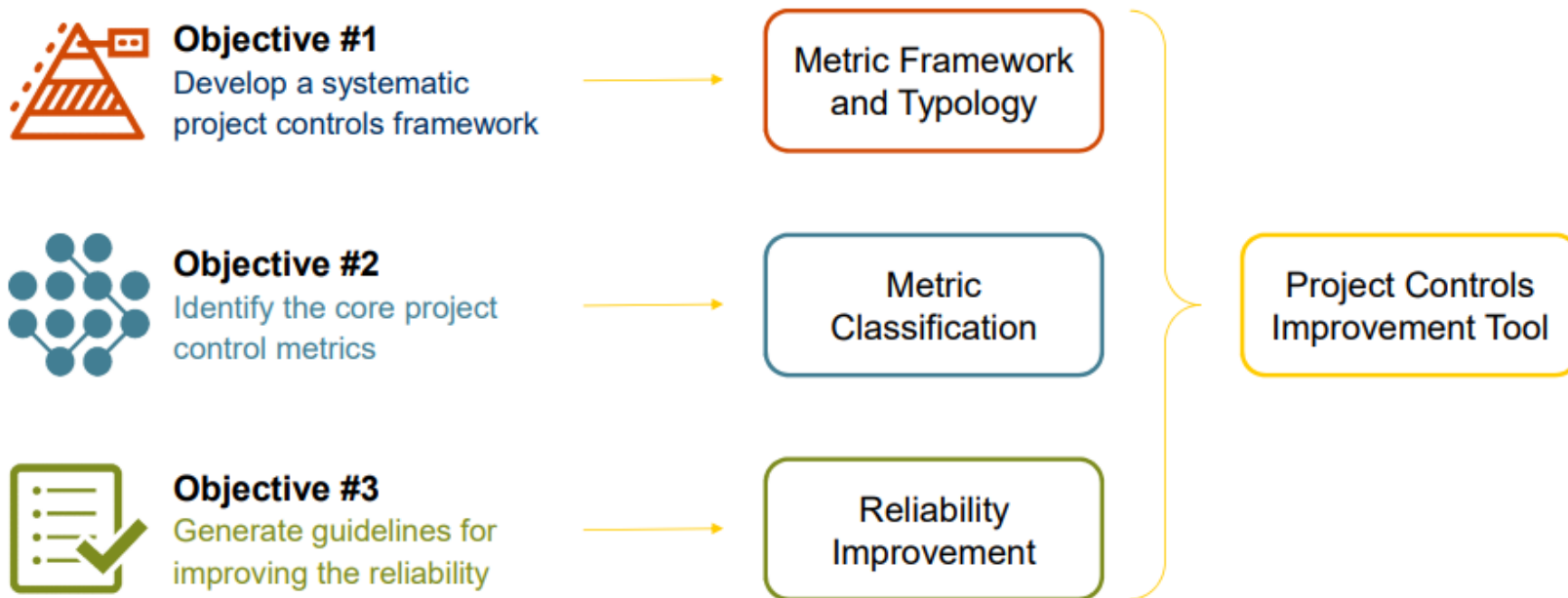
1. Core metrics and
2. Critical Reliability Factors

to ensure robust project progress and performance assessment.

*This **software** is an **effective tool** to improve cost and schedule outcomes at **both** the project and organizational levels.*

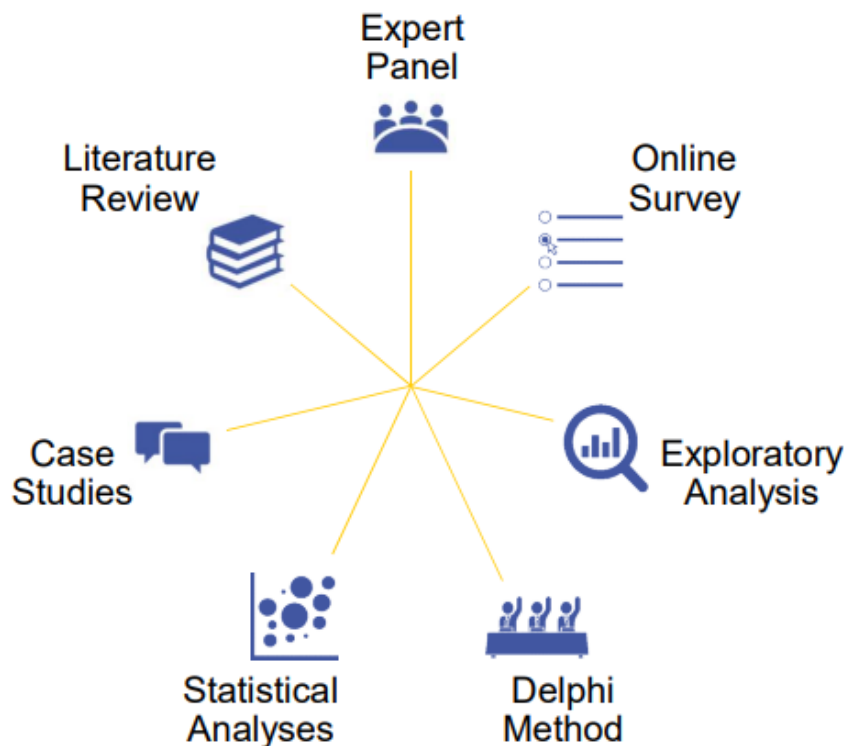
Introduction

The research approach is aligned with the objectives to deliver desired outcomes



Introduction

Various research methods are utilized to produce deliverables and achieve objectives



Introduction

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review



>100 documents

Expert Panel



Scholarly articles

Professional publications
(e.g., CII, PMI, AACE)

Government agency reports
(e.g., DoD, DoE, DoT)

Online Survey



Exploratory Analysis



Delphi Method



Statistical Analyses



Case Studies



Introduction

Various research methods are utilized to produce deliverables and achieve objectives

