The Knowledge Leader for Project Success

Owners • Contractors • Academics

Metrics That Matter: Improving Project Progress and Performance Assessment

RT-322

Acknowledgements

Construction Industry Institute®

Research Team 322




RT-322

Samuel Morse, *Wood Group (Chair)*

Ryan E. King, *S & B Engineers and Constructors, Ltd. (Vice Chair)*

Ralph Abel, *U.S. General Services Administration*

Sam Bambino, *Aecon Industrial*

Buck Blum, *CB&I*

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Nor Edham Bin Lokman, *Petronas*

Jeff Morrison, *IHI E&C International Corporation*

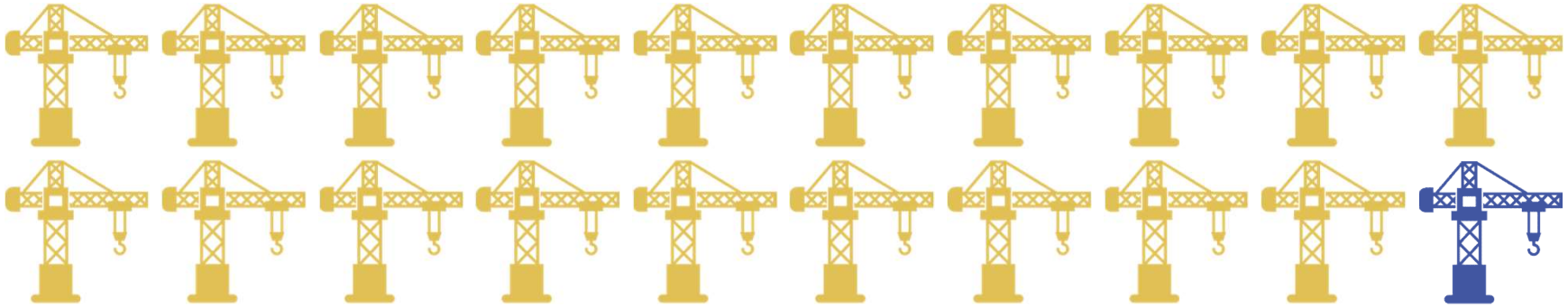
Razi Sohail, *ArcelorMittal*

Zachary M. Tarver, *Marathon Petroleum Company LP*

Brooke Thomas-Eben, *The Dow Chemical Company*

Matthew R. Ware, *Day & Zimmermann*

Construction projects are suffering from significant performance inefficiencies



Only

ONE

in twenty projects

is under budget and on time

Source: Construction Industry Institute, 2012

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

Adverse effects of low project performance is crippling the industry

$100 million

of every $1 billion

invested in projects is wasted

Only

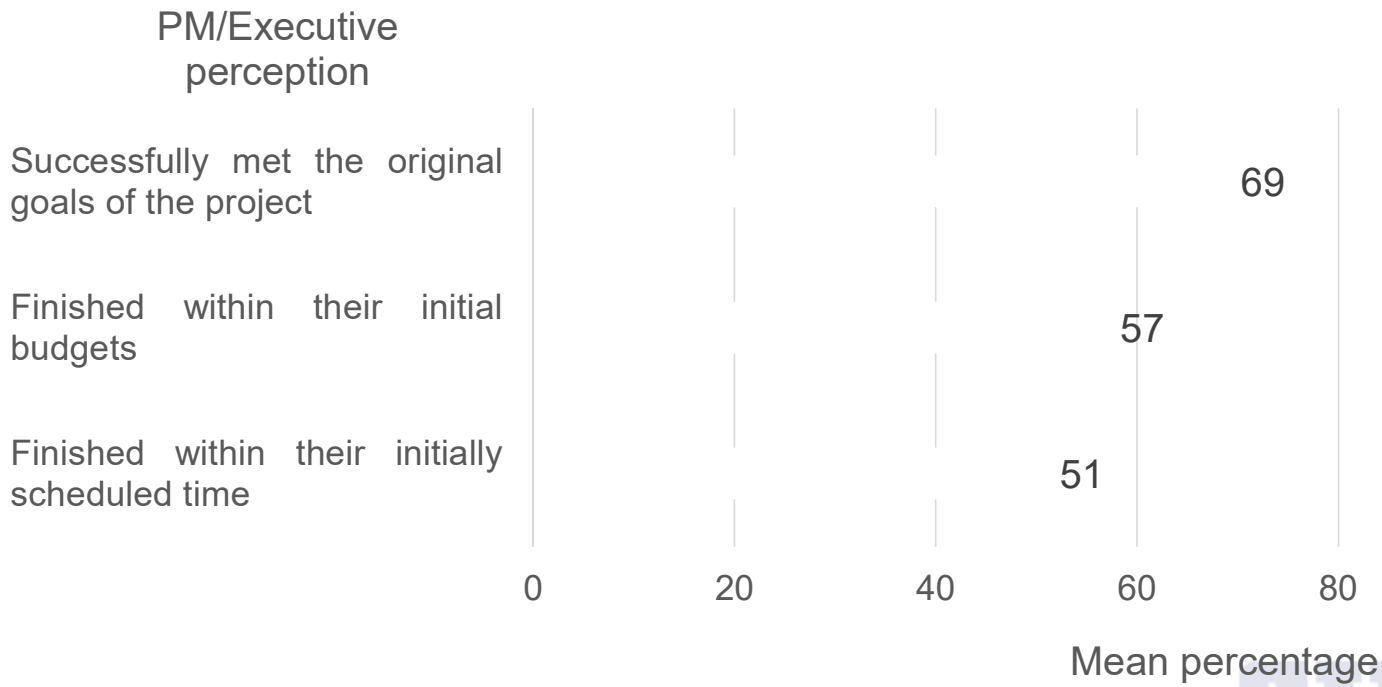
TWO

out of five projects

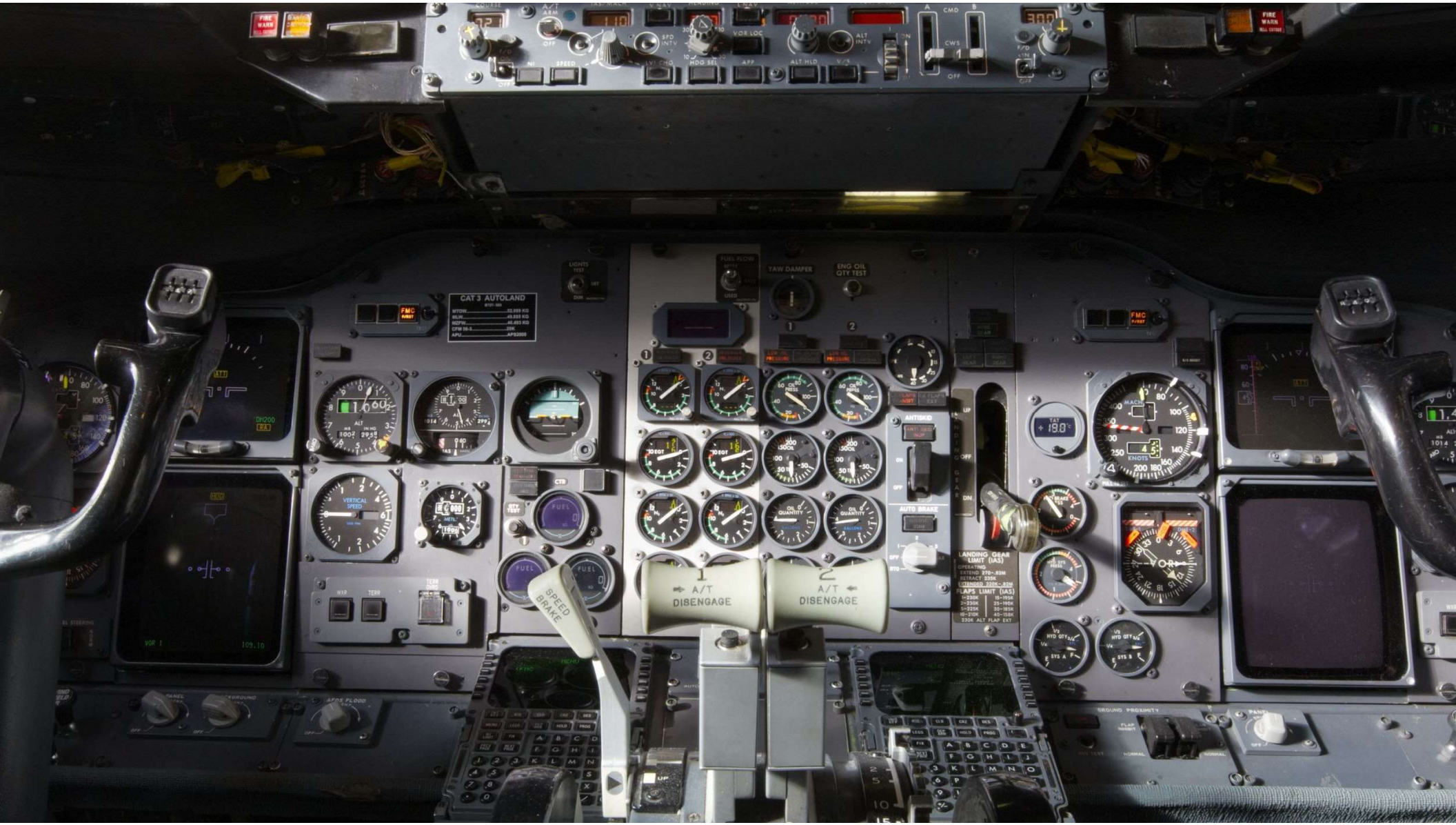
are profitable for contractors

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

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



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


CAT 3 AUTOLAND
YAW DAMPER
ENG OIL QTY TEST
FUEL FLOW
ANTISKID
AUTO BRAKE
LANDING GEAR LIMIT (IAS)
FLAPS LIMIT (IAS)
1 A/T DISENGAGE
2 A/T DISENGAGE
SPEED BRAKE
GROUND PROXIMITY

