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# COAA Major Projects Benchmarking Program

Phase II (2009 – 2012)

**Stephen P. Mulva, Ph.D.**

**Associate Director**

**May 19, 2010**

# Agenda

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- Introduction
  - Construction Industry Institute (CII)
  - COAA Alberta Major Projects Benchmarking Program
- Building a Performance Culture
- Best Practices
- Phase II
  - NextGen Benchmarking System
  - University of Calgary
    - Performance Assessment Lab (PAL)
    - Sector-Specific Research
- Questions



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# CII History



- Established as a recommendation from The Business Roundtable Construction Industry Cost Effectiveness (CICE) Project to address:
  - construction research
  - fragmentation of the industry
- Founded in 1983 by 29 companies; now 110 members
- First to bring research to the engineering-construction world
- First owner-contractor-academic research collaboration for the constructed project
- The principal industry forum for the engineer-procure-construct (EPC) process.



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# COAA Alberta Major Projects Benchmarking Program

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- Completed Phase I May 2009
  - Benchmarked 37 Projects
  - Published “Alberta Report”
- Sponsored by:
  - COAA
  - Government of Alberta, Finance & Enterprise Division
  - COAA Member Companies
- Began Phase II December 2009
  - Additional Development (Metrics / Pipelines)
  - University of Calgary
  - “Alberta Report #2”



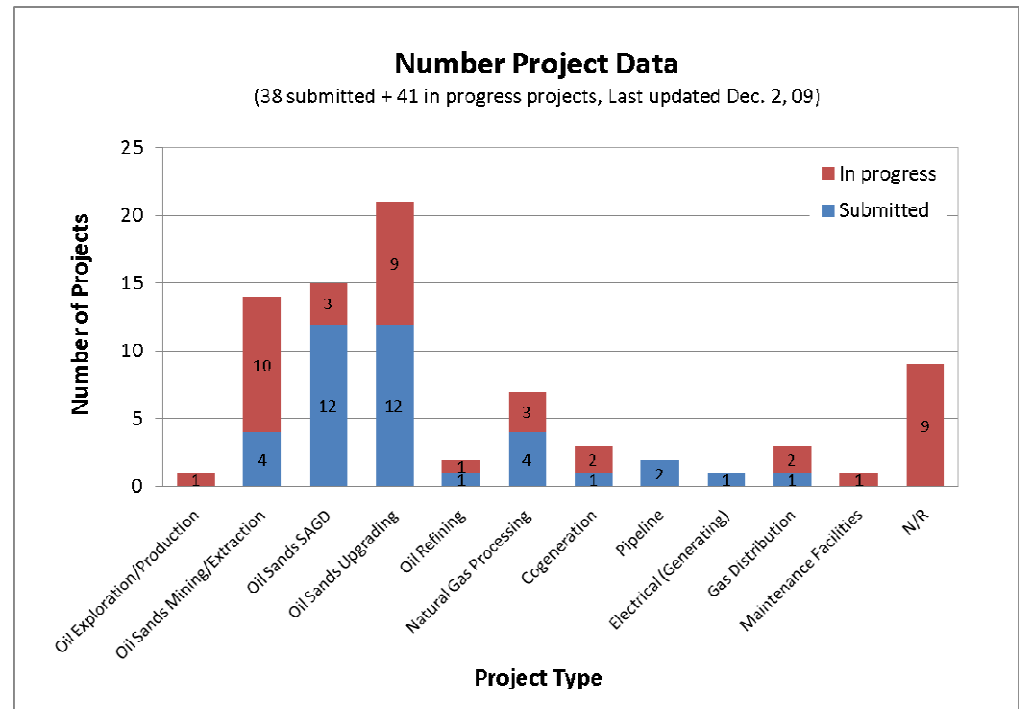
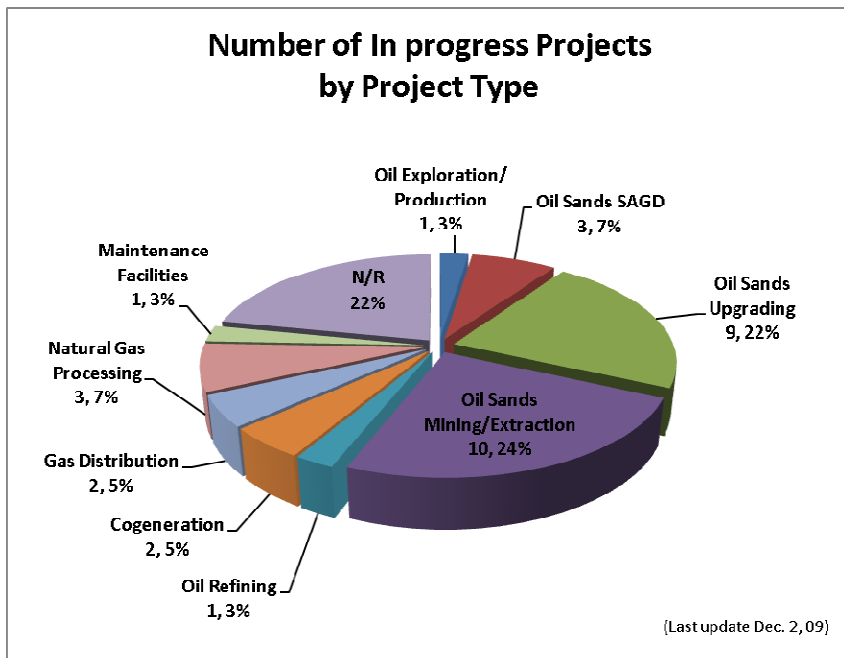
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# Current Status (79 Projects)

- 41 In-progress projects

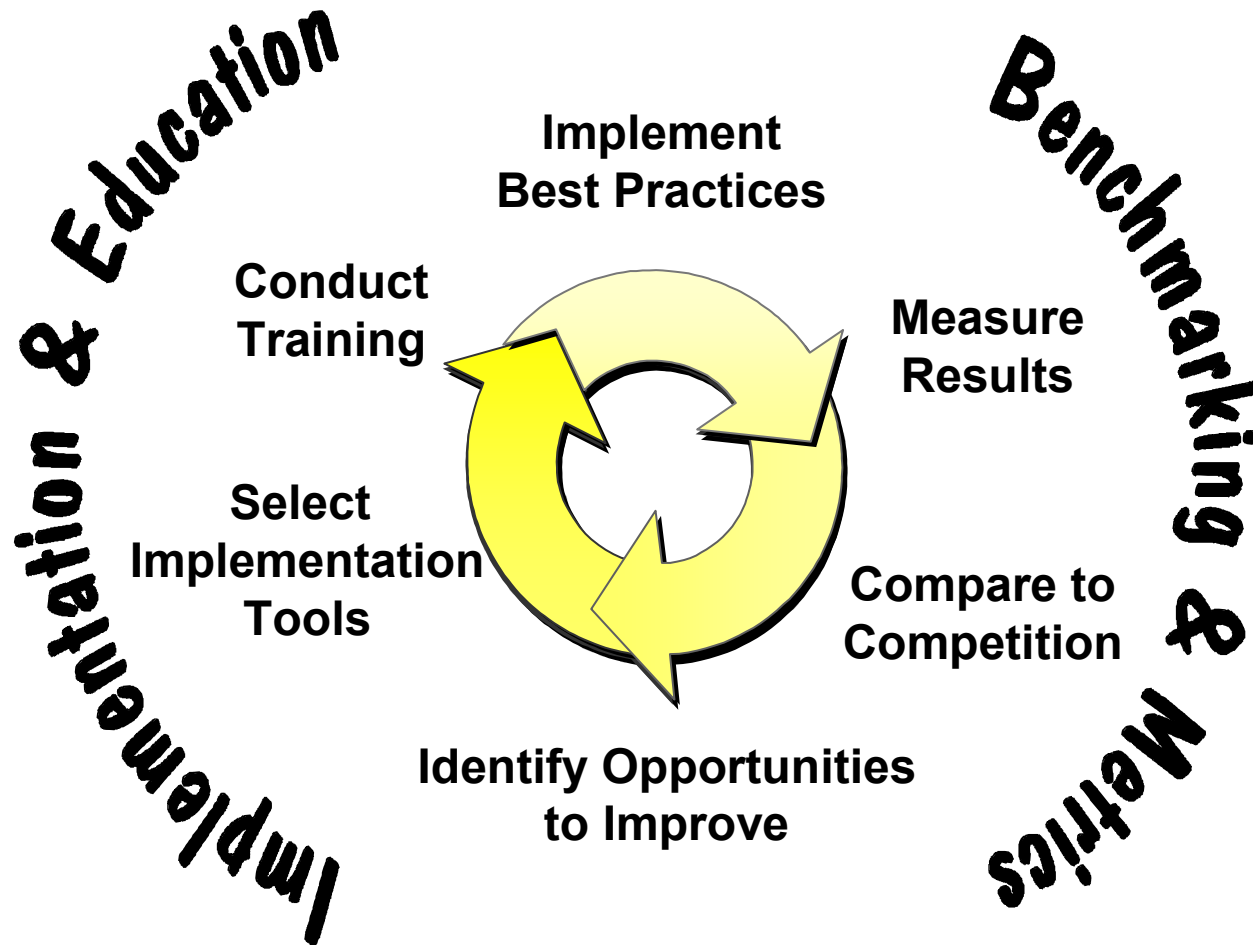
- 38 submitted from phase 1 + 41 in-progress projects



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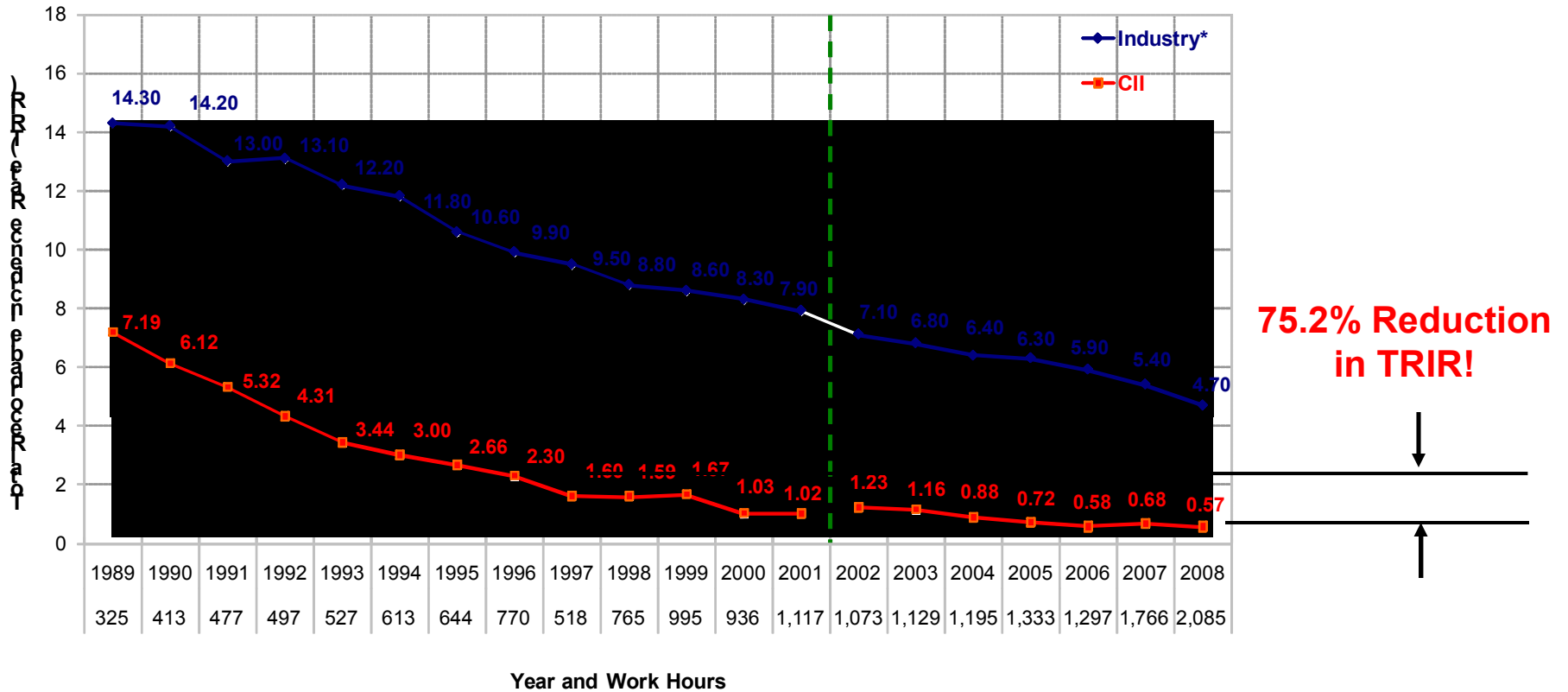
# The Improvement Process



