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# Multi-Perspective Assessment Method for Measuring Leading Indicators in Capital Project Benchmarking

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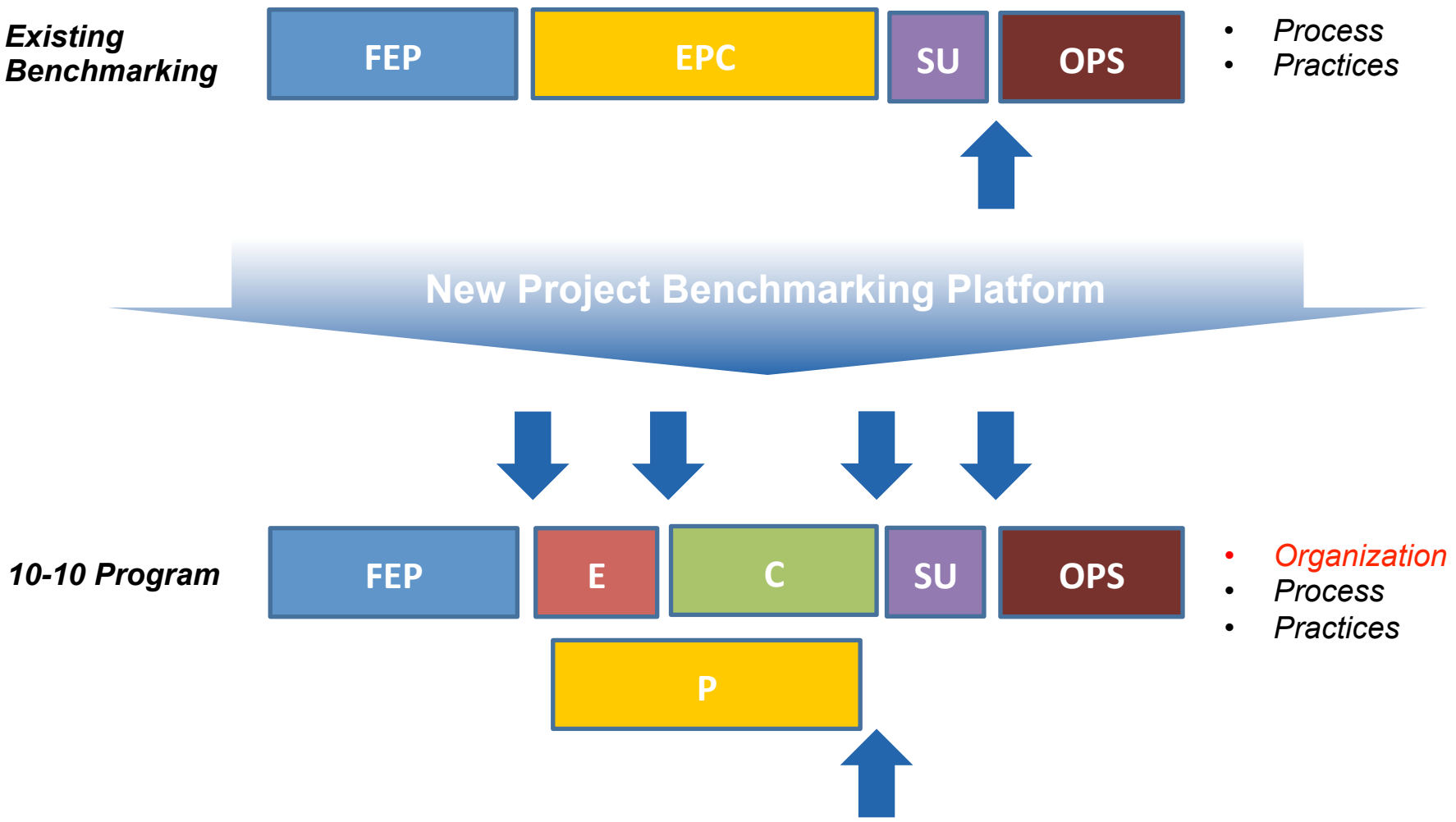
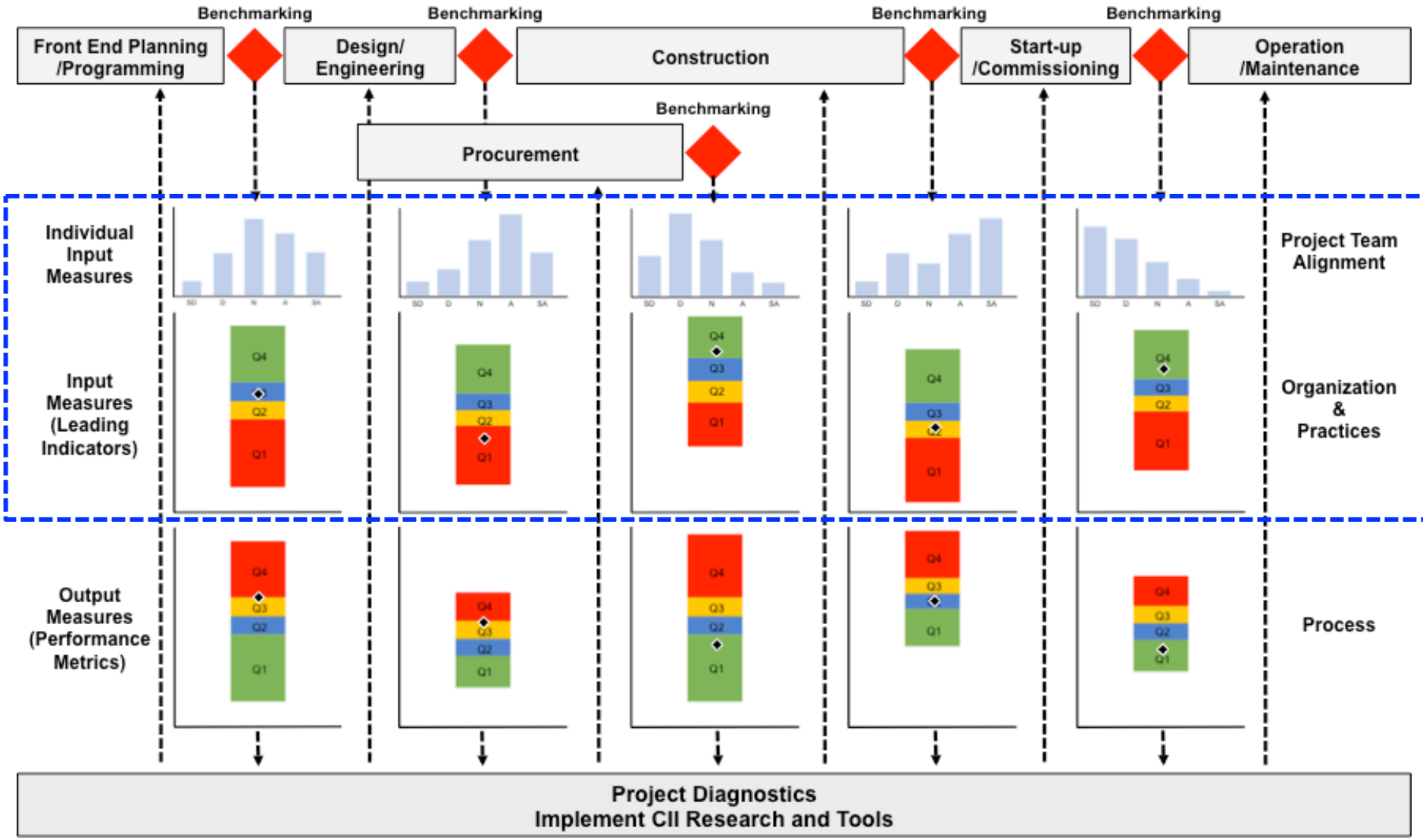
# Outline