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

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

Objective #1
Develop a systematic project controls framework

Objective #2
Identify the core project control metrics

Objective #3
Generate guidelines for improving the reliability

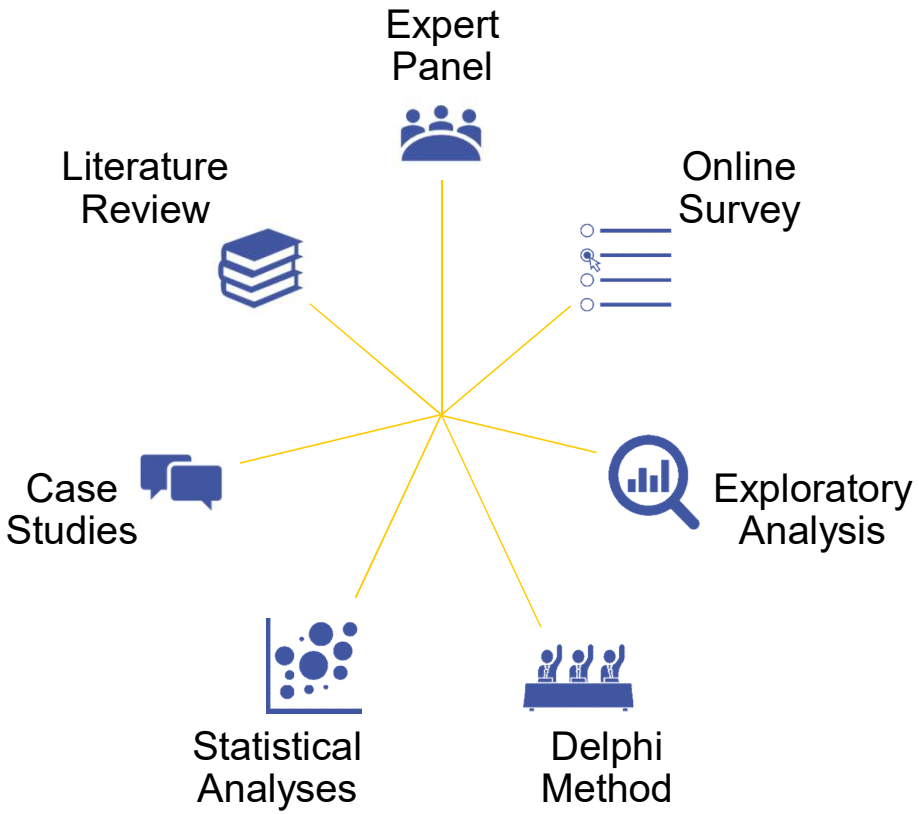
Metric Framework and Typology

Metric Classification

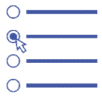
Reliability Improvement

Project Controls Improvement Tool

Various research methods are utilized to produce deliverables and achieve objectives



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
						

>100 documents

Scholarly articles

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

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

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

Research Team 322

13 industry professionals

290+ years of cumulative experience

Representing owner (5) and contractor (8) perspectives

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review

Expert Panel

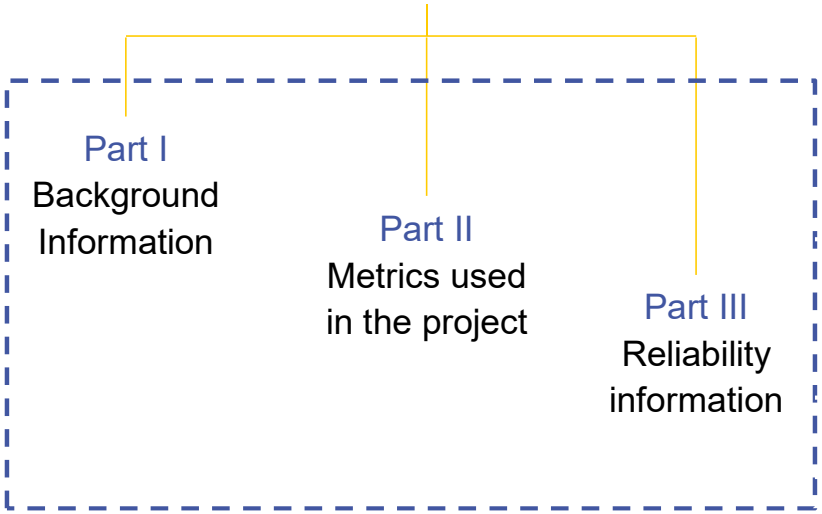
Online Survey

Exploratory Analysis

Delphi Method

Statistical Analyses

Case Studies



44 completed responses

Owner vs. contractor balanced

Predominantly heavy industrial

Average size: ~$120 million

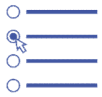
Average duration: ~2 years

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

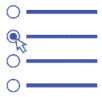
Metric Usage

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review

Expert Panel

Online Survey



Exploratory Analysis

Project controls Subject Matter Experts (SMEs)

Delphi Method

16 industry professionals

360+ years of cumulative experience

Representing owner (2) and contractor (14) organizations

Statistical Analyses

Case Studies

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review

Expert Panel

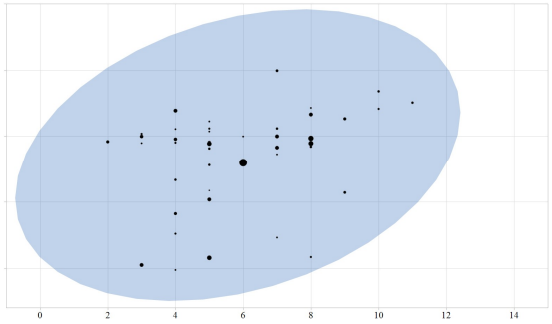
Online Survey

Exploratory Analysis

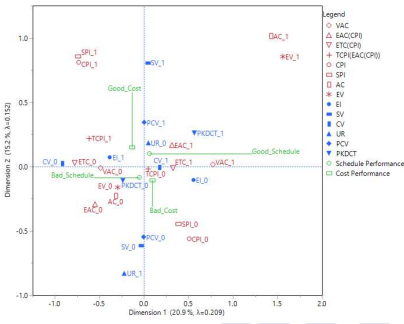
Delphi Method

Statistical Analyses

- Spearman's Rank Correlation



- Multiple Correspondence Analysis



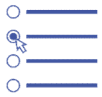
Case Studies

Various research methods are utilized to produce deliverables and achieve objectives