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# Industry Safety Culture



\*OSHA Construction Division, NAICS 236-238, SIC 15-17

--- Reflects OSHA Reporting Change

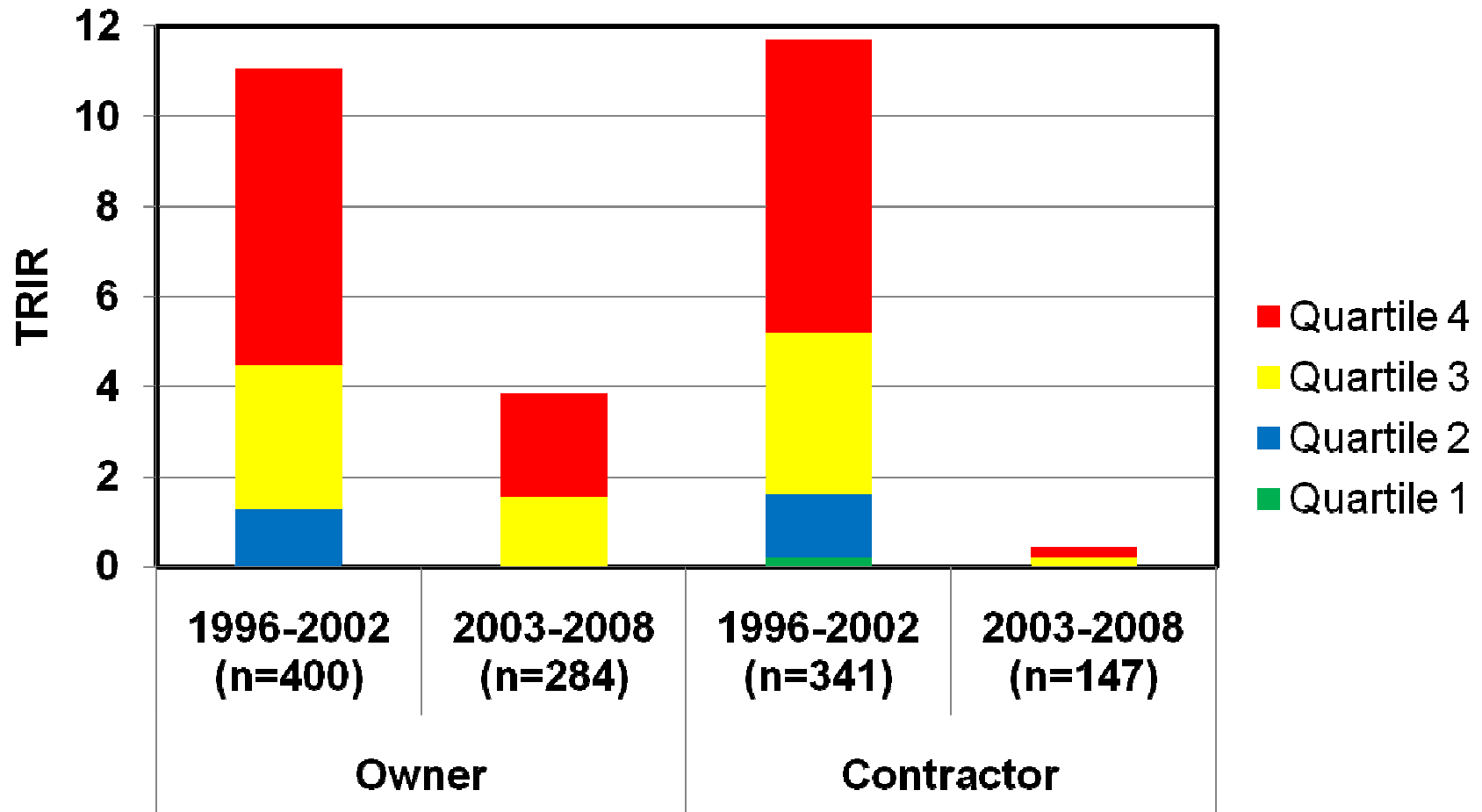
**75.2% Reduction in TRIR!**



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# CII Benchmarking Safety Results



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# What If...

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We Developed a **Performance Culture**

That...

Rivaled Our Industry's **Safety Culture**?



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# Point of Departure

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- 5 Principles of Project Integration
  - Work and Work Process
  - Organizational Engineering
  - Leadership and Governance
  - Communication and Information Flow
  - Culture and Environment
- Best Practices
- Benchmarking

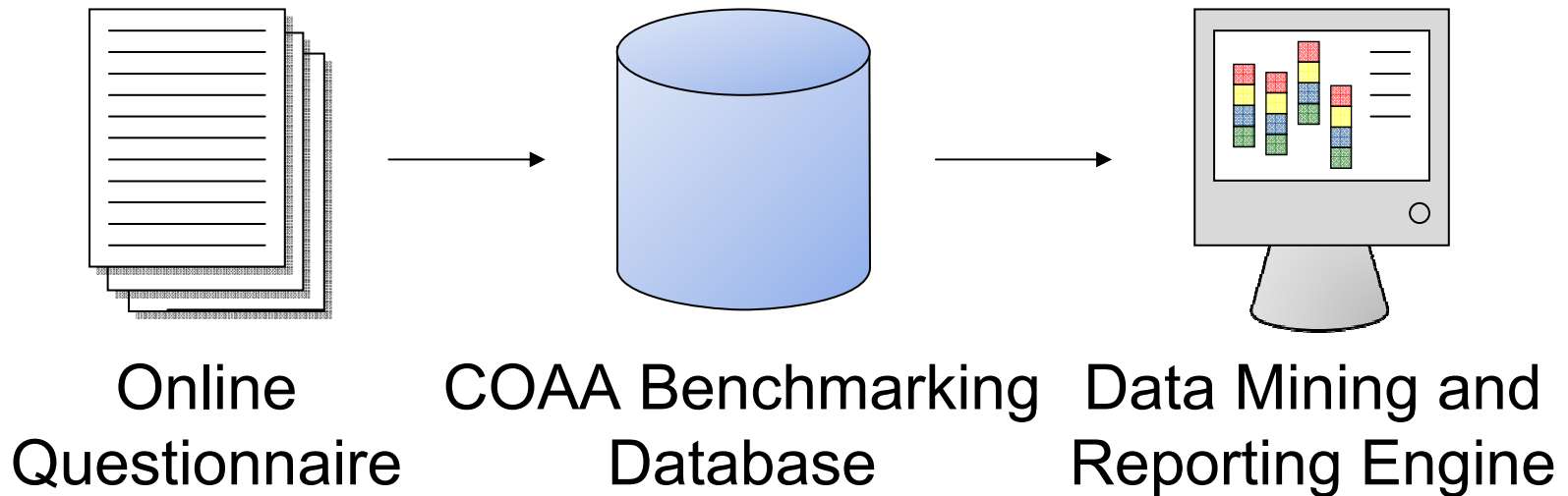


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# COAA / CII Benchmarking Process

## Three-step Process



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# COAA Standard Metrics

## Performance

- Cost Performance
- Schedule Performance
- Safety Performance
- Change Performance
- Rework Performance
- Construction Productivity
- Engineering Productivity

## Practice Use

- Front-End Planning
- Alignment
- Team Building
- Partnering
- Project Risk Management
- Change Management
- Constructability
- Zero Accident Techniques
- Planning for Startup
- Proj. Delivery & Contract Systems
- Benchmarking
- Workface Planning



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# Reporting Best Practice Use Data

## Zero Accidents Techniques

Safety techniques include site specific safety programs and implementation, and auditing and incentive efforts to create a project environment and a level of training that embraces the mind set that all accidents are preventable, and that zero accidents are an obtainable goal.

Was there a written site specific safety plan for this project?		
No	Yes	Don't Know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Which of the following best describes the time commitment of the site safety supervisor for this project?			
No site safety supervisor	Part-time function	Full-time function	Don't Know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Overall how many workers per safety person were typically (i.e., in terms of the average workforce) on site?					
Over 200	150 to 200	70 to 150	20 to 70	1 to 20	Don't Know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How extensive was the job-specific safety orientation conducted for new contractor and subcontractor employees?						
Not at All, Inadequate			Cursory Orientation		Extensive Orientation	
1	2	3	4	5	6	7
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

On average how much ongoing <u>formal</u> safety training did workers receive <u>each month</u> ?					
None	Less than 1 hour/month	1 hour to 5 hours/month	5 hours to 8 hours/month	More than 8 hours/month	Don't Know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

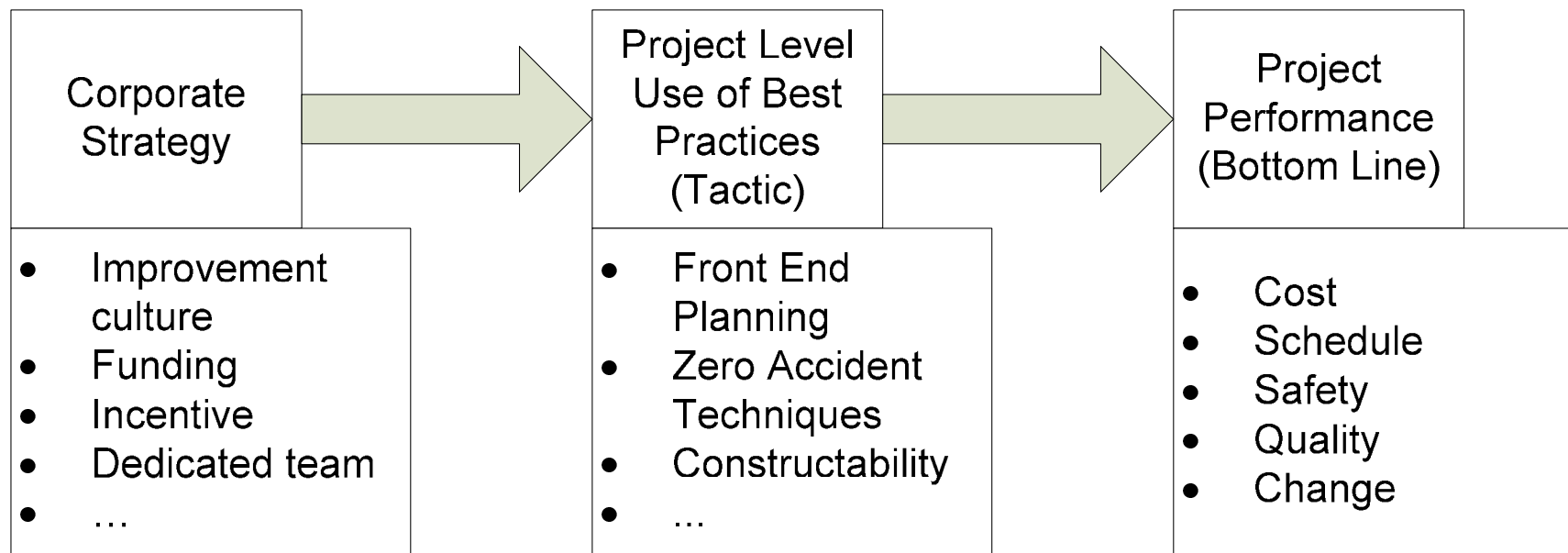
On average, how often were <u>safety toolbox meetings</u> held?						
2 + Times Per Day	Daily	Several time per Week	Weekly	Monthly	None were held	Don't Know
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