Literature
Review



Expert
Panel



Online
Survey



Exploratory
Analysis



Delphi
Method



Statistical
Analyses



Case
Studies



13 industry professionals

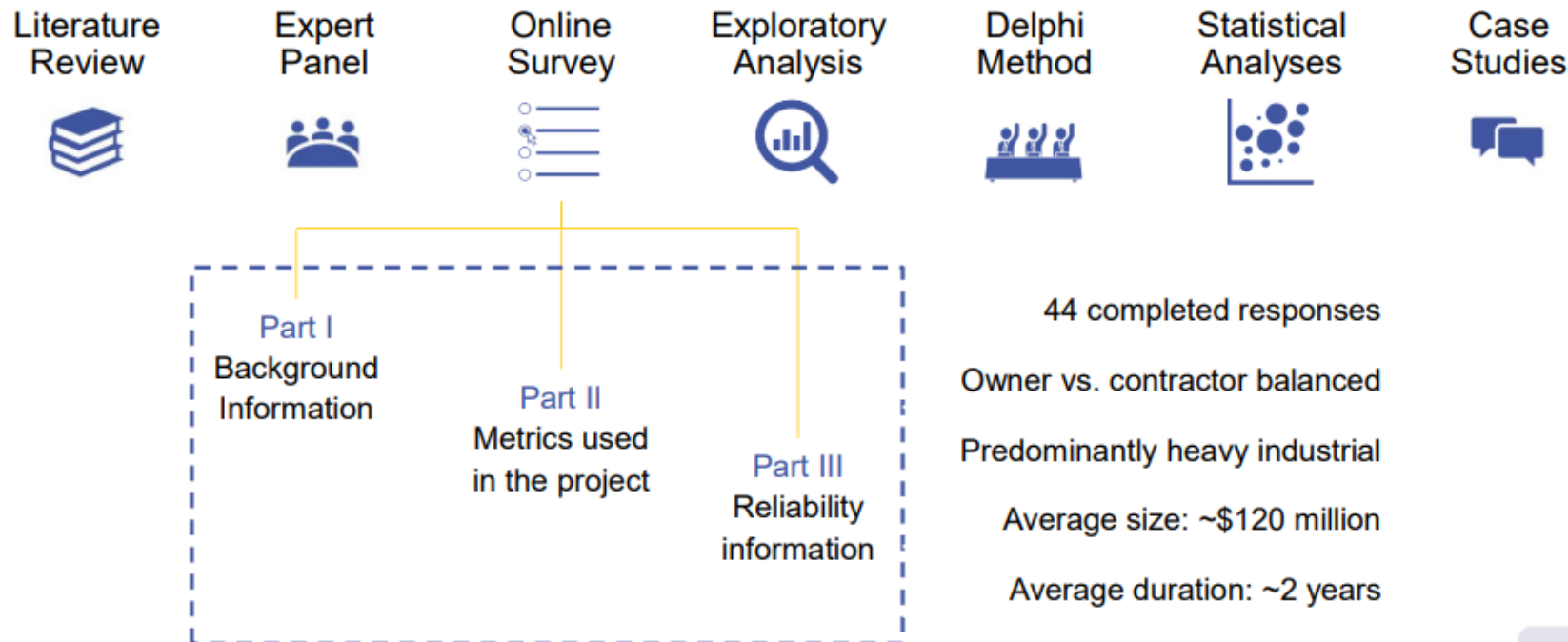
290+ years of cumulative
experience

Representing owner (5) and
contractor (8) perspectives



Introduction

Various research methods are utilized to produce deliverables and achieve objectives



Introduction

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review



Expert Panel



Online Survey



Exploratory Analysis



Delphi Method



Statistical Analyses



Case Studies



Metric Importance

Low – High High – High

Low – Low High – Low

Metric Usage



Introduction

Various research methods are utilized to produce deliverables and achieve objectives

Literature
Review



Expert
Panel



Online
Survey



Exploratory
Analysis



Delphi
Method



Statistical
Analyses



Case
Studies



Project controls
Subject Matter
Experts (SMEs)

16 industry professionals

360+ years of cumulative
experience

Representing owner (2) and
contractor (14) organizations

Introduction

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review



Expert Panel



Online Survey



Exploratory Analysis



Delphi Method



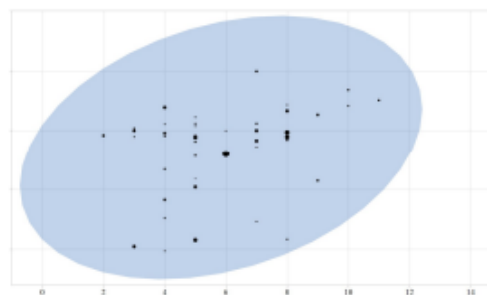
Statistical Analyses



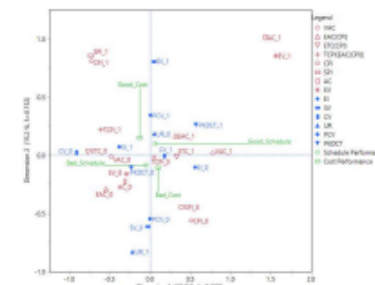
Case Studies



Spearman's Rank Correlation



Multiple Correspondence Analysis



Introduction

Various research methods are utilized to produce deliverables and achieve objectives