Literature Review

Expert Panel

Online Survey



Exploratory Analysis

Delphi Method

In-depth analysis of selected projects

Statistical Analyses

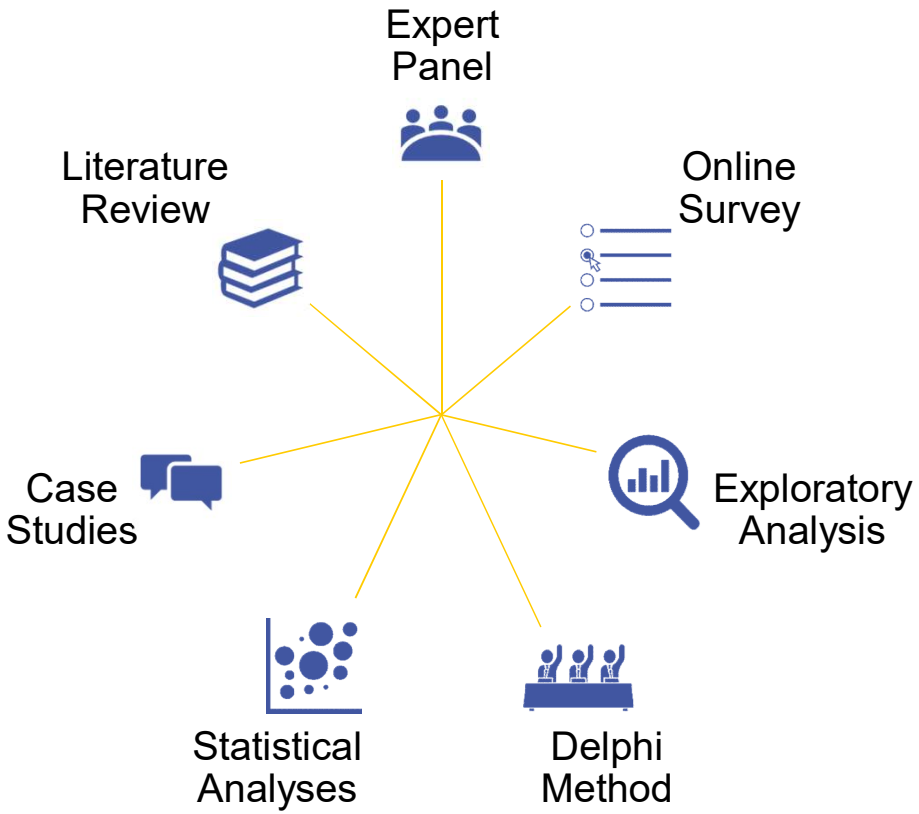
10 projects selected

Contractor (6) and owner (4) perspectives

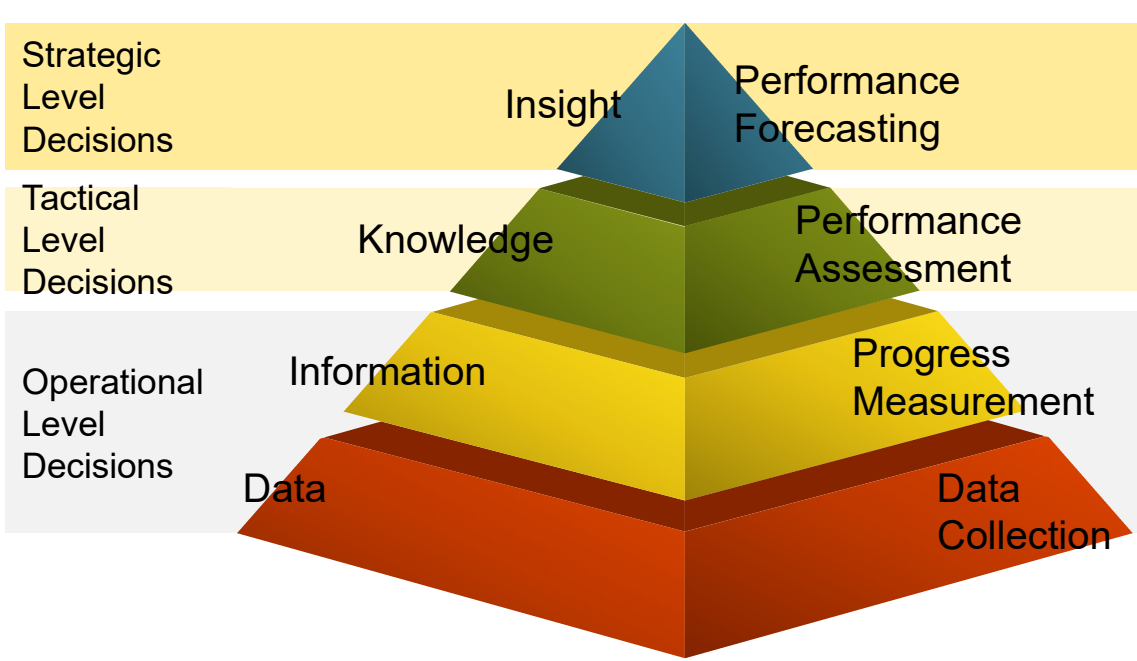
Interviewed 17 project personnel

Case Studies

Various research methods are utilized to produce deliverables and achieve objectives



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



Where Will We Be?

Where Should We Be?

Where Are We?

Why Are We Here?

Predictive Metrics

Predictive metrics **help forecast project cost and duration outcomes** based on current project progress and performance.

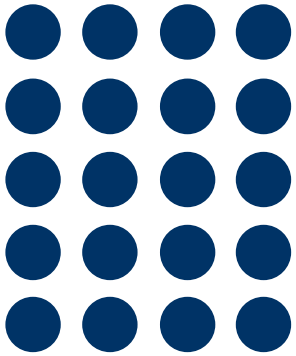
Diagnostic Metrics

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

Literature Revie

Expert Panel

Metric classification was finalized by subject matter experts (SMEs)



– 20

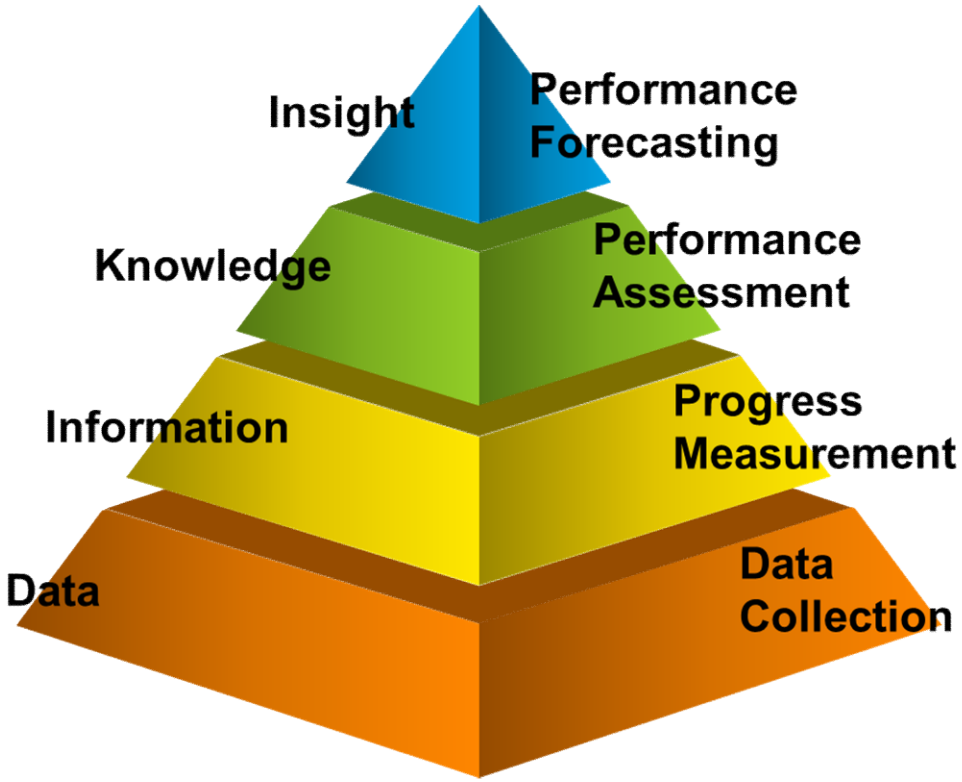
Core metrics

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

Delphi Method

S

Metric Pyramid – *Distribution of Core Metrics*



WHERE ARE WE GOING?

WHERE SHOULD WE BE?

WHERE ARE WE?

WHY ARE WE HERE?