- Introduction: CII's 10-10 Program
  - Concept of Phase-Based Benchmarking
  - Multi-Perspective Assessment Framework
- Challenges
- Framework for Measuring Leading Indicators
- Conclusion and Path Forward

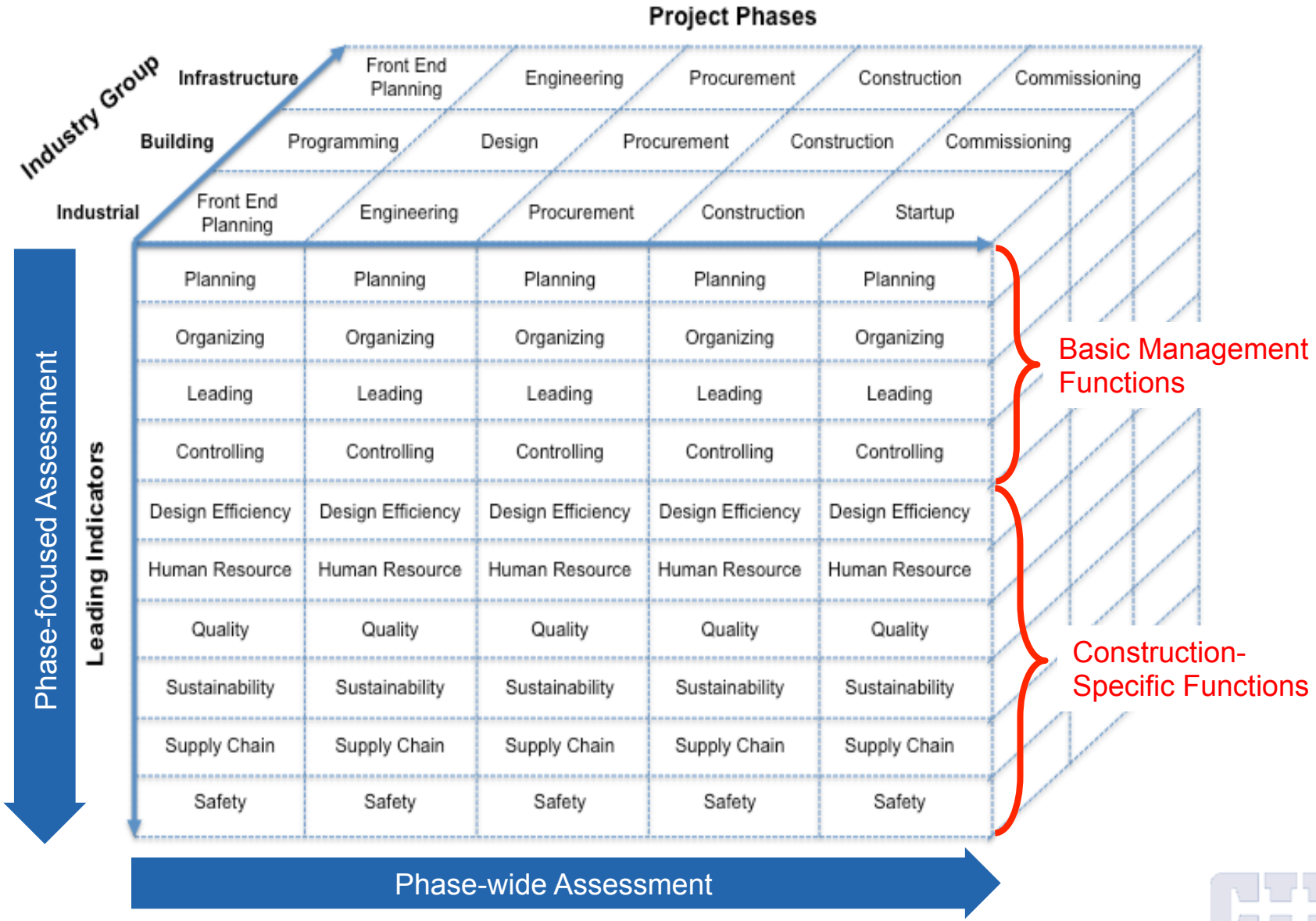
# Introduction: CII's 10-10 Program



# 10-10 Program: Phase-Based Benchmarking



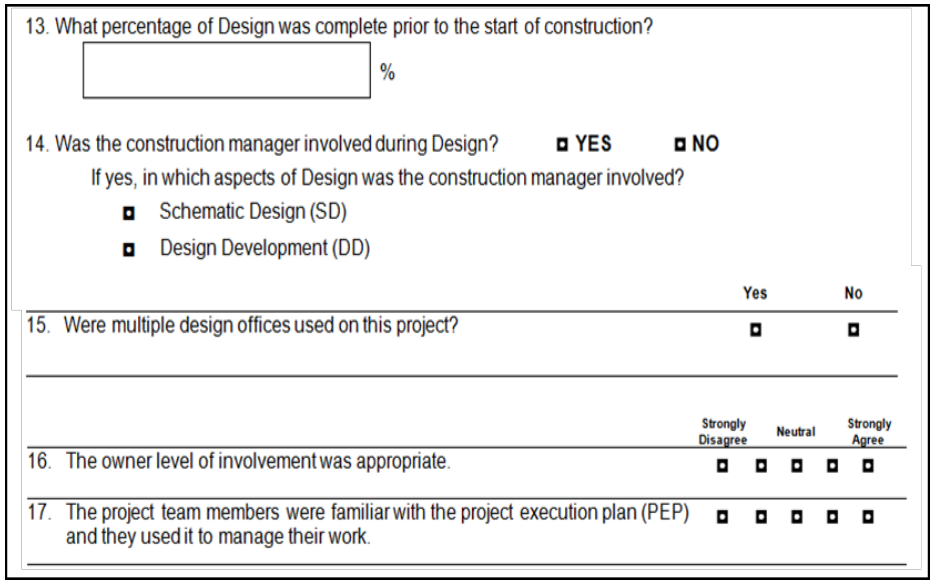
# 10-10 Program: Multi-Perspective Assessment Framework



# Challenges

- Multiple Respondents and Various Data Types
  - Type: Yes/No, single/multiple selections, numeric open-ended, and Likert scale
  - Subjective nature: questions are intentionally subjective by design. *(CII 2013)*
    (less effort in data entry rather than real data such as cost and duration)