Literature
Review



Expert
Panel



Online
Survey



Exploratory
Analysis



Delphi
Method



Statistical
Analyses



Case
Studies



In-depth analysis
of selected
projects

10 projects selected

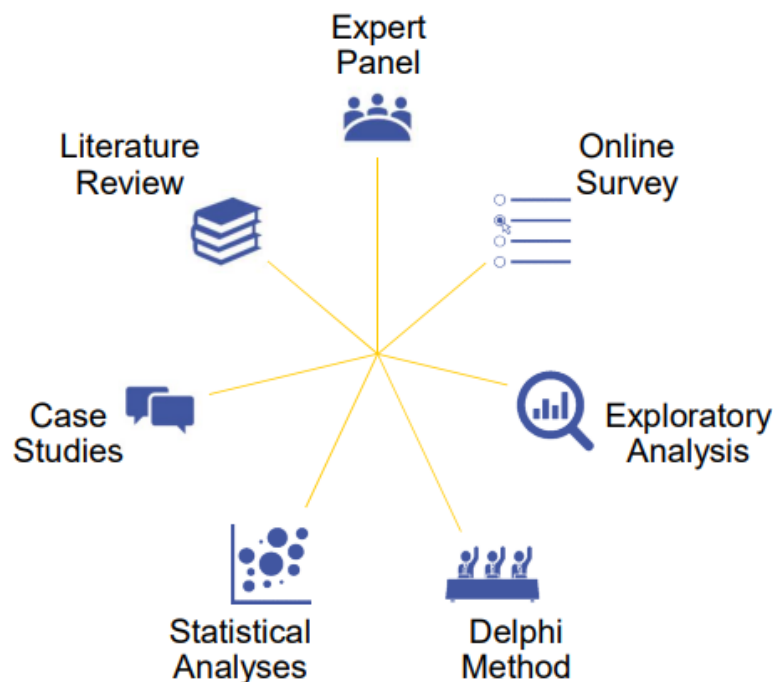
Contractor (6) and owner (4)
perspectives

Interviewed 17 project
personnel



Introduction

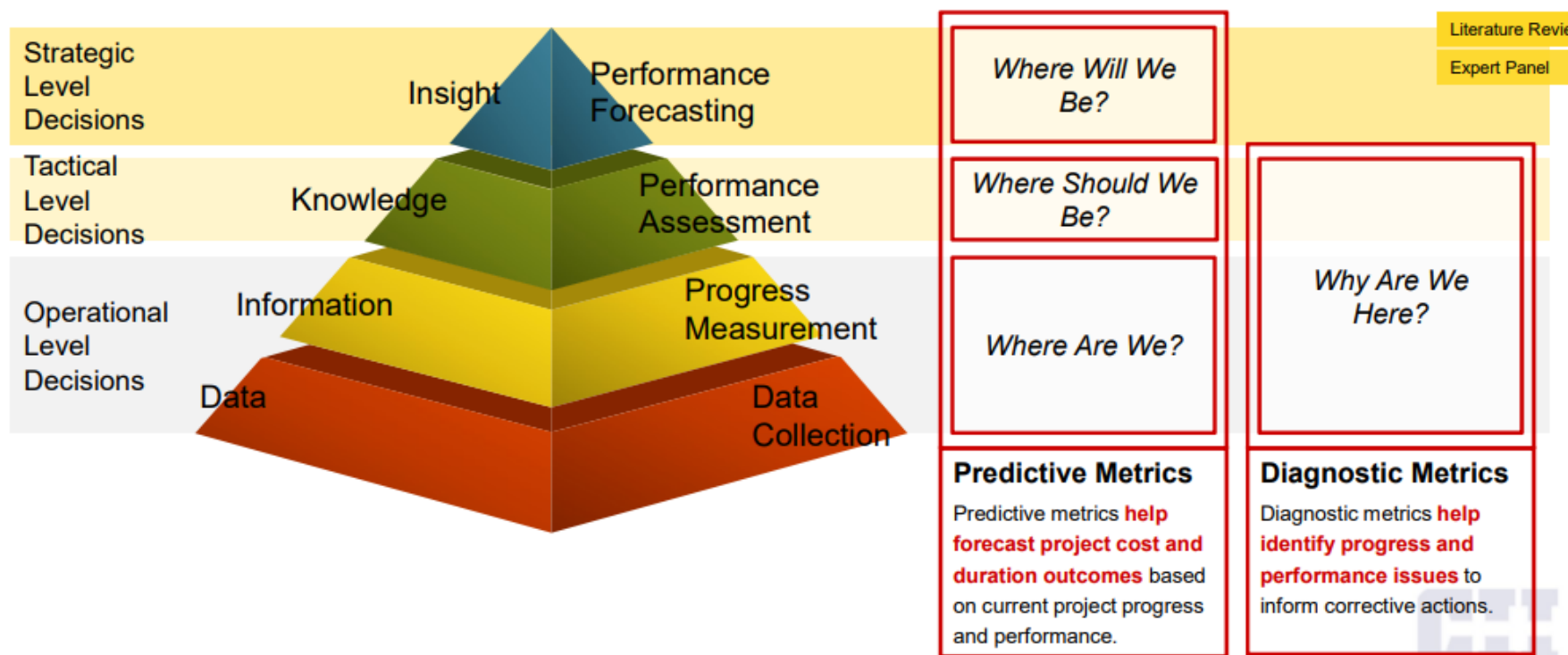
Various research methods are utilized to produce deliverables and achieve objectives



Overview of PCI Tool

Introduction

A systematic framework and typology that allow transforming data into meaningful insights