# Use of Best Practices

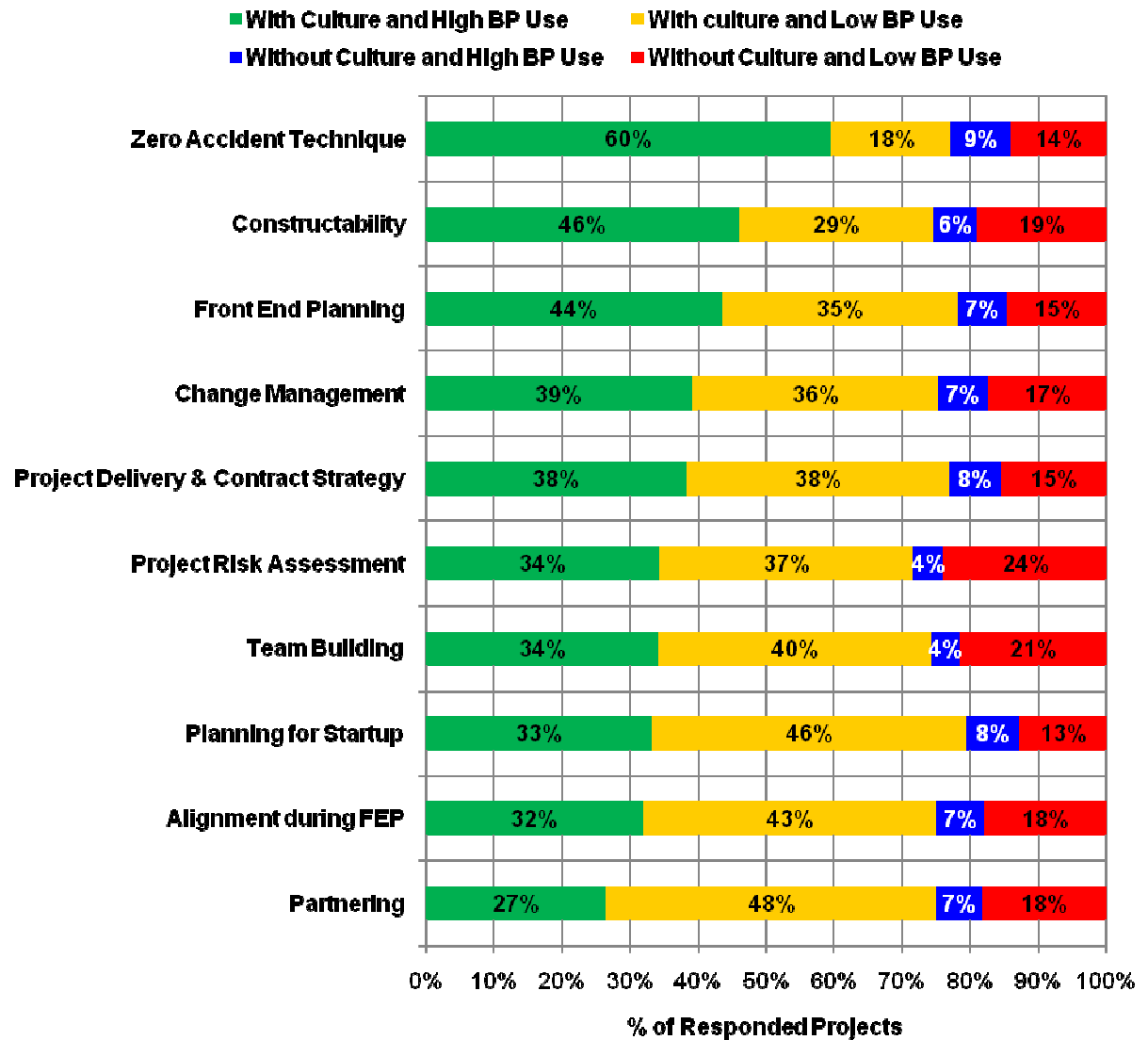
Begins with the 5 PI's (Culture, Leadership)

Ends with Improved Performance

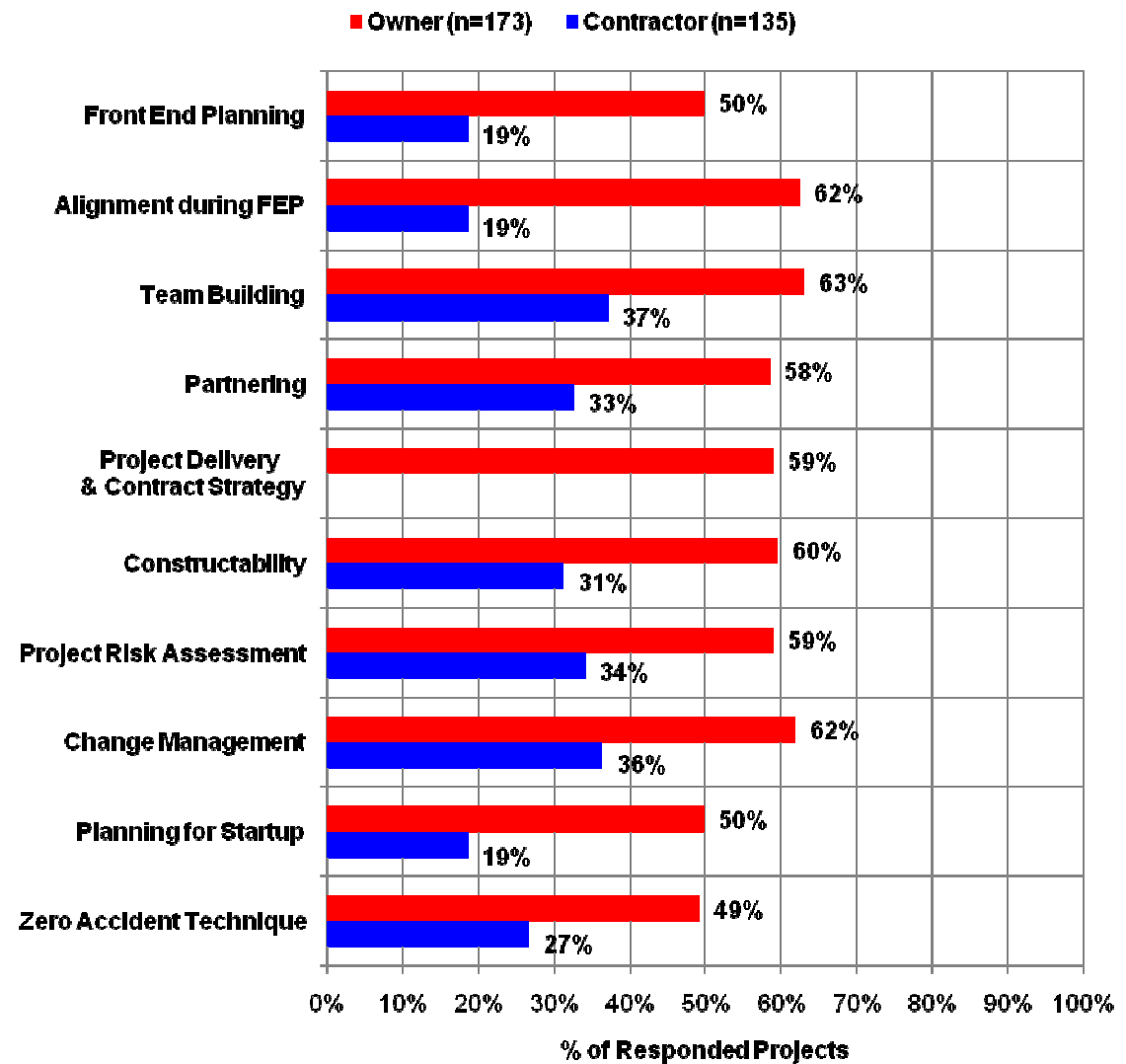


# Culture

A relationship exists between culture and best practice use



# Project Response Rate

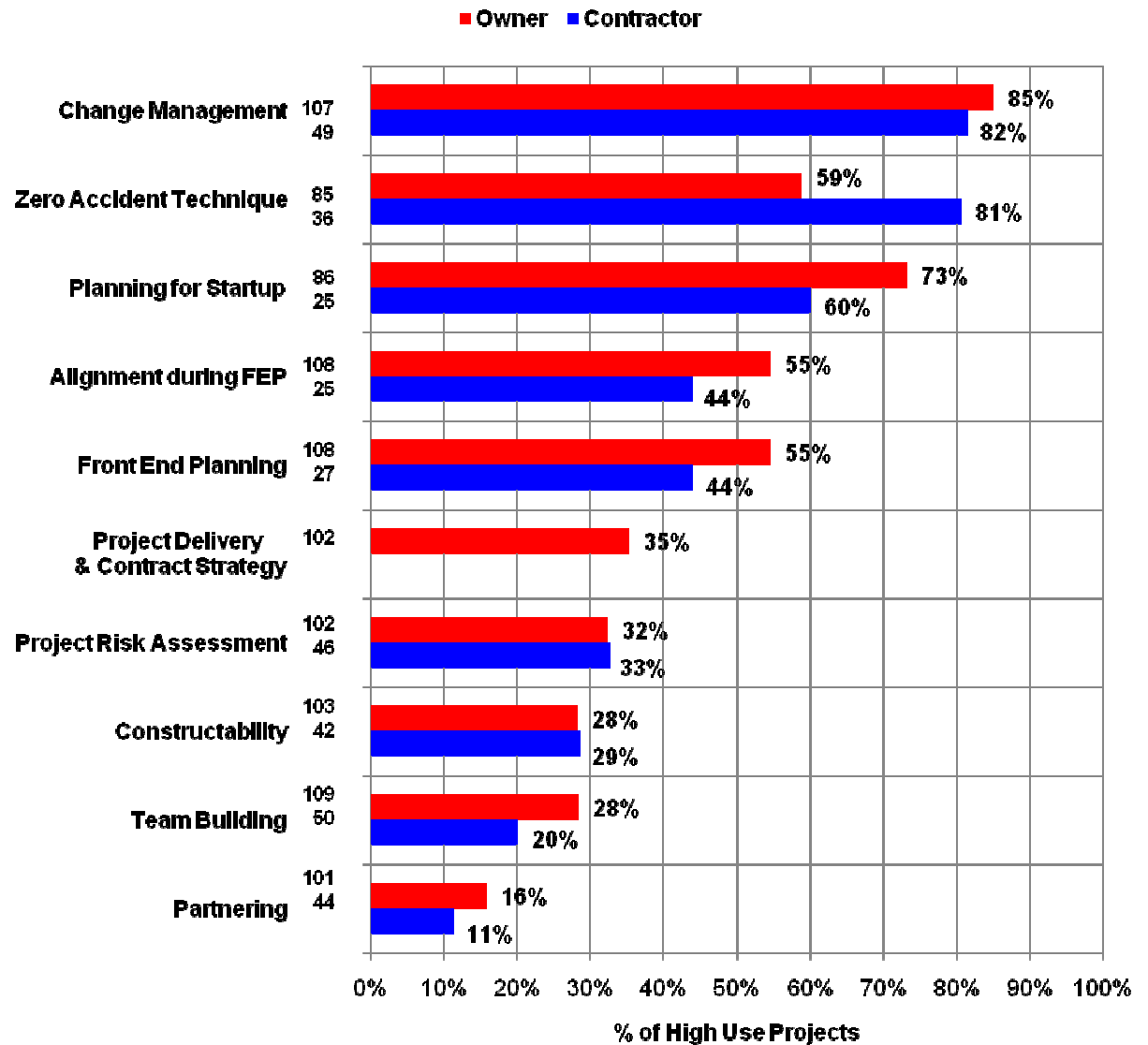


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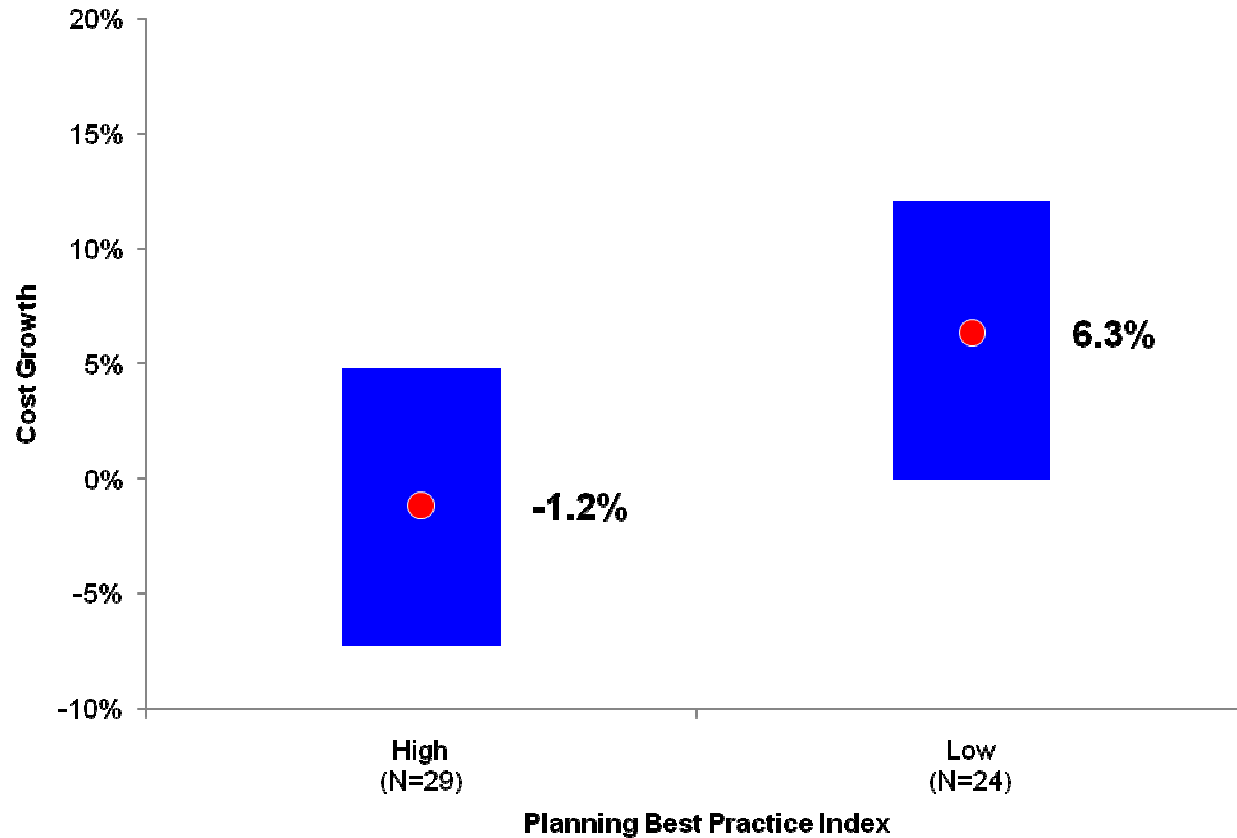
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# Project Response Rate