Forecasting Metrics

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

Diagnostic Metrics

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

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

7 Significant Validation Metrics

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

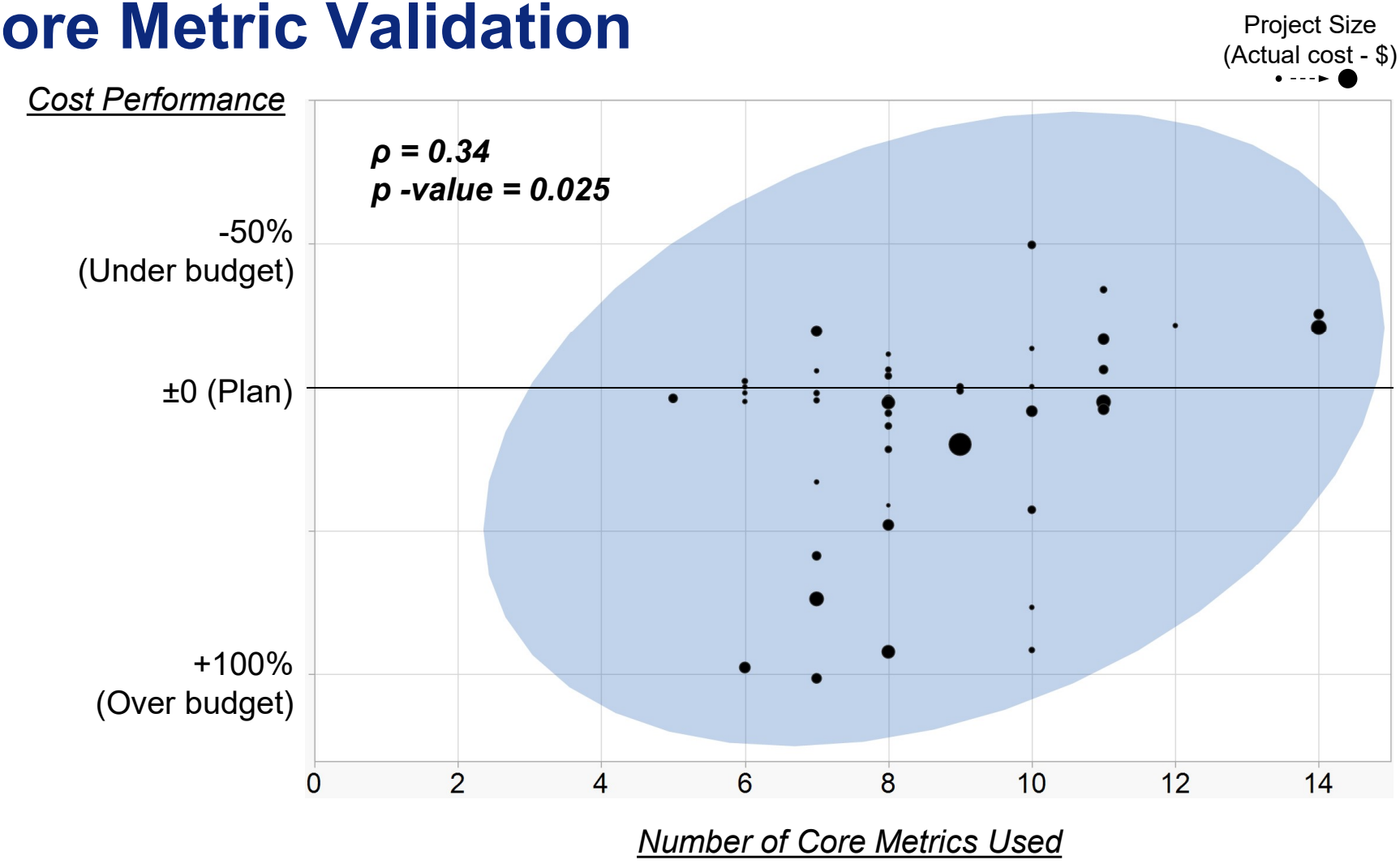
Diagnostic	
Category	*Metric*
Schedule Diagnostics	Percent Activities Started on Time
	Percent Activities Finished on Time
	Critical Path Length Index
Cost Diagnostics	Percent Work Packages on Budget

7 Significant Innovative Metrics

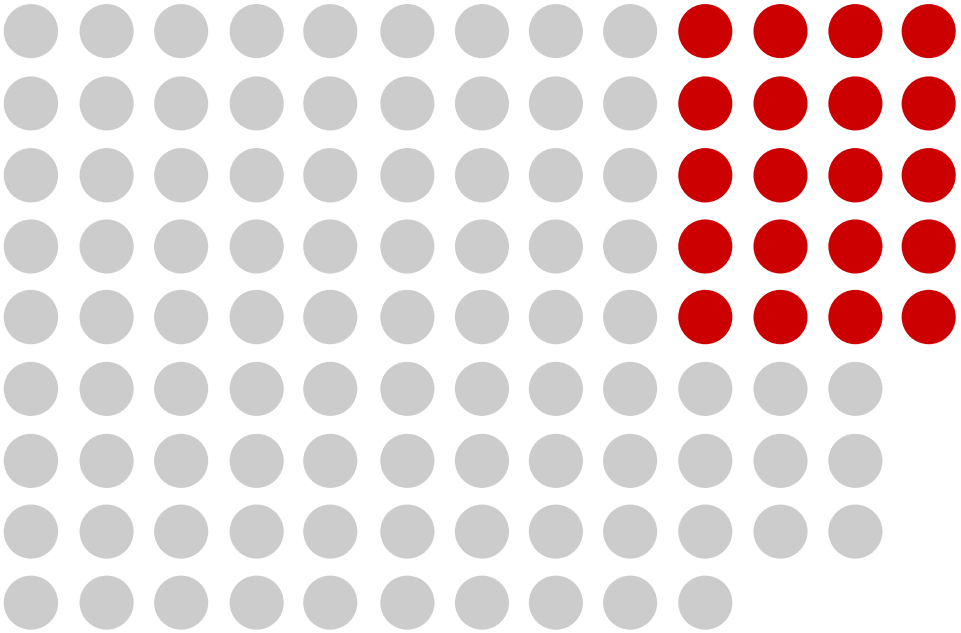
Forecasting	
Category	*Metric*
Performance Forecasting	Estimate at Completion - Time
	Estimate to Completion - Time
Performance Assessment	Schedule Performance Index – Time [SPI(t)]
	Earned Schedule
Progress Measurement / Data Collection	Actual Duration
	Planned Duration

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

Core Metric Validation



Metric Classification – Summary



Data

Core Metrics

Insight

In projects using more **Core Metrics**

50% **Cost** Reduction

30% **Schedule** Improvement

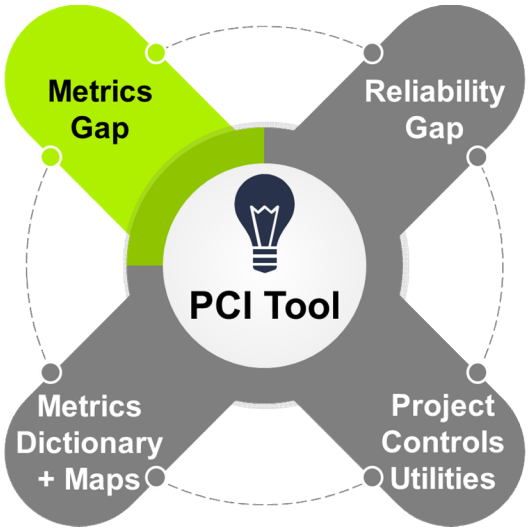
- Literature Review
- Expert Panel
- Survey
- Exploratory Analysis
- Delphi Methods
- Statistical Analyses

Implementation Resource:
Project Controls Improvement Tool

Components of the Project Control Improvement (PCI) Tool

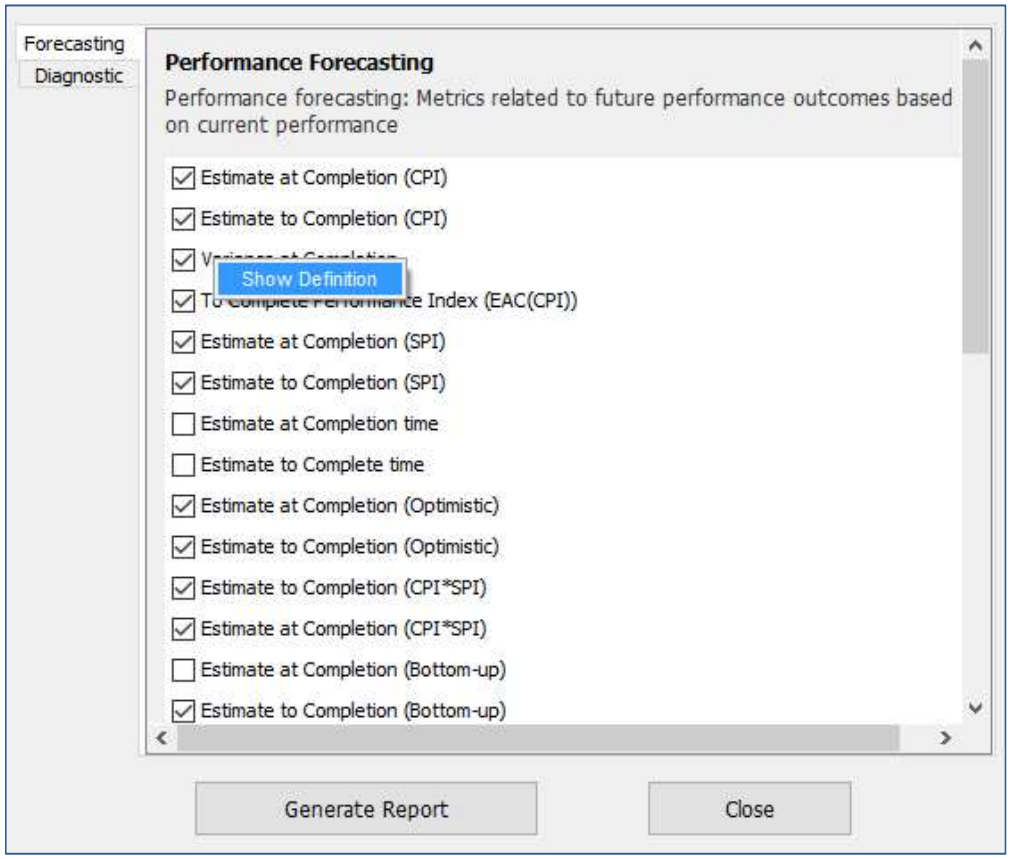
- Features
  - Automated
  - Interactive
  - Dynamic
  - User-Friendly
  - Customized Reporting