Introduction

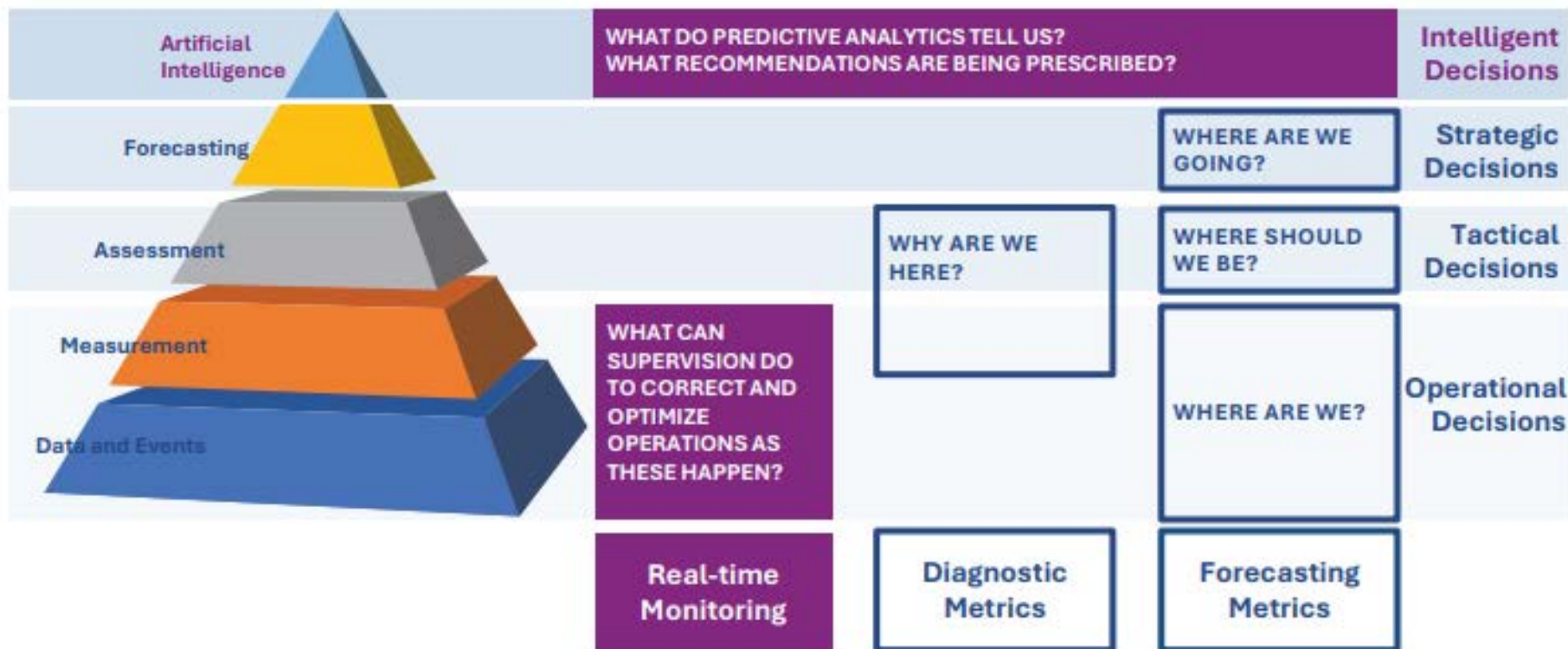


Figure 6. Information Layers

Project controls improvement (PCI) tool

- ❑ The PCI Tool has **four main components** to **identify** possible gaps and **provide** resources for improvements in progress and performance assessment:
1. The Metrics Gap Analysis module enables project stakeholders to identify strengths and areas for improvement in their current project control plans.
 2. The Reliability Gap Analysis module provides a resource for stakeholders to examine their metrics on a holistic level and determine if projects are achieving Critical Reliability Factors, to ensure that assessment is meaningful and robust.
 3. The software also includes a Metrics Dictionary and Maps module to promote standardization of metrics definitions, usage, and selection.
 4. The Project Controls Utilities module further explains detailed aspects of the software's module analysis and provides resources for implementation and training.

Project controls improvement (PCI) tool

- ❑ This user guide consists of a **detailed explanation** of
 1. the different components and features of the tool (Chapter 2),
 2. step-by-step user instructions (Chapter 3), and
 3. different implementation use cases (Chapter 4).

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Project controls improvement (PCI) tool

- ❑ Project management and control teams can use the **PCI Tool** to **evaluate** current practices regarding **project progress** and **performance assessment**.
- ❑ Users receive **customized suggestions** for potential improvements to their metric implementation, enabling project teams to make improvements based on **identified gaps and recommended actions**.
- ❑ The **software's customized reports** can be saved and shared **among stakeholders and partner organizations**.
- ❑ In addition, since the PCI Tool includes information related to diverse metrics and reliability factors, it can also be **used for educational or training purposes** in owner and contractor companies.

Project controls improvement (PCI) tool

❑ Some **potential applications** include the following:

- ❖ a **reference** for project managers and control teams for project control plan development
- ❖ a **gap analysis tool** to evaluate **current** in-flight project control practices
- ❖ a **source** of **potential corrective actions** to improve current progress and performance assessment practices
- ❖ a document to **track** **reliability improvement practices** across different project **phases**
- ❖ an **owner's reference** for formulating **contractual** project control requirements
- ❖ a **training reference** for entry-level project control professionals.

Project controls improvement (PCI) tool

- ❑ The PCI Tool enables **project stakeholders** (e.g., project managers, project control teams, engineering managers, cost engineers, and schedulers in both owner and contractor organizations) to **better** monitor, control, and communicate project progress and performance assessment.

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PCI Tool Structure and Components

PCI tool structure and components

□ Figure 1

1. shows **how these modules connect to each other** within the PCI Tool and
2. presents their **targeted approach** to improve in-flight project controls and reliability.

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PCI tool structure and components

- ❑ Each of these modules requires separate input from the user to automatically generate unique outputs.



Figure 1. Overview of PCI Tool Components

Key terminology for better understanding the PCI tool

❑ Forecasting versus Diagnostic Metrics

❖ **Forecasting** and **Diagnostic** metrics represent the two **major metrics categories** based on their roles.

1. Forecasting metrics help users **predict** project cost and schedule outcomes based on a **current understanding** of project progress and performance.
2. Diagnostic metrics help users **identify** progress and performance **issues**, to **inform corrective actions**.

Key terminology for better understanding the PCI tool

❑ Core, Validation, Innovative, and Other Significant Metrics

❖ In terms of importance, **metrics** are first categorized into **two groups**:

1. Core metrics are the “**must have**” metrics that provide the **greatest insight** into project controls.
2. Significant metrics **supplement** or complement **Core metrics**, and they have the **potential** to **become Core metrics** if more widely tested and adopted in the industry.

Key terminology for better understanding the PCI tool

❑ Core, Validation, Innovative, and Other Significant Metrics

❖ In terms of importance, **metrics** are first categorized into **two groups**:

✓ Significant metrics are further classified into three categories:

- a) **Validation metrics** (e.g., Monthly Cost Growth, Critical Path Length Index) are useful as checks or proxies for the indicators of Core metrics.
- b) **Innovative metrics** (e.g., Earned Schedule) are not extensively used in the industry, but are still deemed highly beneficial within organizations that utilize them.
- c) **Other Significant metrics** (e.g., Project Buffer Index, Number of Backlog Activities) are metrics that might add value to a project if resources were available to incorporate their use.