Percent of Projects with High Best Practice Use



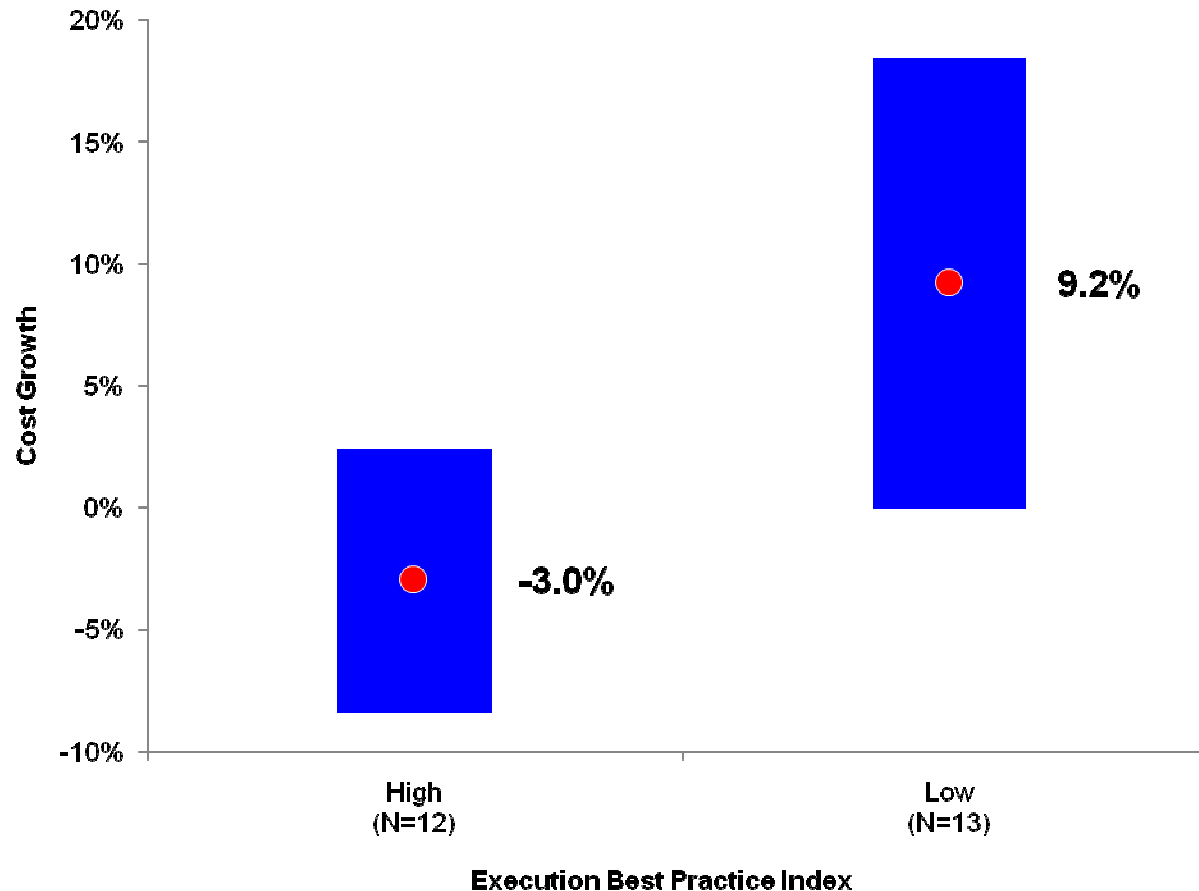
# Owners Plan\*



\*FEP, Alignment During FEP, Planning for Startup



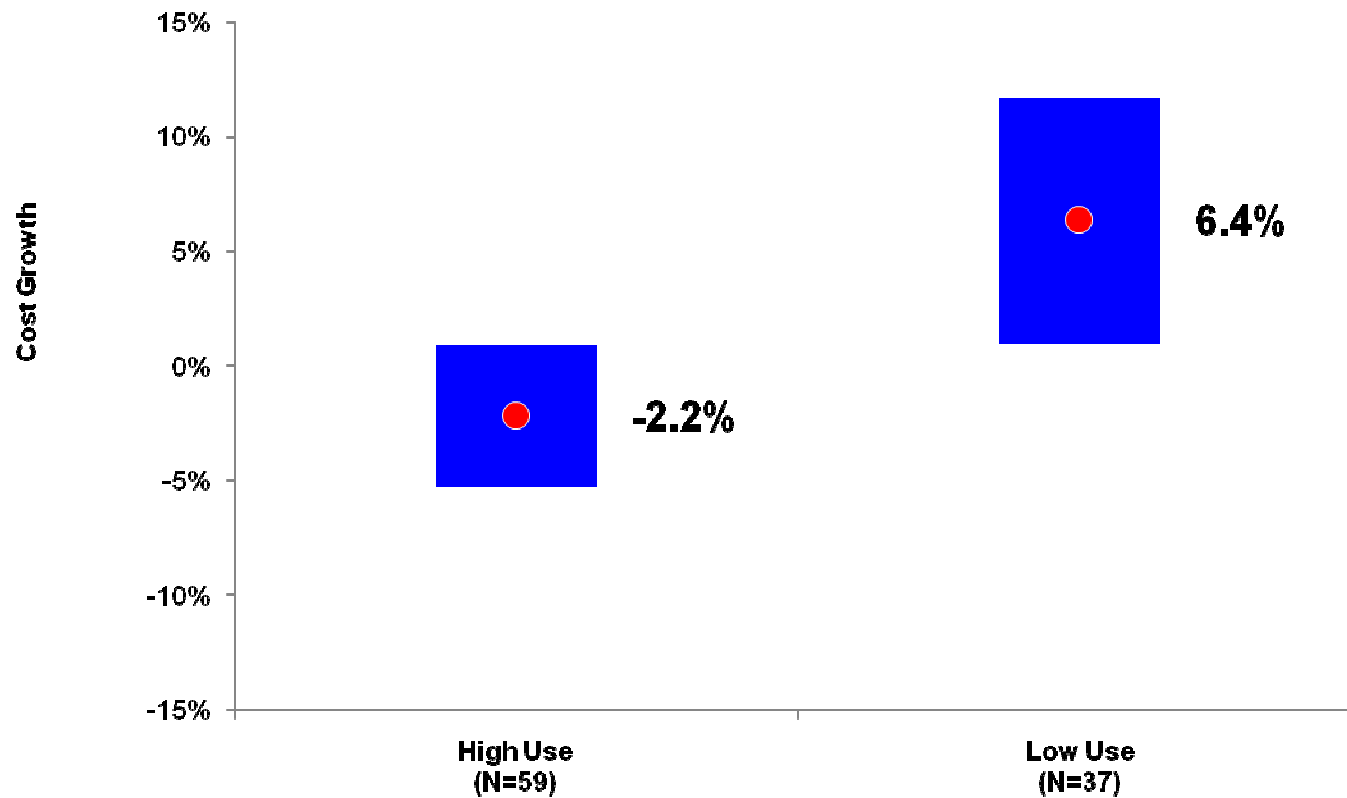
# Contractors Execute\*



\*Constructability, PRA, Change Management



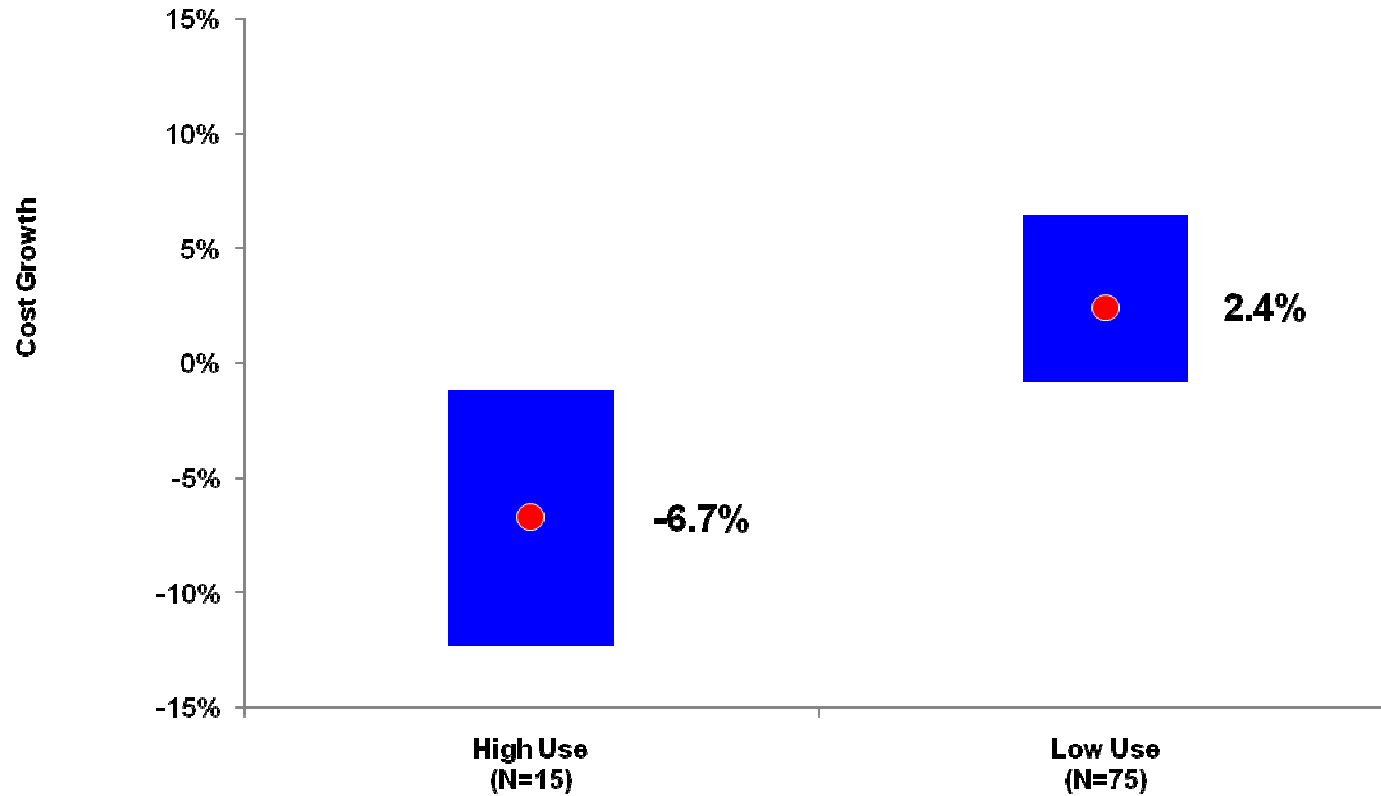
# Owners Use of Front End Planning



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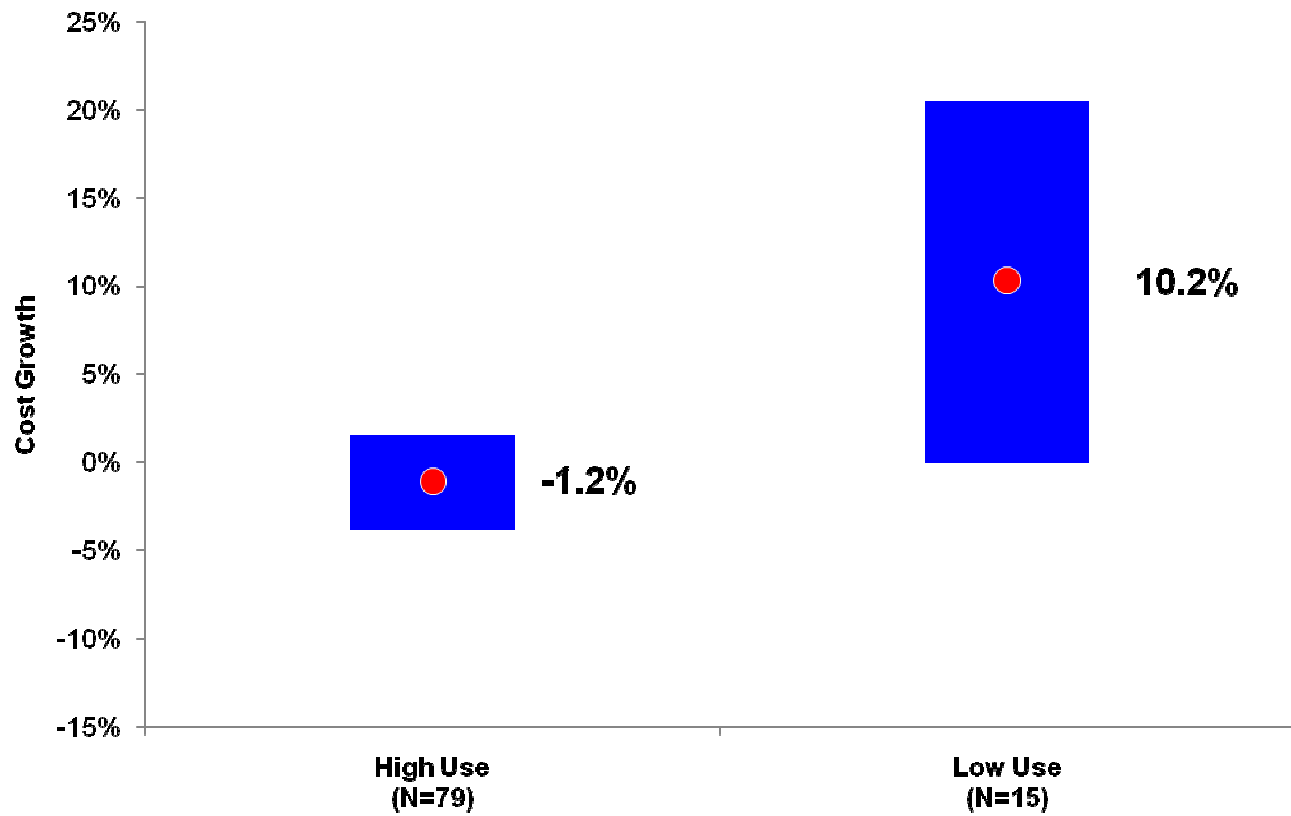