Metrics Gap Module

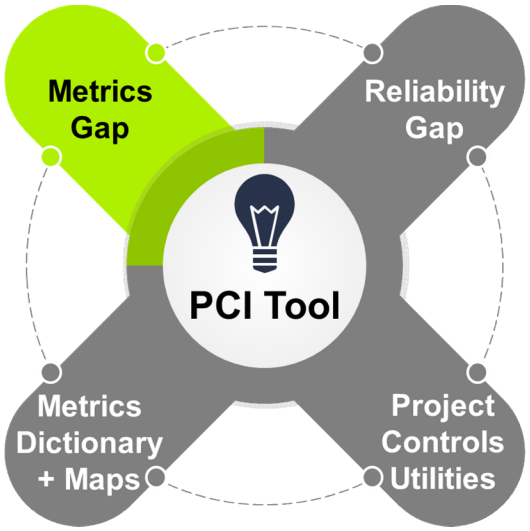


Sharpen the Metrics Dashboard

User Input: Selection of Currently Used Metrics

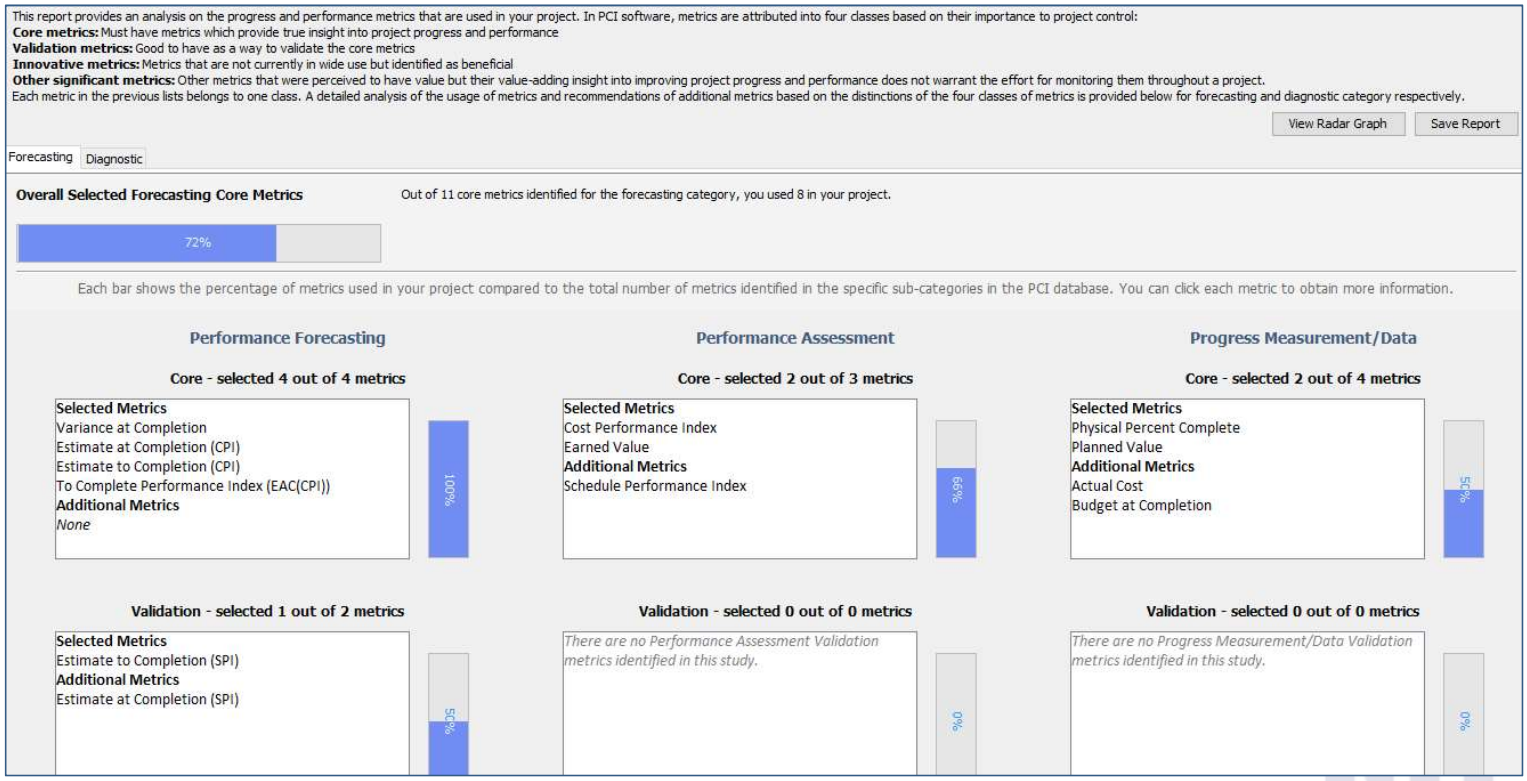


Metrics Gap Module

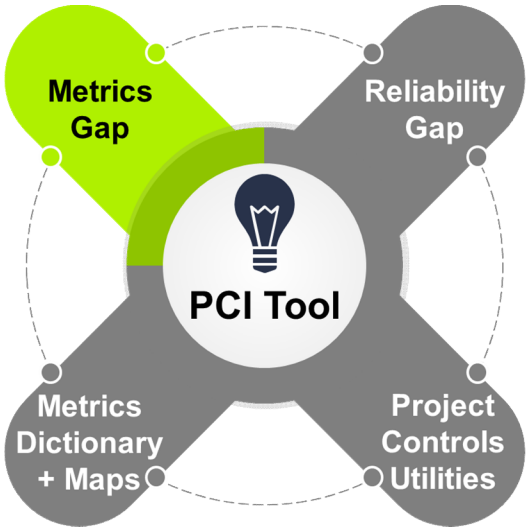


Sharpen the Metrics Dashboard

Output: Scorecard of Current Status and Additional Recommended Metrics

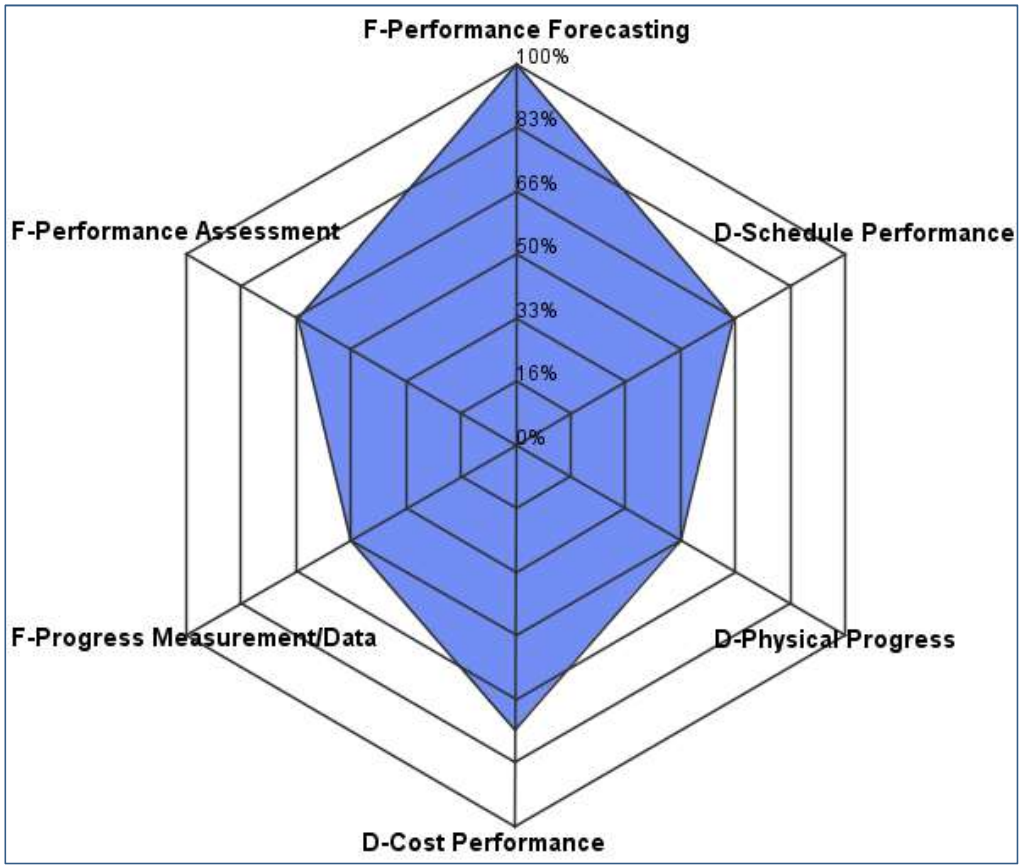


Metrics Gap Module

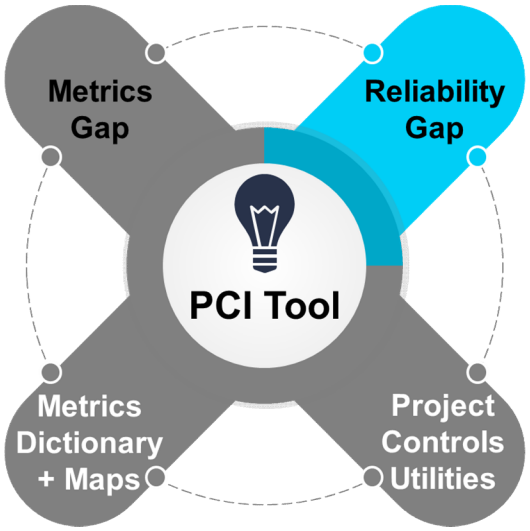


Sharpen the Metrics Dashboard

Output: The Radar Graph

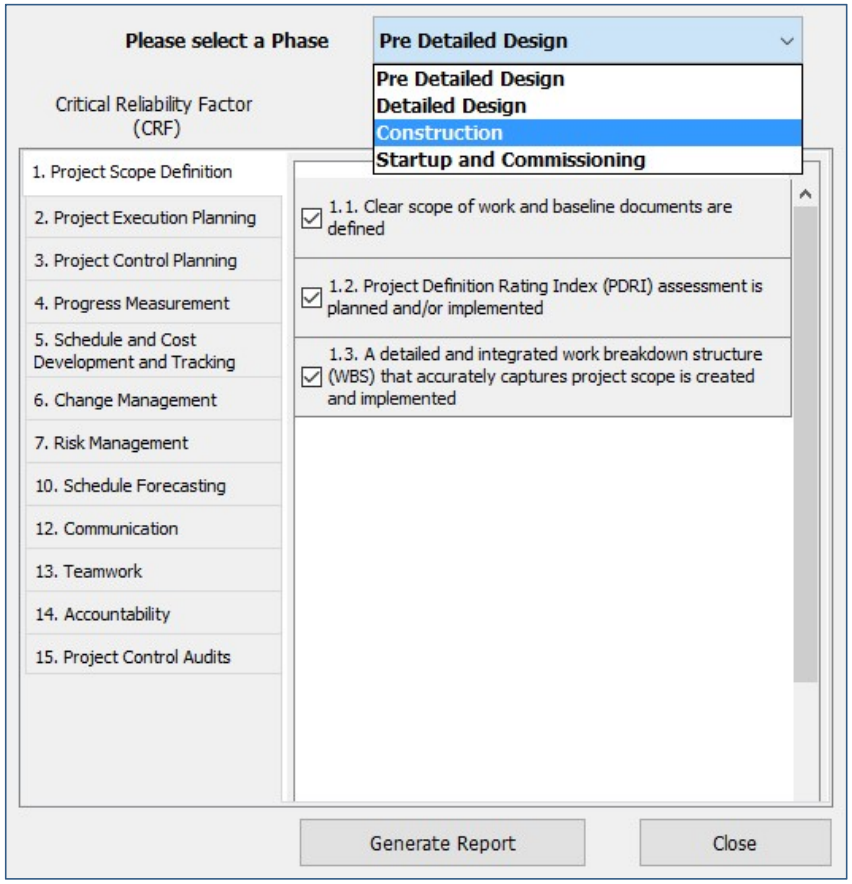


Reliability Gap Module

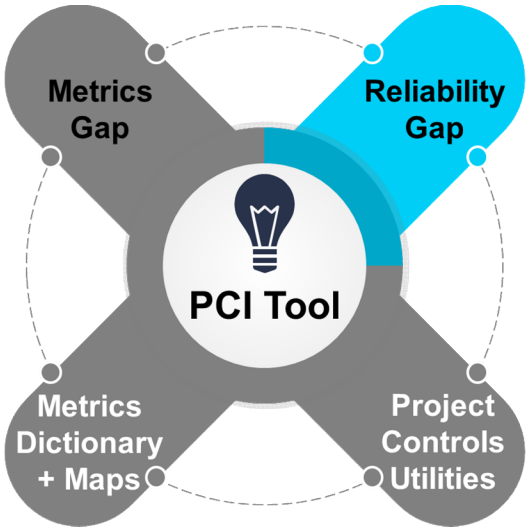


Build Reliability into Project Controls

User Input: Evaluation of Reliability Factors



Reliability Gap Module

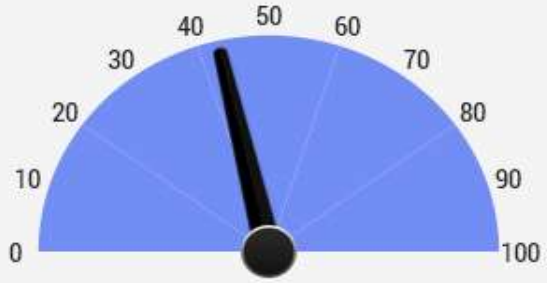


Build Reliability into Project Controls

Output: Scorecard of Current Status, Gaps, and Recommended Improvements

Pre Detailed Design | Detailed Design | Construction | Startup and Commissioning

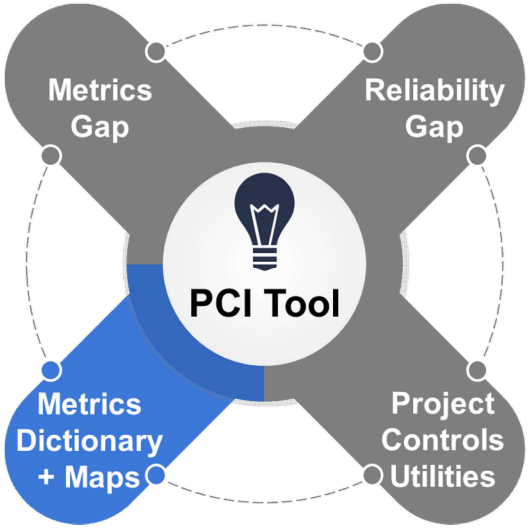
Critical Reliability Factor (CRF)	Percentage of Indicators Achieved
2. Project Execution Planning	100%
3. Project Control Planning	50%
4. Progress Measurement	33%
5. Schedule and Cost Development and Trac...	100%
6. Change Management	80%
7. Risk Management	60%
8. Progress Audits	0%
9. Metric Trend Analysis	50%
10. Schedule Forecasting	0%
11. Cost Forecasting	60%
12. Communication	0%
13. Teamwork	66%
14. Accountability	75%
15. Project Control Audits	100%