Key terminology for better understanding the PCI tool

❑ Critical Reliability Factors and Reliability Indicators

❖ The PCI Tool employs **15 Critical Reliability Factors (CRFs)** that individually and collectively **influence** the reliability of a project's progress and performance assessment metrics:

- | | |
|---|----------------------------|
| 1. Project Scope Definition | 9. Metric Trend Analysis |
| 2. Project Execution Planning | 10. Schedule Forecasting |
| 3. Project Control Planning | 11. Cost Forecasting |
| 4. Progress Measurement | 12. Communication |
| 5. Schedule and Cost Development and Tracking | 13. Teamwork |
| 6. Change Management | 14. Accountability |
| 7. Risk Management | 15. Project Control Audits |
| 8. Progress Audits Metric Trend Analysis | |

Key terminology for better understanding the PCI tool

- ❑ Within these factors, **83 Reliability Indicators** contribute to **improving** the **reliability** of a project control system and related metrics.
- ❑ **Each Reliability Indicator** has a unique timeline, **determined** by five milestones related to the **phases** in which they are used (e.g., prior to, at the beginning, during, at the end, post).
- ❑ These **specific timing milestones** should be carefully considered for **effective implementation** of CRFs and indicators.

Metrics Gap Analysis

- ❑ The Metrics Gap Analysis module helps users to identify gaps between
 - ❖ **currently used in-flight** project control metrics and
 - ❖ the **Core** and **Significant** metrics determined by RT-322 research.
- ❑ The **PCI Tool** provides **recommendations** that **identify** which **additional metrics** should be considered.
- ❑ **Users** are asked to **select** the Forecasting and Diagnostic metrics **currently used** in their projects from the list of metrics on the **input page**.

Metrics Gap Analysis

- ❑ Based on their selections, users **receive a report** that includes the following information:
 - ❖ the Core, Validation, Innovative, and Other Significant metrics **currently being used** in the project
 - ❖ **additional** Core, Validation, Innovative, and Other Significant metrics that **should be considered to improve** project progress and performance assessments
 - ❖ an **overall score** that indicates the **extent of any gap** in the project's use of Core Forecasting and Diagnostic metrics.

Reliability Gap Analysis

- ❑ The Reliability Gap Analysis module enables users to **assess CRFs** related to progress and performance assessment at the **current** or **desired project phase** (i.e., pre-detailed design, detailed design, construction, or startup and commissioning).
- ❑ For each project phase, users select the **reliability indicators** already achieved in their project.
- ❑ Based on their selections, **users obtain** an analysis report that includes the following information:
 1. a reliability score based on the overall Critical Reliability Factors and indicators achieved in a specific phase
 2. CRFs and indicators that need improvement
 3. a timetable showing the appropriate timing for implementation of each CRF and indicator.

Metrics dictionary and maps

- ❑ The Metrics Dictionary and Maps give users a **comprehensive database** of in-flight project control metrics.
- ❑ The Metrics Dictionary **includes** rich information related to metric categories (i.e., Forecasting or Diagnostic), definitions, equations, uses and interpretations, references, additional resources, and metrics maps.
- ❑ Its **search function** enables users to **search metrics** by name or specific attributes, such as by **metric category** or **level of importance** (i.e., Core, Validation, Innovative, or Other Significant).
- ❑ The Metrics Dictionary serves as a **valuable reference** for project management and control teams to learn about, correctly calculate, and utilize various metrics.

Metrics dictionary and maps

□ **Appendix A** provides the **complete definitions** of all Core and Significant metrics, and

Appendix B includes **metrics maps** that show how to calculate each metric.

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Project controls utilities

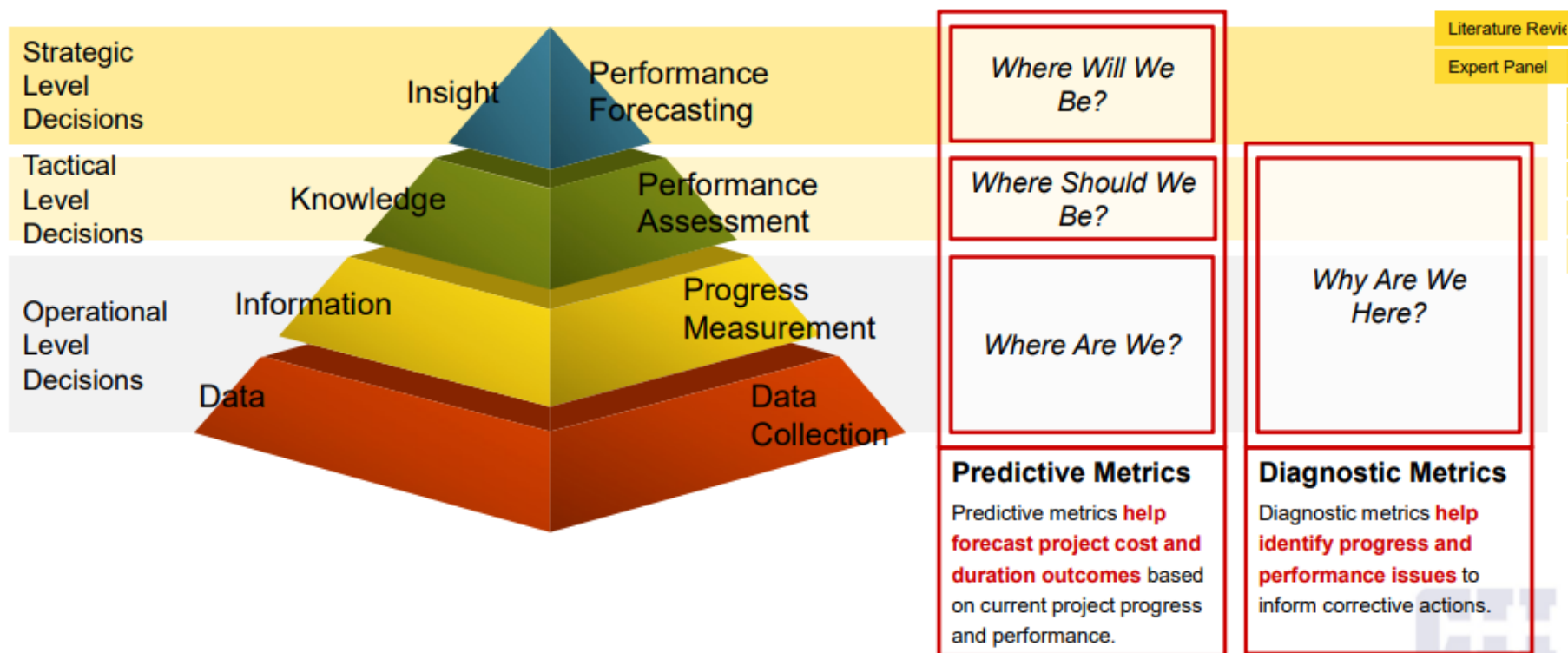
- ☐ By using the Project Controls Utilities of the PCI Tool, users have access to essential information related to Core (and Significant) metrics and Reliability Improvement.
- ☐ Its **two sub-modules** allow users to create **printable documents** that show detailed information.