# Owners Use of Partnering



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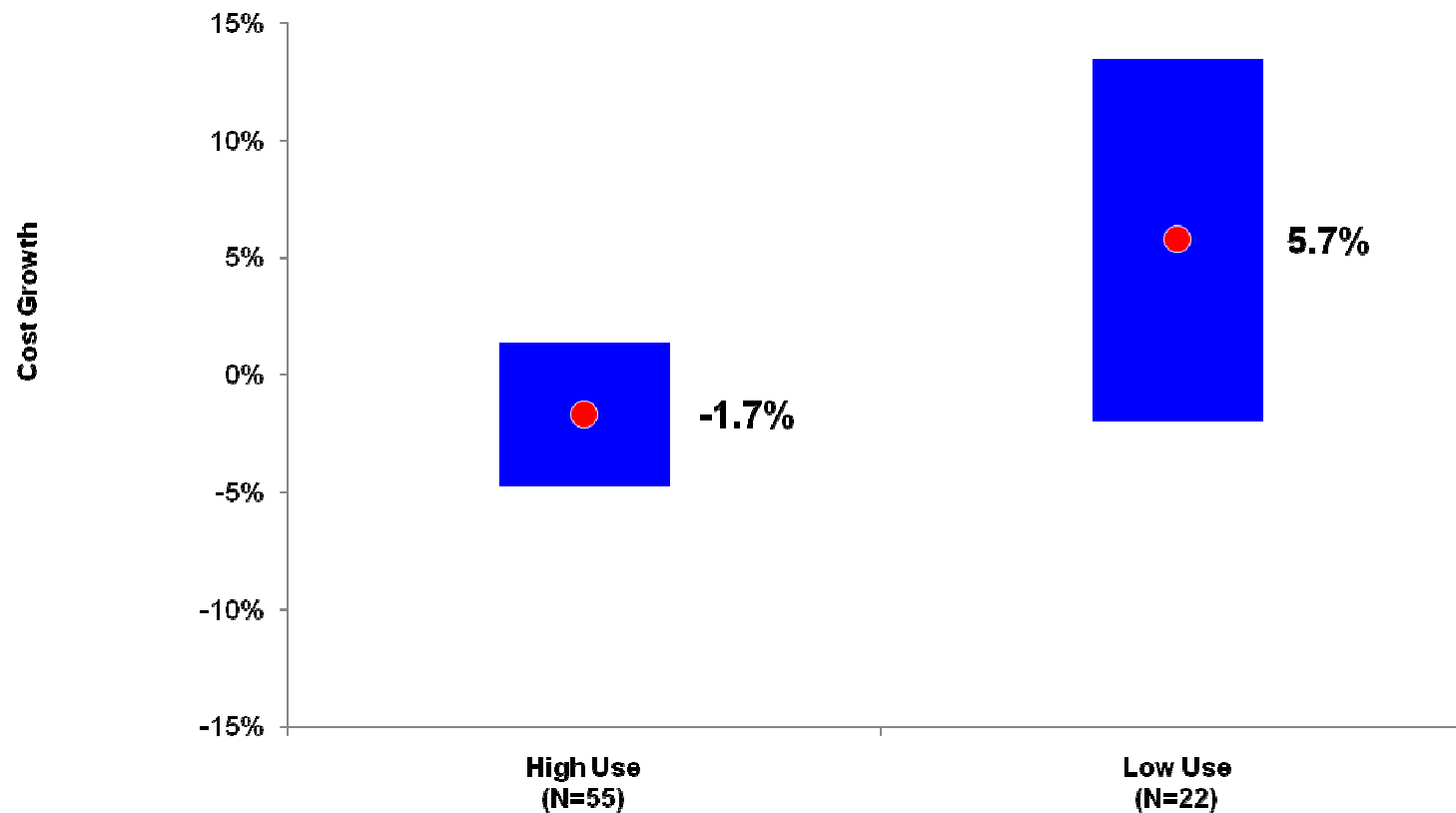
# Owners Use of Change Management



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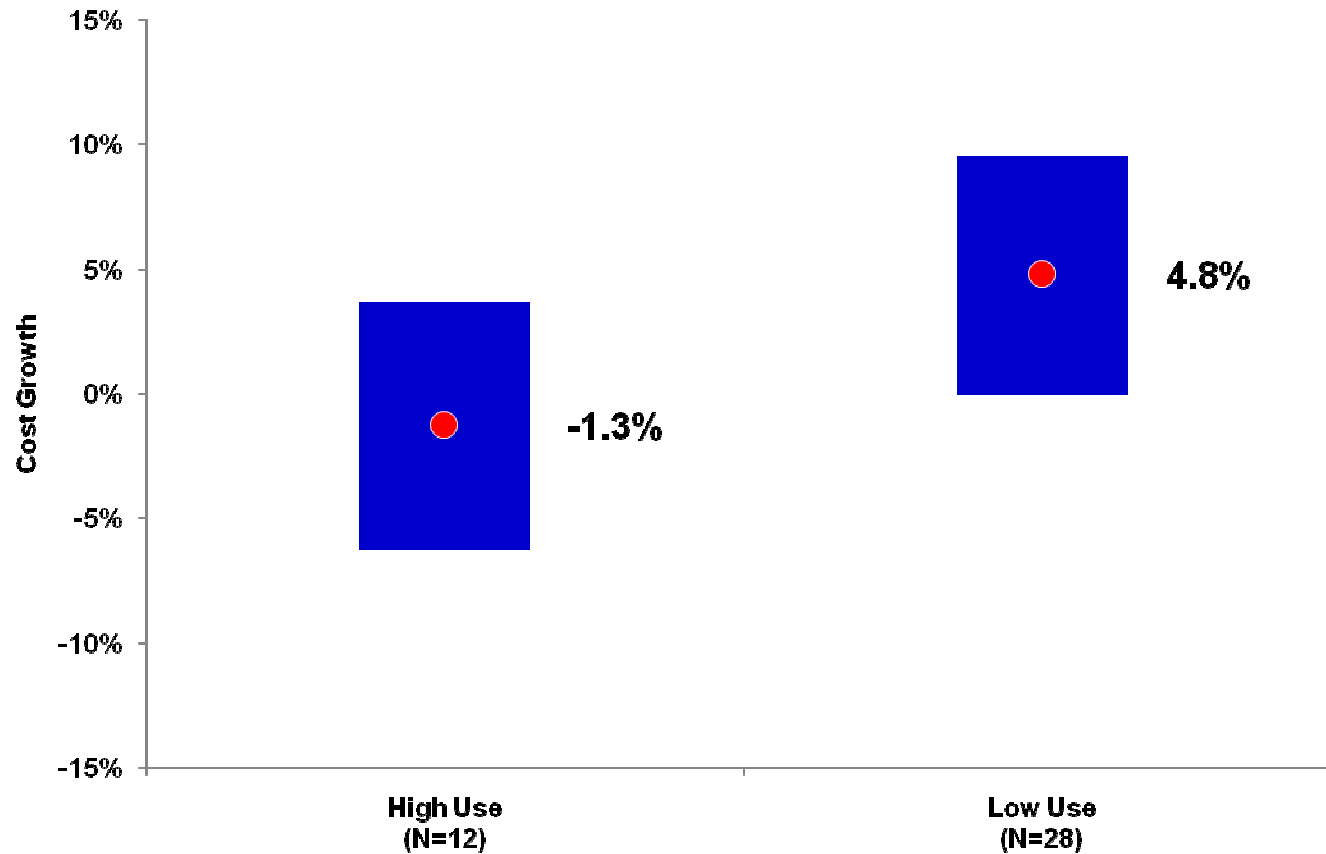
# Owners Use of Planning for Startup



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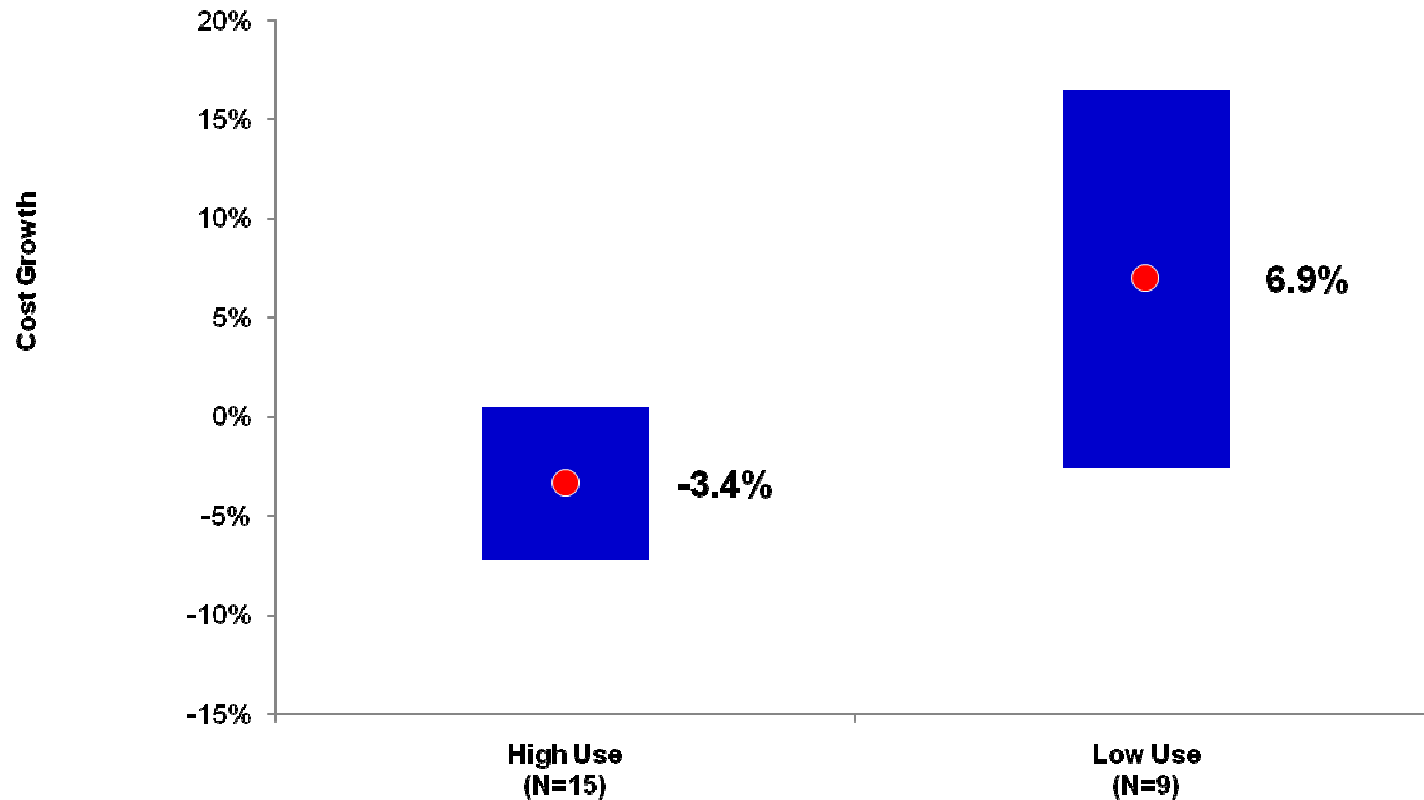
# Contractors Use of Constructability