Overall Percentage of Reliability Indicators Achieved in This Phase: 42%

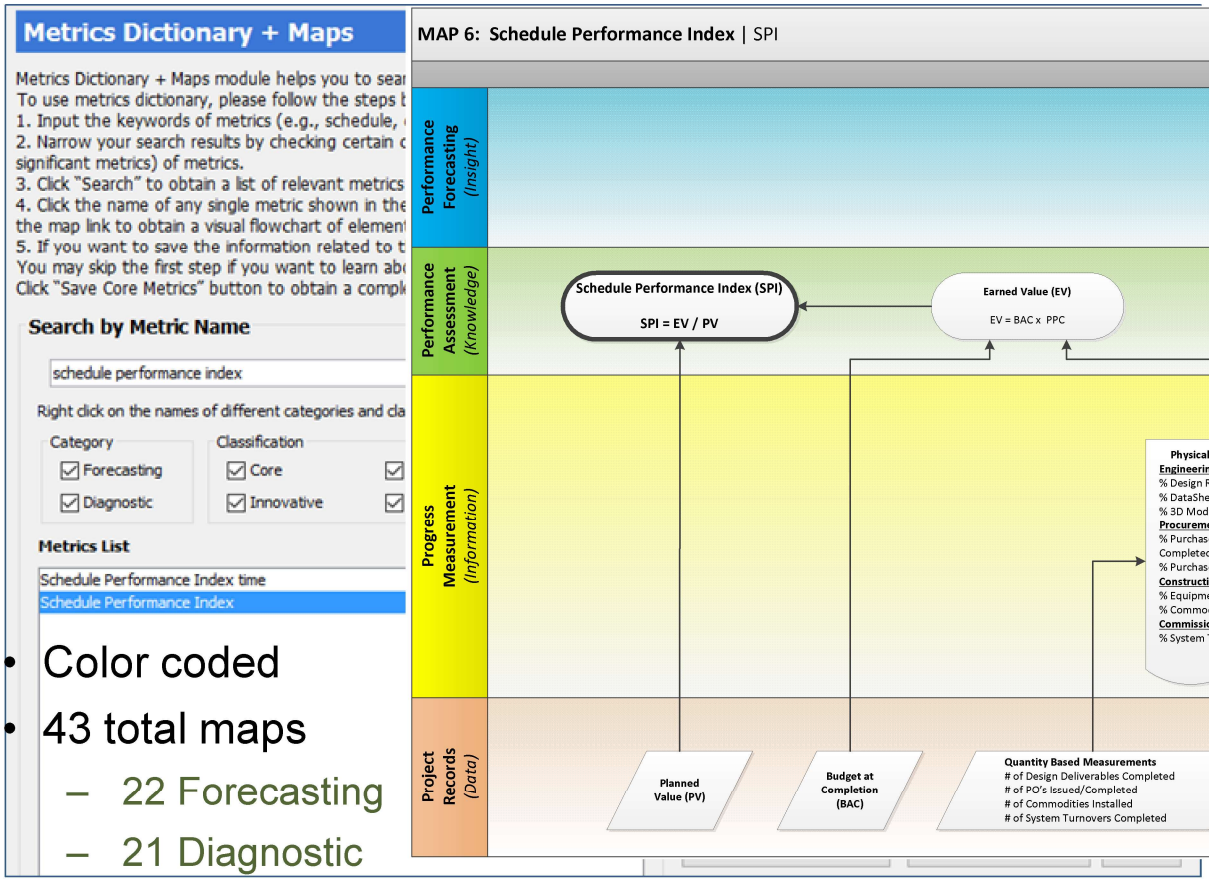
Display Reliability Factor Implementation Timing | Save Report | Close