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Core Metrics Directory

Introduction

A systematic framework and typology that allow transforming data into meaningful insights



Introduction

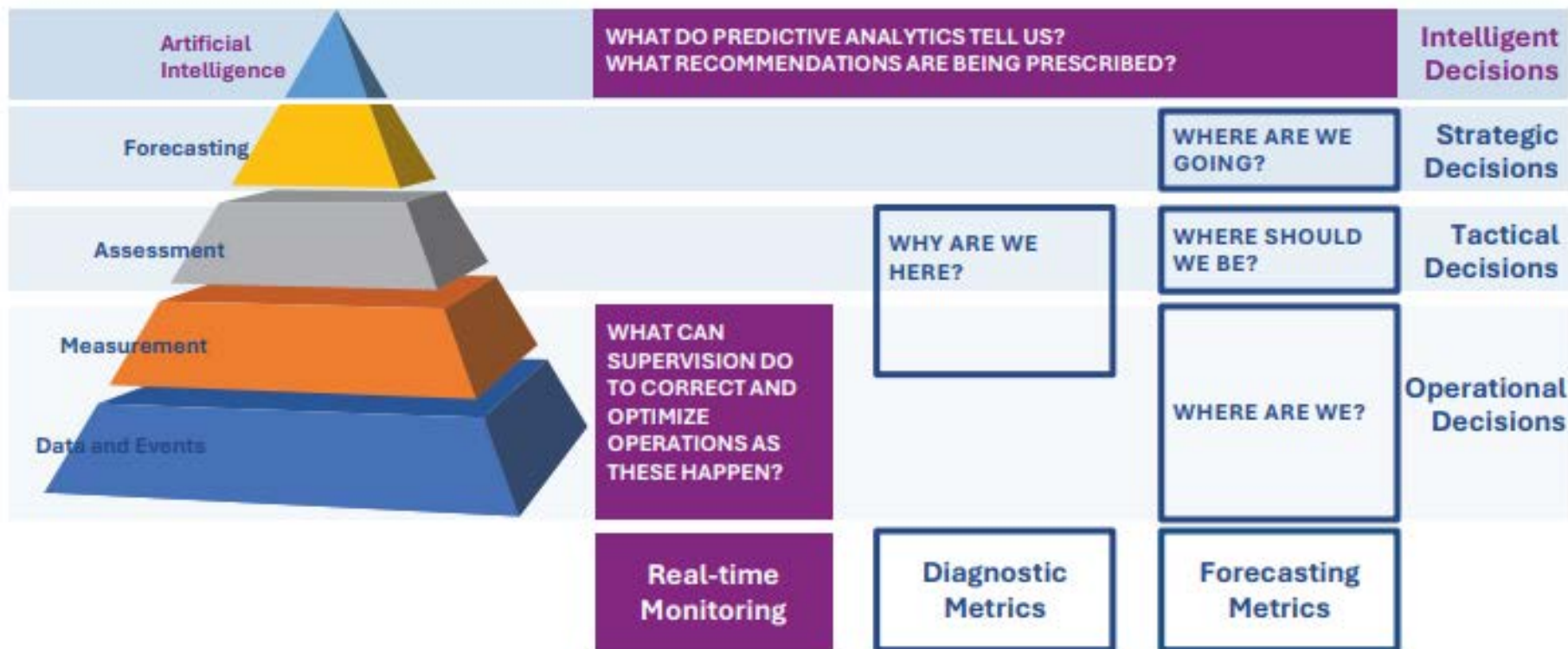
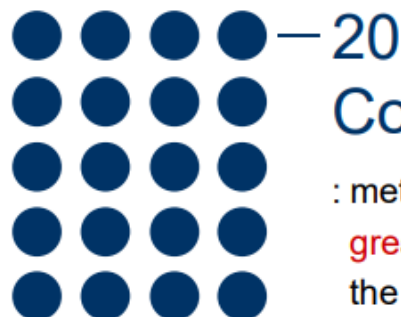
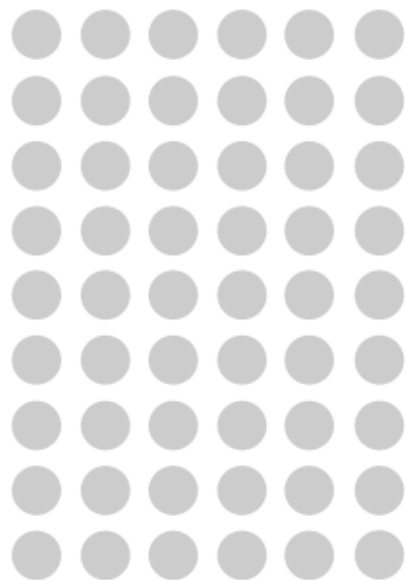