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# Contractors Use of Planning for Startup



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# Main Findings

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- Implementation of Practices is Differential Between Owners and Contractors
  - All 14 Should Not be Applied Universally
  - Change to CII Implementation Philosophy
- Partnering is Biggest Surprise
- On Average, Owners Have 20.4% Unrealized Cost Performance (Contractors, not as much)
- CII Best Practices Show Little Schedule Advantage (same as previous studies / research opportunity)
- Other (TBD)



# NextGen Benchmarking System

- 24/7 Data Mining (Entire Questionnaire)
- Expanded Key Report
- Level 1 Engineering and Construction Productivity
- Internal (Business Unit, Product Line) Benchmarks
- Instant Feedback with Quarterly Quartile Updates
- Performance Assessment Lab (University of Calgary)



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# NextGen System – Key Report

- Key Report Format
  - Progress Key (with Quarterly Updates)
  - Eliminate Percentile Bar and Chart (Confusing)
  - Proposed
    - Score (ex. 0.069)
    - Quartile (ex. 2Q)
    - Percentile (ex. 60%)
    - Comparison Criteria Listed (Not in Appendix)

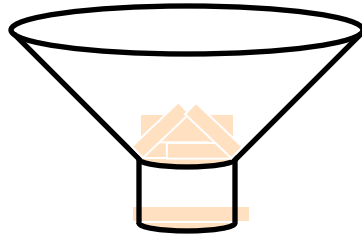
Cost Performance									
Metric	Project Score	Database Mean	Quartile	Percentile	Comparison criteria				
					Industry Group	Project Type	Project Nature	Cost	n
Project Cost Growth	0.069	-0.022	4Q	20%	Infrastructure	All	Grass Roots	15-50MM	24
Delta Cost Growth	0.069	0.083	2Q	60%	Infrastructure	All	Grass Roots	15-50MM	24



# Project-Level Productivity

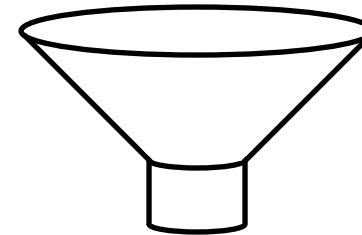
## DISCIPLINE-LEVEL PRODUCTIVITY

Electrical Engineering Productivity  
Instrumentation Engr. Productivity  
Concrete Engineering Productivity  
Structural Steel Engr. Productivity  
Piping Engineering Productivity  
Equipment Engr. Productivity



**ENGINEERING  
PRODUCTIVITY**

Instrumentation Field Productivity  
Structural Steel Field Productivity  
Scaffolding Field Productivity  
Equipment Field Productivity  
Insulation Field Productivity  
Electrical Field Productivity  
Concrete Field Productivity  
Piping Field Productivity



**CONSTRUCTION  
PRODUCTIVITY**

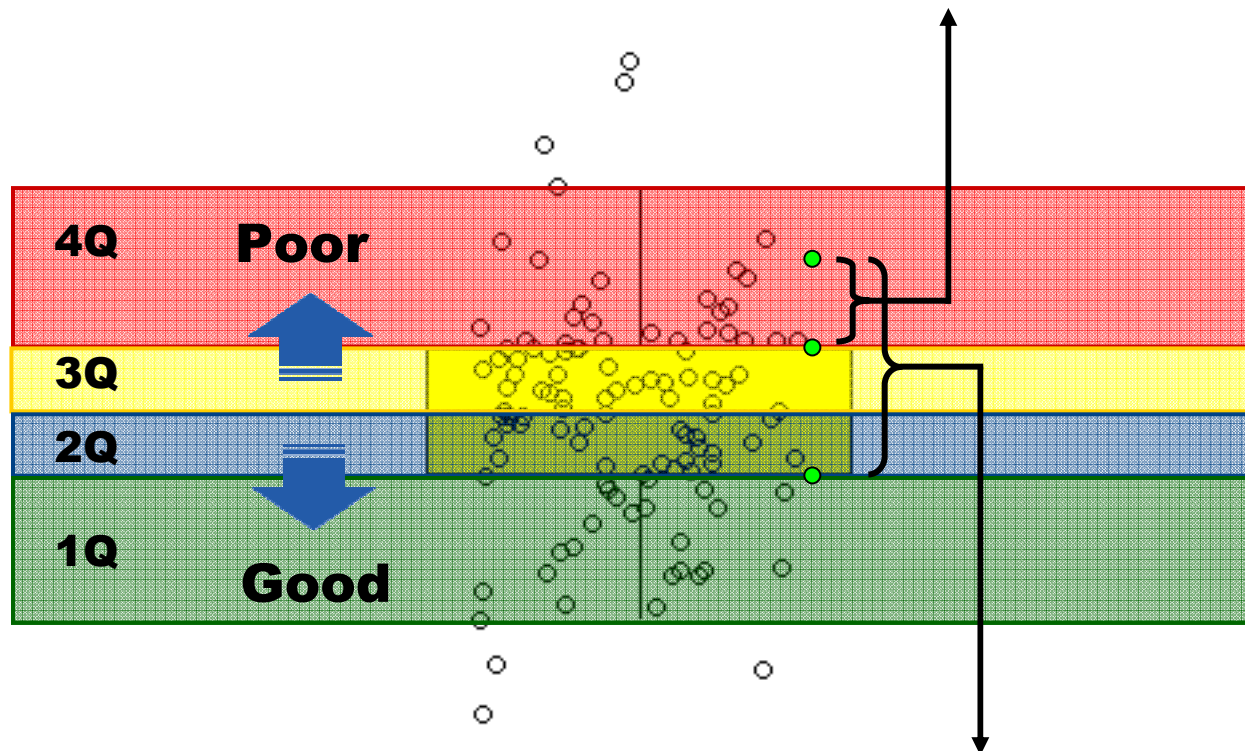


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# Project-Level Productivity Example

- 11% Improvement (4<sup>th</sup> to 3<sup>rd</sup> Quartile)



- 26% Improvement (4<sup>th</sup> to 1<sup>st</sup> Quartile)



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# 24/7 Data Mining

- Chart-o-Rama (Step 1)

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Project Central | CII Main Site

## Chart o Rama

v2.02 beta

### 1. Output Format

Dr. Jikun Dai, Construction Industry Institute

Please select which type of Project Output you would like to generate.

**Chart** **Key Report**

**Without Projects** **With Projects**

**Pharma Dashboard**

873 Projects Available for Charting

**Reset Data**  
**Submit**

2. Enter information



# 24/7 Data Mining

- Chart-o-Rama (Step 2)

The screenshot displays the 'Chart-o-Rama' web application interface. At the top, the CII Construction Industry Institute logo is on the left, and the tagline 'The Knowledge Leader for Project Success' is on the right. Below the logo, the text 'Project Central | CII Main Site' is visible. The main heading 'Chart-o-Rama' is prominently displayed. A navigation bar includes '1. Output Format' and '2. Enter Information'. Under '2. Enter Information', there are tabs for 'Projects', 'Comparison Basis', and 'Metrics'. The 'Main Comparisons' section contains several filter categories with radio button options: 'Respondent' (Owner, Contractor), 'Cost Category' (All, <= \$5MM, \$5MM - \$15MM, \$15MM - \$50MM, \$50MM - \$100MM, > \$100MM), 'Industry Group' (All, Heavy Industrial, Light Industrial, Buildings, Infrastructure), 'Project Nature' (All, Grass Roots, Modernization, Addition), and 'Project Location' (All, International, US & Canada). On the right side, a vertical panel shows '873 Projects Available for Charting' and buttons for 'Reset Data' and 'Submit'. A version indicator 'v2.02 beta' is located in the top right corner.



# 24/7 Data Mining

- Chart-o-Rama (Step 3)

The screenshot displays the Chart-o-Rama web application interface. At the top left is the CII Construction Industry Institute logo. To the right is the tagline 'The Knowledge Leader for Project Success' with subtext 'Owners • Contractors • Academics'. Below this is 'Project Central | CII Main Site'. The main title 'Chart-o-Rama' is prominently displayed. A 'Help' icon and 'v2.02 beta' version number are in the top right. The interface is divided into two main sections: '1. Output Format' and '2. Enter Information'. Under '2. Enter Information', there are three tabs: 'Projects', 'Comparison Basis', and 'Metrics'. The 'Metrics' tab is active, showing a tree view of metrics. The 'Cost' category is expanded, listing various metrics such as 'Project Cost Growth', 'Project Budget Factor', 'Delta Project Cost Growth', 'Delta Project Budget Factor', 'Design Phase Cost Growth', 'Procurement Phase Cost Growth', 'Construction Phase Cost Growth', 'FEP Phase Cost Factor', 'Design Phase Cost Factor', 'Procurement Phase Cost Factor', 'Construction Phase Cost Factor', and 'Startup Phase Cost Factor'. Other categories like 'Design', 'Schedule', 'Changes', 'Rework', 'Safety', and 'Practices' are also visible. On the right side of the interface, a box indicates '873 Projects Available for Charting'. At the bottom right, there are two buttons: 'Reset Data' and 'Submit'.