Metrics Dictionary and Maps Module



Calculate and Interpret Metrics Correctly

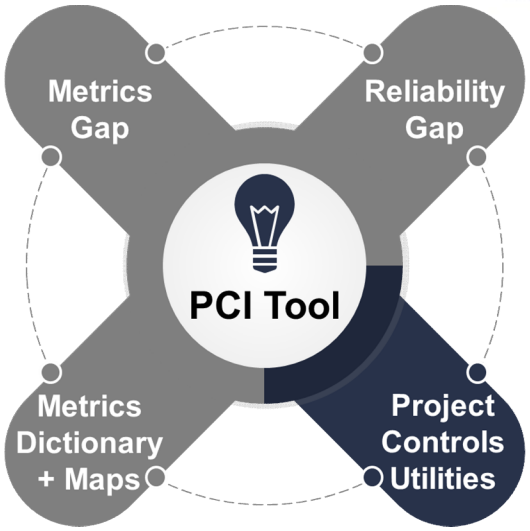
Searchable Metrics Dictionary



- Color coded
- 43 total maps
  - 22 Forecasting
  - 21 Diagnostic

Maps for all Metrics in the Dictionary

Project Controls Utilities – *Core Metrics Directory*



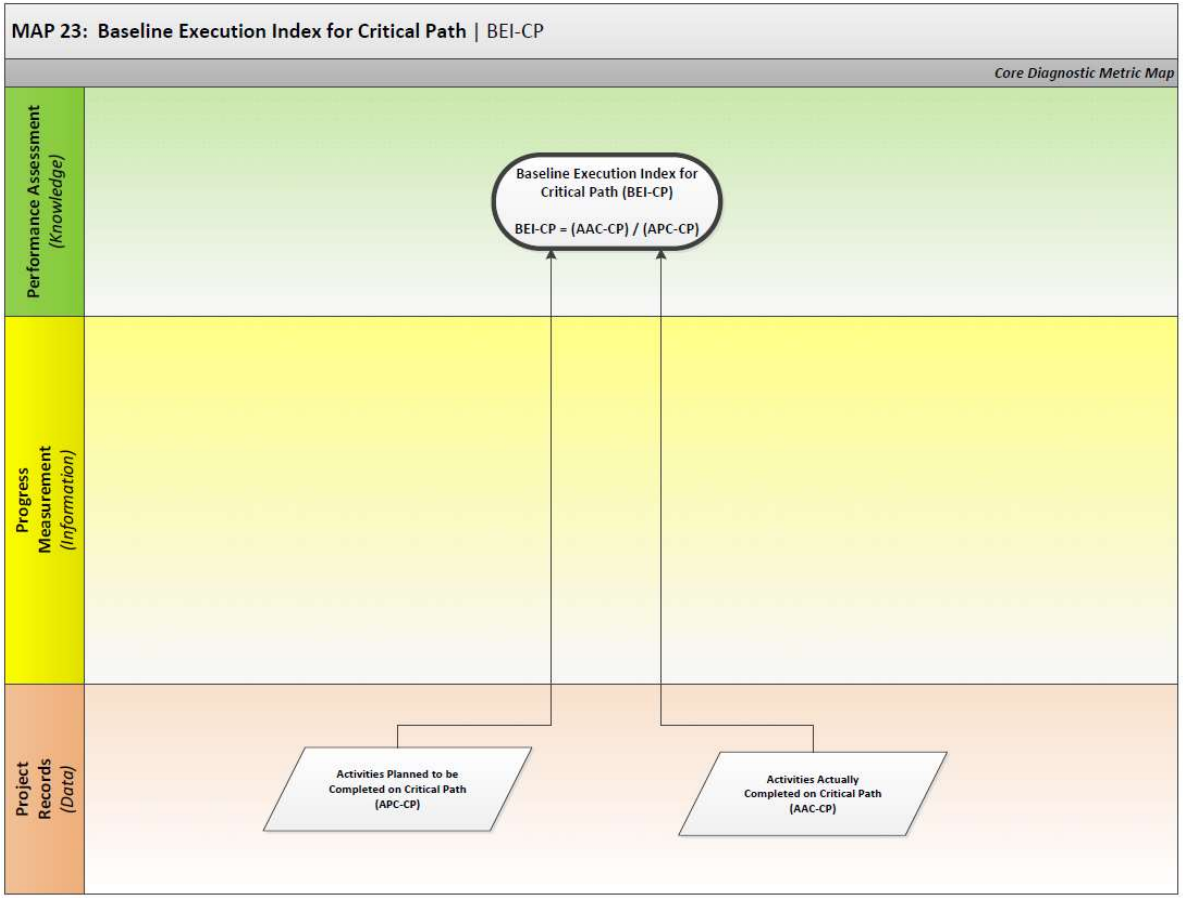
Learn about Project Controls

Classification | Name | Equation | Use and Interpretation | Reference

Category | Definition | Indicator | Map ID | Additional Sources

Classification	Category	Name	Definition	Equation	Indicator	Use and Interpretation	Map ID * ("X": targeted metric; "o": utilized for other metrics) 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	Reference	Additional Sources
Core Metrics	Performance Forecasting	Variance at Completion | VAC	A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.	VAC = BAC - EAC(CPI)	VAC>0 The project is under budget; VAC=0 The project is on budget; VAC<0 The project is over budget	VAC could be used in trending analysis for forecasting purposes. It can be used to communicate cost status of the project to senior management.	X	PMI Lexicon of Project Management Terms Version 3.0	
		Estimate at Completion | EAC(CPI)	EAC(CPI) is a metric to project total cost using the cost performance to date.	EAC(CPI) = AC + (BAC-EV) / CPI	Cost performance can be tracked over time using EAC(CPI).	This is one of the five variations of calculating EAC. This metric can be compared to the EAC which is the manager's projection. It is an easy to calculate metric.	o X o o	A Guide to Managing Programs Using Predictive Measures (NDIA, 2014)	PMI Lexicon of Project Management Terms Version 3.0 DCMA-EA PAM 200.1
		Estimate to Completion | ETC(CPI)	The expected cost to finish all the remaining project work.	ETC(CPI) = (BAC - EV) / CPI		This is one of the five variations of calculating ETC. A common practice is to use ETC periodically during the life of project. ETC may be compared to project manager's estimate.	o o X o o	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
		To Complete Performance Index | TCPI (EAC(CPI))	A measure of the cost performance that is achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget.	TCPI_EAC(CPI)) = (BAC-EV) / (EAC(CPI)-AC)	TCPI_EAC(CPI) ≤ 1: Cost objective achievable; TCPI_EAC(CPI) > 1: It becomes more difficult to achieve the EAC	TCPI is the future cost performance required to finish the project within EAC. TCPI is a check index for ETC which is used to validate whether or not the estimate to complete can be achieved. Once ETC and EAC are calculated, calculate TCPI to determine whether the EAC is reasonably achievable.	X	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
	Performance Assessment	Cost Performance Index | CPI	A measure of the cost efficiency of budgeted resources expressed as a ratio of earned value to actual cost	Cost Performance Index (CPI) CPI = EV / AC	CPI > 1: Project cost performance favorable; CPI = 1: Project cost performance on track; CPI < 1: Project cost performance unfavorable	CPI is an indicator of cost performance. However, CPI can be calculated either based on cost or man hours.	o o o o X o o o o o o o o	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
		Schedule Performance Index | SPI	A measure of schedule efficiency expressed as the ratio of earned value to planned value.	Schedule Performance Index (SPI) SPI = EV / PV	SPI > 1: Project schedule performance favorable; SPI = 1: Project schedule performance on track; SPI < 1: Project schedule performance unfavorable;	SPI is an indicator of schedule performance. However, SPI can be calculated either based on cost or man hours. A drawback to the use of SPI is that approximately halfway through the project SPI begins to converge to 1 regardless of the actual schedule performance. Using SPI(t) is a better alternative for assessing schedule performance.	X o o o o o o o o o o o o	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
		Earned Value | EV	The measure of work performed expressed in terms of the budget authorized for that work.	EV = BAC x Physical % Complete	EV > PV: Project cost performance favorable; EV = PV: Project cost performance on track; EV < PV: Project cost performance unfavorable	Accurately measuring physical progress is critical in calculating EV. However, earned value makes no distinction between a critical quantity and a non-critical quantity. Therefore, EV may not be closely tied to achievement of critical path.	o o o o o o X o o o o o o o o o o o o o o o o o o o o o	PMI Lexicon of Project Management Terms Version 3.0	
	Progress Measurement/Data	Physical Percent Complete | PPC	Represents the amount of work performed as a percent of the total physical work required.		PPC ≥ Planned percent complete: Project component is on track; PPC < Planned percent complete: Project component is lagging	Physical percent complete is based on Quantity Based Measurements, Milestones, or Other methods (e.g., Rules of Credit and Level of Effort). Accurately measuring physical progress is critical in calculating EV.	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	CII RT-222	
		Budget at Completion | BAC	The sum of all budgets established for the work to be performed.			BAC must incorporate all approved changes.	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	PMI Lexicon of Project Management Terms Version 3.0	