Figure 6. Information Layers

Introduction

Metric classification was finalized by subject matter experts (SMEs)



Core metrics

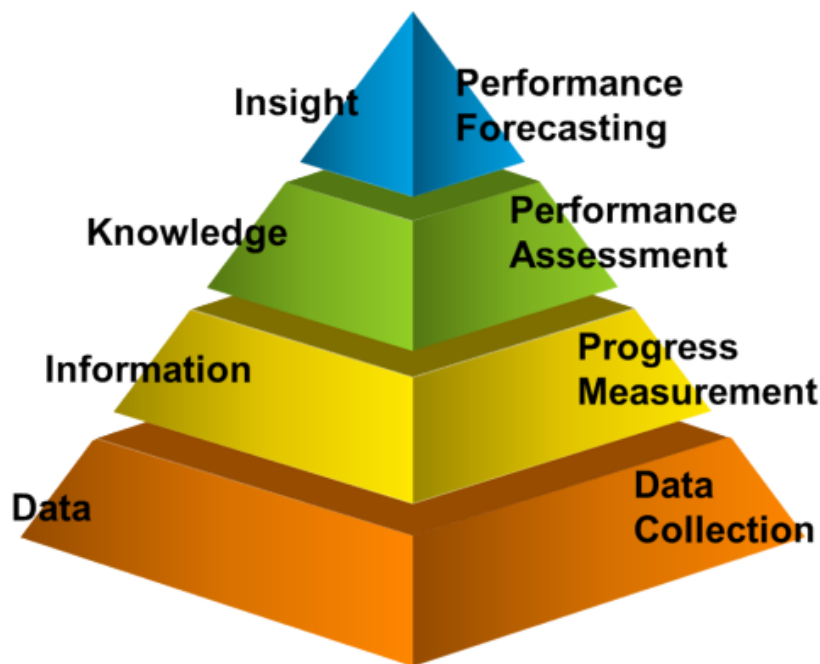
: metrics that provide the
greatest insight for indicating
the likely project outcomes

Delphi Method



Introduction

Metric Pyramid – *Distribution of Core Metrics*



WHERE ARE WE GOING?
● ● ● ●

WHERE SHOULD WE BE? ● ● ●

WHERE ARE WE?
● ●

Forecasting Metrics
Forecasting metrics **help the user to predict project cost and duration outcome** based on understanding of the current project progress and performance.

● ● ● ●
● ● ● ●
● ●

WHY ARE WE HERE?

Diagnostic Metrics
Diagnostic metrics **help the user to identify progress and performance issues** to inform corrective actions.

Introduction

20 Core Metrics

Forecasting

Category	Metric
Performance Forecasting	Variance at Completion
	Estimate at Completion (CPI)
	Estimate to Complete (CPI)
	To Complete Performance Index (EAC-CPI)
	Budget at Completion
Performance Assessment	Cost Performance Index
	Schedule Performance Index
Progress Measurement / Data Collection	Physical Percent Complete
	Earned Value
	Planned Value
	Actual Cost

Diagnostic

Category	Metric
Schedule Diagnostics	Baseline Execution Index for Critical Path
	Number of Critical (or Near Critical) Paths
	Schedule Variance
Cost Diagnostics	Unit Rate
	Cost Variance
	Procurement Cost Variance
Physical Progress Diagnostics	Efficiency or Productivity Index
	Ratio of Actual to Planned Progress
	Percent Key Deliverables Completed on Time



Introduction

7 Significant Validation Metrics

Forecasting

Category	Metric
Performance Forecasting	Estimate at Complete (SPI)
	Estimate to Complete (SPI)
Performance Assessment	Monthly Cost Growth

Diagnostic

Category	Metric
Schedule Diagnostics	Percent Activities Started on Time
	Percent Activities Finished on Time
	Critical Path Length Index
Cost Diagnostics	Percent Work Packages on Budget

Introduction

7 Significant Innovative Metrics

Forecasting	
Category	Metric
Performance Forecasting	Estimate at Completion - Time
	Estimate to Completion - Time
Performance Assessment	Schedule Performance Index – Time [SPI(t)]
	Earned Schedule
Progress Measurement / Data Collection	Actual Duration
	Planned Duration