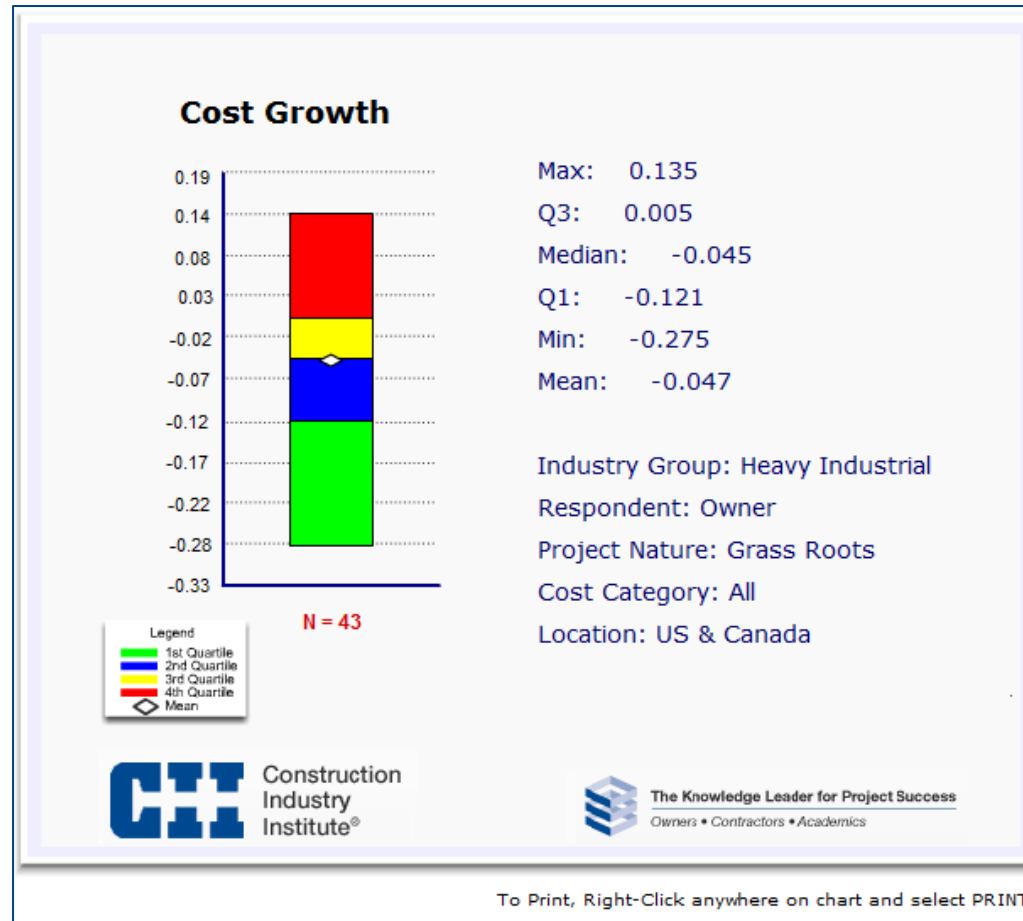


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# 24/7 Data Mining

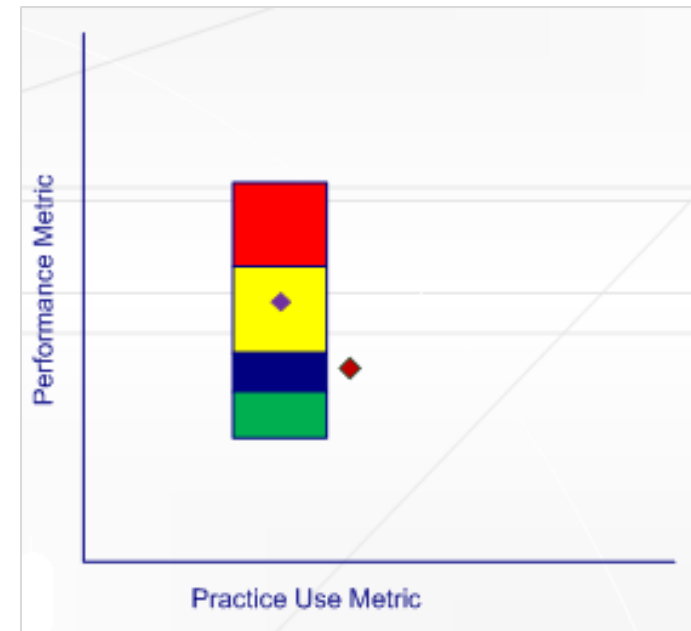
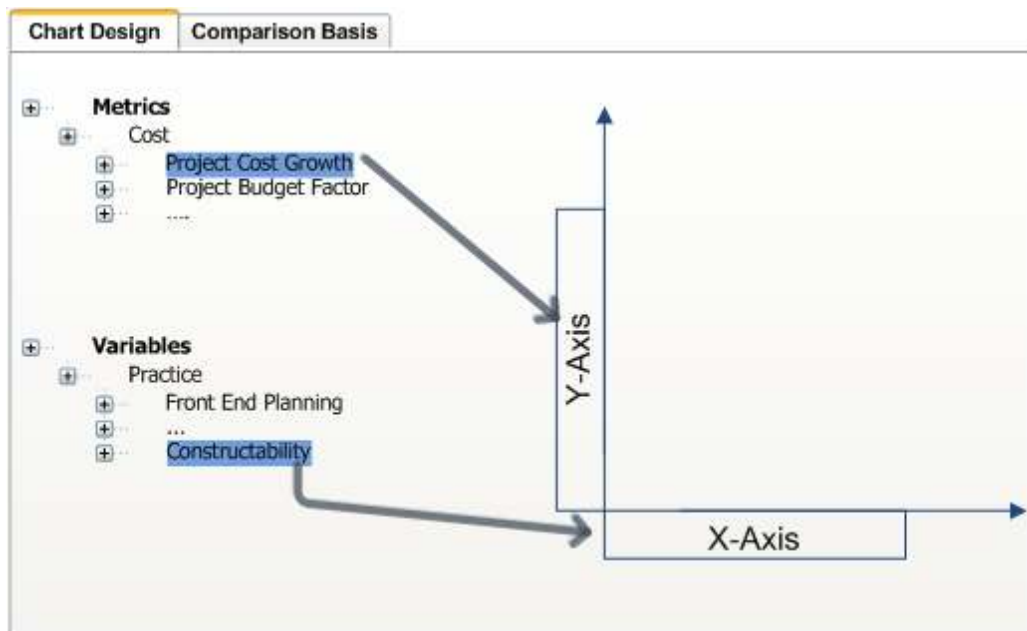
- Chart-o-Rama (Step 4)



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# 24/7 Data Mining

- Construct **ANY** Comparison (by Sector / PAL)
  - Metric vs. Metric, Variable, or Criteria
  - **1<sup>st</sup> of its Kind**
  - **Informs Research**

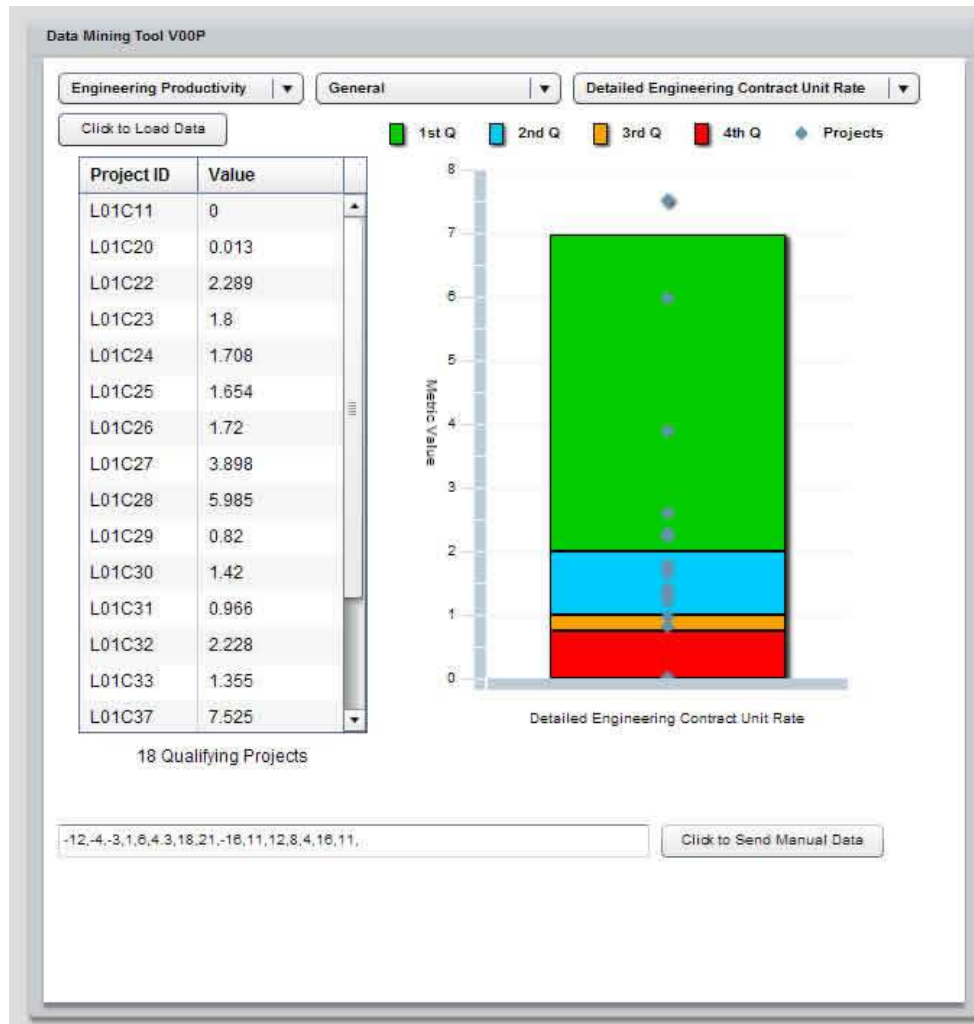


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# 24/7 Data Mining

- Programming in Progress



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# NextGen System (Company Hierarchy)

Home Page | Learn | Create a Project | View/Edit Projects | My Account | Help | Logout

### Hierarchy Control Panel

Company | Business Unit | Product Line

Country / State / City

- United States
  - Texas
    - Austin**
    - Dallas
    - Houston
  - Florida
  - California
- Brazil
- United Kingdom
- Canada

### Hierarchy Editor

#### Project Assignments

Assigned Projects:

Project ID	Project Name	Status
L01C23	A BRAN NEW PROJECT	In Progress
L01C24	Another Test	In Progress
L01C26	Fixed Structure	In Progress

Your Unassigned Projects:

Project ID	Project Name	Status
L01C10	me 123	In Progress
L01C13	125	In Progress
L01C15	Test Project 1234	In Progress
L01C16	Binary Thinking	In Progress
L01C17	PMTes't's project	In Progress
L01C22	Fun Times	In Progress
L01C25	Still more	In Progress
L01C27	HULL	In Progress
L01C28	Topside Accomod	In Progress
L01C29	Topside Flare	In Progress

#### User Assignments

- Single Page Setup
- Easily Updated
- Benchmarking Manager
  - Authorized to Setup
  - Authorized to Maintain
- Optional (Only if Company wants Internal Benchmarks)



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# COAA Phase II Development Summary

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- Benchmarking at Sanction & Completion
- Normalization (Cost Index) of Absolute Metrics
- Modularization Metrics for Const. Productivity (\$/m<sup>3</sup>)
- Construction Indirect Cost and Workhours
  - \$ / Construction Indirect WH
  - \$ / Construction Equipment
- Field Rework
- Closeout (Product List) / Production Capacity
- Best Practices, PDRI, Delivery System (EPCM)
- **Pipeline Metrics**
- Other



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# COAA Phase II Development Summary

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- Pipeline Metrics

- Metrics Classifications

- Project Performance & Delivery Strategies
    - Pipeline Construction
    - Productivity
    - Labour

- Analysis Categories/ Project Considerations

- Contract Type and \$ (road ditch, weights/anchors, concrete coating, crossings)
    - Workday/Equipment Type
    - Labour Pool (union/merit, CLAC)
    - Shift Schedule (WH/day, days/week)
    - Worker Accommodations (camp, travel allowance)



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# COAA Phase II Development Summary

- Pipeline Metrics (Project Performance & Delivery Strategy)
  - \$Pipe/TIC, \$Pipe/Km
  - \$TIC/Dia.(inch)/ mile
  - \$Construction Cost/dia. (inch)/mile
  - Capacity (m<sup>3</sup>/day)
  - \$Owner PM/TIC
  - \$Owner PM/Construction Cost
  - \$Engineering Cost/km and \$Engineering Cost/TIC
  - \$Permit Fee/TIC
  - \$Land Cost/km
  - \$Environmental Studies & Monitoring/TIC
  - \$Environmental Studies & Monitoring/km



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# COAA Phase II Development Summary

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- Pipeline Metrics (Productivity)
  - Weld cm<sup>3</sup>/Wh or Weld/Day (segmented by pipe diameter)
  - Wh/km
  - Km/day
  - Indirect Wh/Direct WH
  - Peak Indirect Wh/Direct Wh
  - Other?