		Planned Value | PV	The authorized budget assigned to scheduled work.			PV is also reffered to as Budgeted Cost of Work Performed which is the sum of the performance budgets for all work scheduled to be accomplished in a given time period. This includes detailed work packages, Level of Effort (LOE) packages, apportioned effort, and planning packages. Typically represents cumulative to date values, unless some other time period is specified.	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	PMI Lexicon of Project Management Terms Version 3.0	A Guide to Managing Programs Using Predictive Measures (NDIA, 2014)
		Actual Cost | AC	The actual cost of the work determined by the paid costs to date and accruals.	AC = Paid Costs (PC) + Accruals		This actual cost reported by the project control group may be more current and complete than that reported by accounting	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	PMI Lexicon of Project Management Terms Version 3.0	

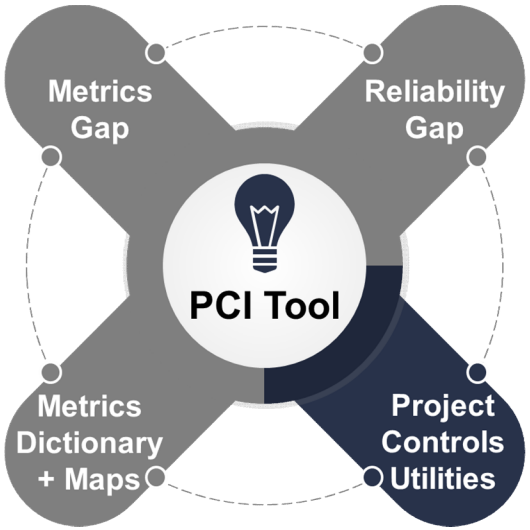
Project Controls Utilities – *Core Metrics Directory*

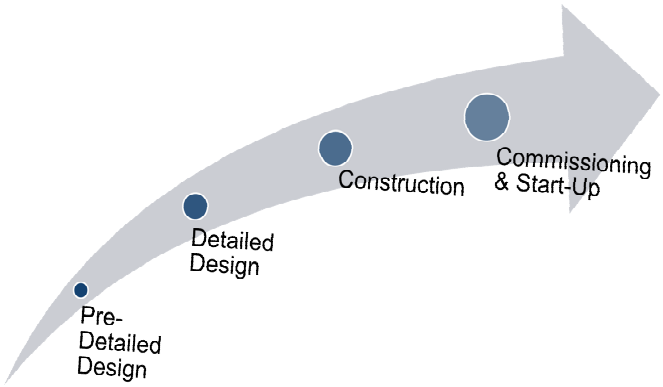


Name	Definition	Equation
Baseline Execution Index for Critical Path | BEI-CP	The ratio between the Number of Activities Actually Completed on the Critical Path (AAC-CP) and the number of Activities Planned to be Completed on the Critical Path (APC-CP)	BEI-CP = (AAC-CP) / (APC-CP)

Indicator	Use and Interpretation
BEI-CP ≥ 1: Favorable BEI-CP < 1: Unfavorable	BEI is used to indicate the efficiency with which actual critical path work has been accomplished when measured against the baseline. This metric provides insight pertaining to project progress performance on the critical path.

Project Controls Utilities – *Reliability Improvement Checklist*





Critical Reliability Factors

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 Tracking	13. Teamwork
6. Change Management	14. Accountability
7. Risk Management	15. Project Control Audits
8. Progress Audits	

Project Control Critical Reliability Factor (CRF)	Indicator of CRF Achievement	CRF Achievement Check Point																			
		Pre-Detailed Design					Detailed Design					Construction					Start-up and Commissioning				
		PR	B	D	E	PO	PR	B	D	E	PO	PR	B	D	E	PO	PR	B	D	E	PO
1. Project Scope Definition	1.1. Clear scope of work and baseline documents are defined																				
	1.2. Project Definition Rating Index (PDRI) assessment is planned and/or implemented																				
	1.3. A detailed and integrated work breakdown structure (WBS) that accurately captures project scope is created and implemented																				
2. Project Execution Planning	2.1. Project organizational chart is developed and maintained																				
	2.2. Detailed execution and labor contracting strategies are created, maintained, and communicated to all stakeholders																				
	2.3. Project execution plan adequately addresses project scope																				
	2.4. Priority between cost and schedule are defined																				
	2.5. The project organizational chart includes all the positions listed and associated roles and responsibilities are defined clearly																				
3. Project Control Planning	3.1. Metrics and their thresholds are determined based on project characteristics (e.g., size, type, and complexity)																				
	3.2. Metrics are aligned with contractual requirements																				
	3.3. The quality and detail requirements of the schedule is defined																				
	3.4. Project control plan defines reporting requirements																				
	3.5. The commercial and technical milestones are aligned with project delivery requirements																				

Project Controls Utilities – *Reliability Improvement Checklist*

Project Control Critical Reliability Factor (CRF)	Indicator of CRF Achievement	CRF Achievement Check Point																			
		Pre-Detailed Design					Detailed Design					Construction					Start-up and Commissioning				
		PR	B	D	E	PO	PR	B	D	E	PO	PR	B	D	E	PO	PR	B	D	E	PO
4. Progress Measurement	4.1. Rules of credit for project deliverables are defined to provide accurate progress measurement		◆					◆					◆								
	4.2. Consistent rules of credit are tied to tangible deliverables to provide accurate progress measurement		◆					◆					◆								
	4.3. Level of effort and percent complete are aligned for project deliverables		◆					◆					▭		→						
	4.4. Discipline-specific and trade-specific rules of credit are used consistently							▭		→			▭		→			▭		→	
	4.5. Discipline specific quantity-based commodity curves are used													▭							
	4.6. Commodity curves based on project schedule are used													▭							

PR: Prior to**; B:** At the Beginning**; D:** During**; E:** At the End**; PO:** Post

▭ **represents the reliability indicator observed at a specific time**

→ **represents monitoring a reliability indicator over a certain period of time within the phase**

◆ **represents the reliability indicator achievement milestones**

*** Indicators occuring prior to Pre-Detailed Design phase are mostly programming requirements that must be done prior to project approval/authorization.**

Use of PCI Tool - Examples

Who?	How?	When?
▪ Project manager	▪ Resource for project execution planning	▪ During project planning
▪ Project control manager	▪ Improve company-wide use of metrics and reliability	▪ During company-wide performance assessment enhancement
▪ Cost Engineer/ Scheduler	▪ Benchmark core metrics and reliability practices across different projects	▪ During project execution

Mostafavi@tamu.edu

PCI Tool Structure