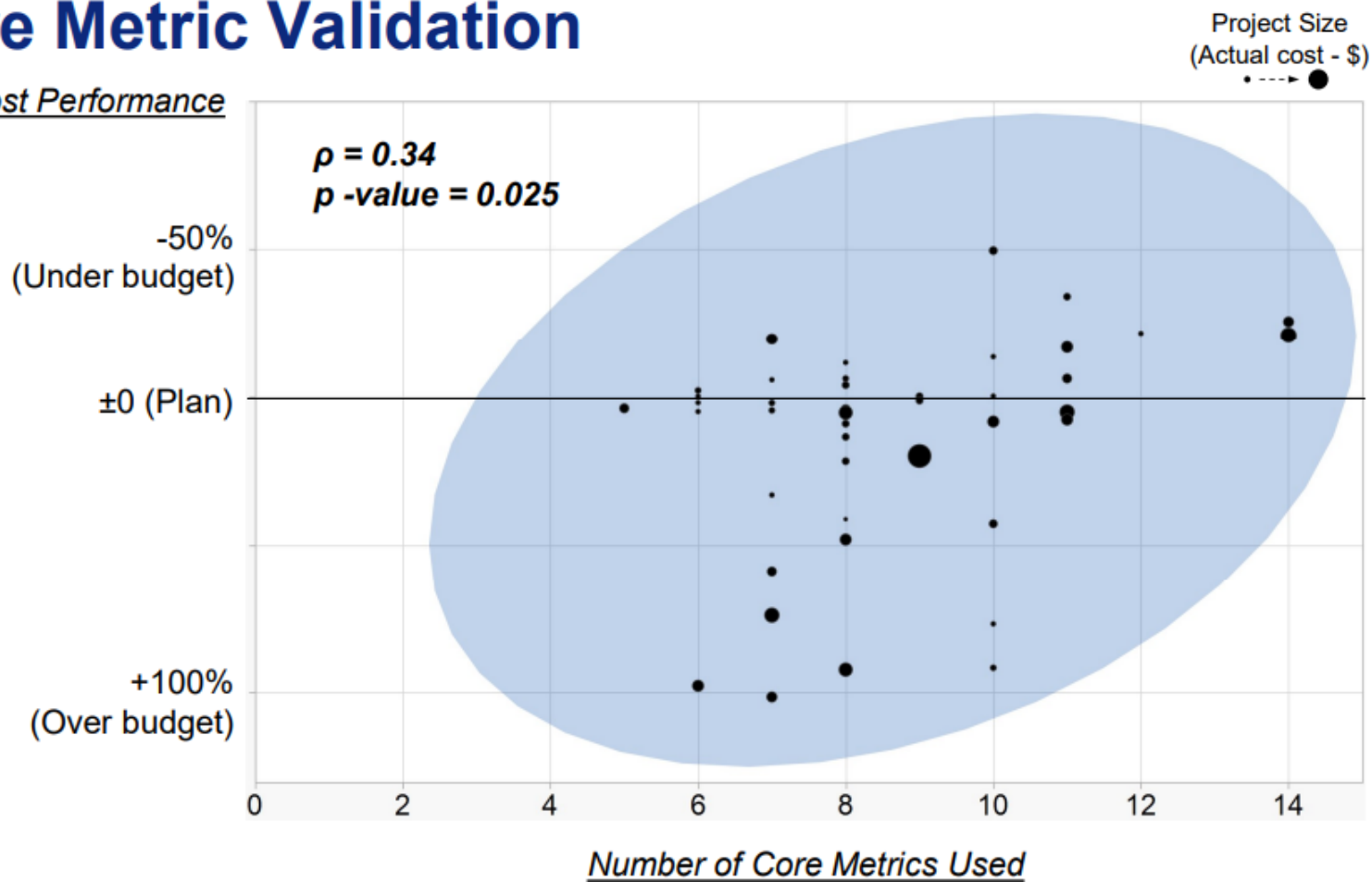
Diagnostic	
Category	Metric
Schedule Diagnostics	Schedule Variance – Time [SV(t)]



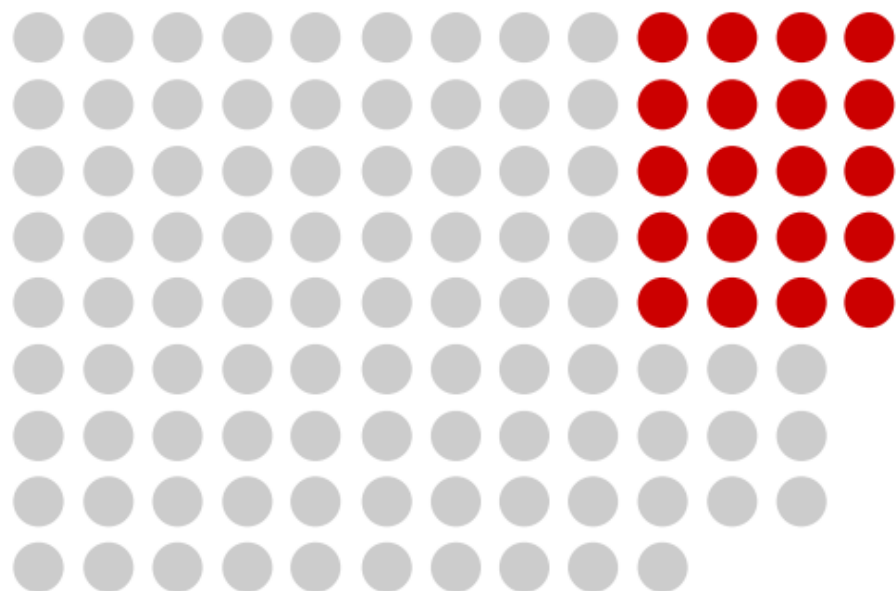
Introduction

Core Metric Validation

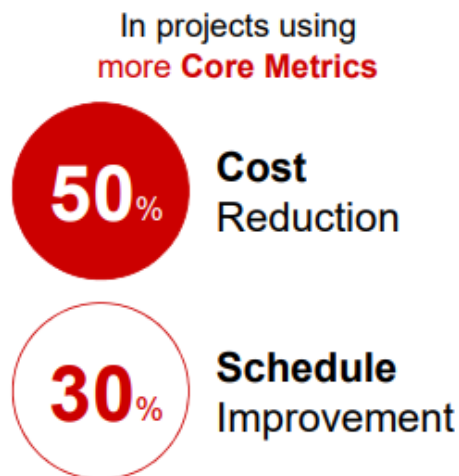
Cost Performance



Metric Classification – Summary



Data
↓
Core Metrics
↓
Insight



Literature Review
Expert Panel
Survey
Exploratory Analysis
Delphi Methods
Statistical Analysis



Appendix A - Details of Core and Significant Metrics

- ☐ Tables A1–A4: Forecasting Metrics
- ☐ Tables A5–A8: Diagnostic Metrics

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Appendix B - Core and Significant Metrics Maps

- ☐ Maps 1–22: Forecasting Metrics Maps
- ☐ Maps 23–43: Diagnostic Metrics Maps

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Reliability Improvement Checklist

Appendix C - Reliability Improvement Factors and Indicators with Specific Timing

- ☐ Tables C1–C3: All Phases
- ☐ Tables C4–C6: Pre-Detailed Design Phase
- ☐ Tables C7–C9: Detailed Design Phase
- ☐ Tables C10–C12: Construction Phase
- ☐ Tables C13–C15: Startup and Commissioning Phase

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User Guide

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

دفتر آموزش



تهران، بلوار فردوس شرق، مجتمع آبگینه، طبقه سوم اداری، واحد C42



+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۴۵



+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۵۰



info@dralavipour.com



www.dralavipour.com



@alavipour_pm



@acemi_social



@alavipour_pm



@IRANACEMI