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# University of Calgary (PAL)

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- COAA Phase II
- Dedicated Server at Univ. of Calgary
- Faculty Involved:
  - Dr. George Jergeas
  - Dr. Janaka Ruwanpura
  - Dr. Jim Lozon (Postdoc)
- Research (2 Graduate Students)
  - COAA Metrics / Additional Development
  - Pipeline Projects
  - Other?
- Here to Help You



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# CII Sector-Specific Research

- Current
  - Pharmaceutical
  - D/S Oil & Gas
  - Oil Sands (COAA)
  - U/S Oil & Gas
  - Healthcare Facilities
- Future
  - (Nuclear) Power
  - Aviation Facilities
  - Others



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# CII PAL Global Network

- ★ Upstream O&G
- ★ Downstream O&G

- ★ Pharma / Biotech
- ★ Healthcare

- ★ General Program
- ★ Oil Sands



## FUTURE

- ★ Power
- ★ Aviation

- ★ High Tech
- ★ Chemicals

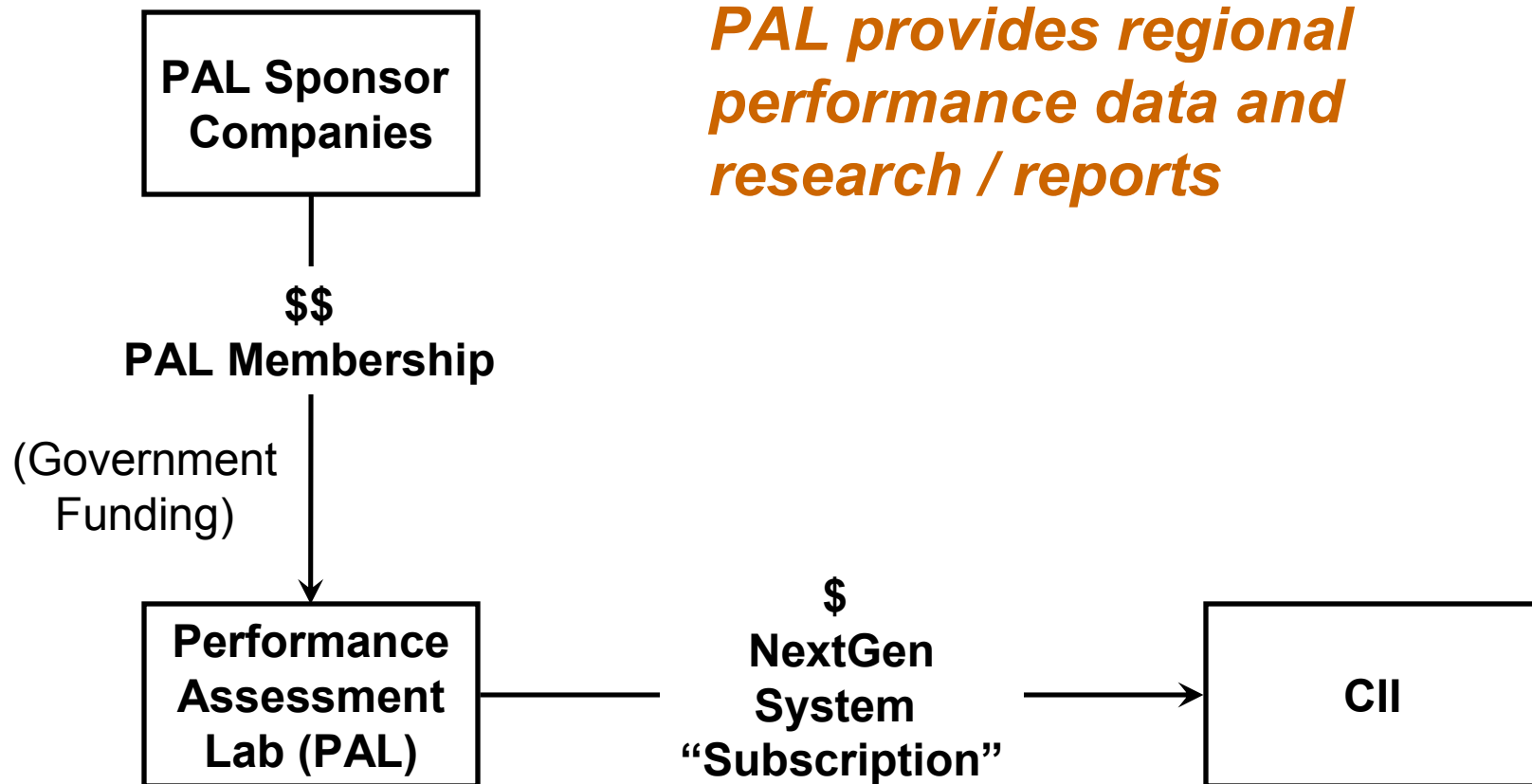
- ★ Food / Beverage
- ★ Metals & Mining



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# PAL Financial Model



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# CII NextGen System

## (Performance Assessment Lab (PAL))



Universidade  
Federal  
Fluminense



Prominp



Construction  
Industry  
Institute®

Performance Assessment Lab

[Home Page](#) | [Learn](#) | [Login](#) | [Help](#)



### Bem vindo ao laboratório de avaliação de performance

Bem vindo a home page do laboratório de avaliação de projetos upstream de óleo e gás. Este é o portal para compreensíveis informações sobre a performance dos projetos upstream de capital. Neste site, você poderá inserir dados dos projetos, assim como, obter análises e comparações detalhadas dos projetos passados e futuros. Qualquer empresa fazendo negócio no setor de Óleo e Gás é bem vinda à participar do programa através do contato com a Universidade Federal Fluminense.

O laboratório de avaliação de projetos upstream de óleo e gás é um projeto de pesquisa reunindo a Universidade Federal Fluminense, the Construction Industry Institute e The University of Texas at Austin. Questões envolvendo a pesquisa devem ser endereçadas para a Universidade Federal Fluminense.






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# CII NextGen System

(Performance Assessment Lab (PAL))




Universidade  
Federal  
Fluminense



Prominp



L01019  
Upsilon Project B  
Company Upsilon  
Upsilon BM  
Logged in as Master Lab



Construction  
Industry  
Institute®

Performance Assessment Lab

[Current Questionnaire](#) | [Learn](#) | [Create a Project](#) | [View/Edit Projects](#) | [My Account](#) | [Help](#) | [Logout](#)

  **5. Custo do Projeto**

[Custo do Componente](#) | [Custo por Fase](#) | [Custo das Alterações](#) | [Custo do Retrabalho](#)

### 5.3 Custo Direto do Retrabalho no Campo

5.3.1 Se você conduziu algum retrabalho de campo, indique o seu custo Direto com o retrabalho. Este custo direto relata todos os custos necessários para o desempenho do retrabalho. Se não há custo direto ou impacto no cronograma pelo retrabalho no campo, favor colocar zero.

Custo Direto do retrabalho no Campo: \$

---

5.3.2 Total de Horas de retrabalho no Campo:



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# Can a Performance Culture Improve Project Performance?



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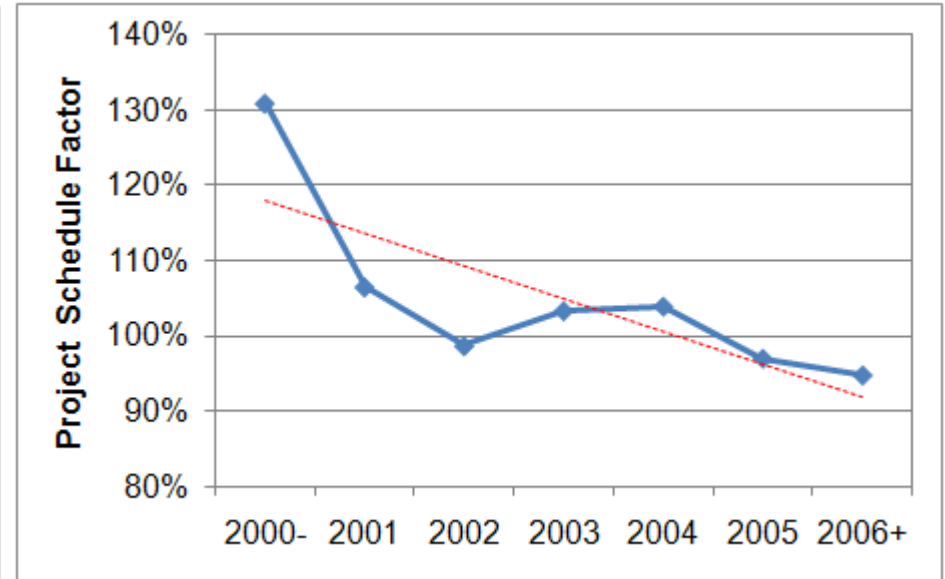
# YES! (Benchmarking + Sector-Specific Research)

## CII Pharmaceutical and Biotech Performance Research



### Cost Performance

**6% Less**



### Schedule Performance

**26% Less**



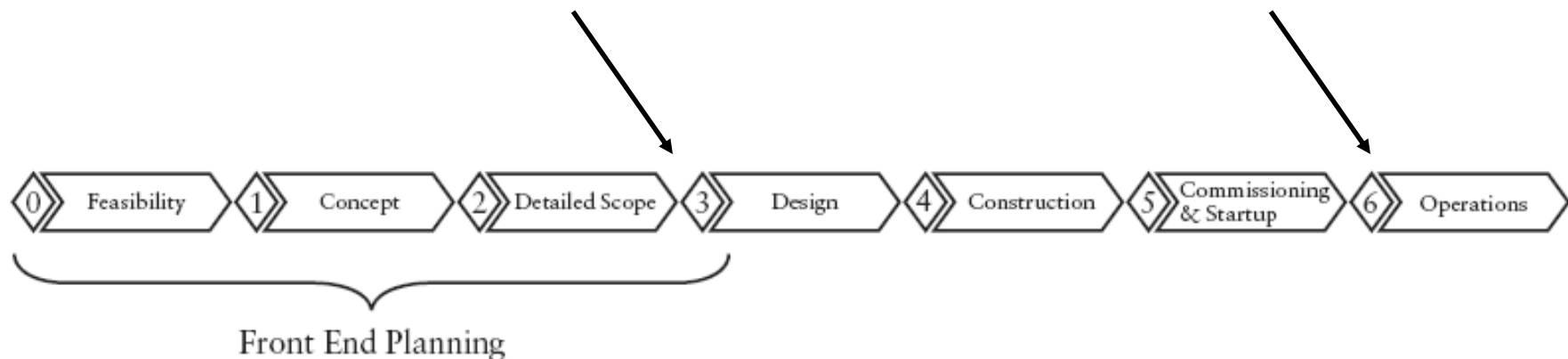
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# How Do We Build a Performance Culture?

- Include COAA Benchmarking In Work Processes
  - Owner's Gated Asset Development Processes
  - Contractor's Operating Procedures Guidebook

**USE COAA BENCHMARKING HERE**



# Questions?

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# COAA Phase II Development Summary

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- Types of Pipeline Projects
  - Product – Oil, Gas
  - Terrain Type- Rock, Clay, Sand/Gravel, Muskeg
  - Wall Thickness- Line pipe, Heavy wall
  - Installation- String, Weld, Joint coating, Lower in
  - Other?



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# COAA Phase II Development Summary

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- Pipeline Project Considerations
  - By Product: Oil, Gas- Sweet, Sour, etc.
  - By Project Type: Green field, Looping program, Parallel foreign pipeline, etc.
  - By Siting: By Location, Terrain type
  - By Pipe Spec.:
    - Material, #valves (count)/Km and size of line pipe, mainline etc.
    - Pipe grade
    - Source of pipe: Country vs. Foundry
    - Parallel, Lateral Line
    - Thickness, coating (\$), double jointing, freight (to stockpile), freight (stock pile to coater), freight (coater to stock pile),
    - By Schedule: Spring, Summer, Fall, Winter
    - By Other?



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# COAA Phase II Development Summary

- Pipeline Construction

- Avg. Installed Pipe (km)/Day
- \$ Site Prep. (access and cleaning off right of way)/TIC (freight, clearing, ROW access, etc.)
- % of terrain
- \$ Mainline Construction Cost/TIC (grading, stringing, bending, welding, coating of weld, ditching, Lowering in backfill)
- \$ Mainline Construction Cost/Wh(grading, stringing, bending, welding, coating of weld, ditching, Lowering in backfill)
- \$ Crossing Construction Cost/TIC and /km
- \$ Contractor Safety & Environmental/TIC
- \$ Survey/Km
- \$ Inspection/Km
- \$ Row Restoration/Km
- Other?



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# COAA Phase II Development Summary

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- Pipeline Construction Labour
  - Average Mainline Construction Crew size (by line item)
    - clearing, ditch, grade, bending, tie in, clean up, testing crew)
  - \$ Mainline Construction cost (by line item)/TIC
    - clearing, ditch, grade, bending, tie in, clean up, testing crew)
  - Mainline WH (by line item)/Wh
    - clearing, ditch, grade, bending, tie in, clean up, testing crew)
  - Equipment Cost
    - excavators, side booms, graders, dozers, etc.
  - Other?



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# COAA Phase II Development Summary

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- Other Pipeline Metrics (Under Consideration)
  - # and Size of Crossings
  - Type of Crossings
    - HDD (Horizontal Directional Drilling)
  - Issues
    - %Redundancy
    - Operating Philosophy
    - etc.
  - Target: 30 Key Metrics
  - Questions?



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# Quantifying the Value

- What is the Value of:
  - Informed Decision-Making?
  - Specific Project Knowledge?
  - Project Performance Validation?
  - Best Practices?