  - Data entry from multiple respondents for the section. (*CII 2013, Kang et al. 2014)*
    : Reduce bias from respondents' perceptions by collecting numerous responses

**Data Entry in Survey Instrument**



13. What percentage of Design was complete prior to the start of construction?

    ____ %

14. Was the construction manager involved during Design? ◘ YES ◘ NO

    If yes, in which aspects of Design was the construction manager involved?

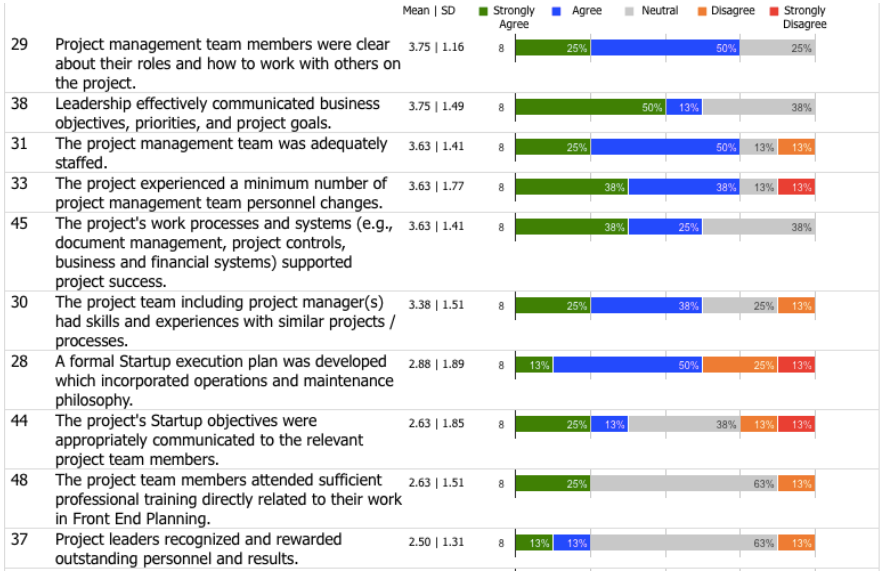
    ◘ Schematic Design (SD)

    ◘ Design Development (DD)

| | Yes | No |
|---|---|---|
| 15. Were multiple design offices used on this project? | ◘ | ◘ |

| | Strongly Disagree | | Neutral | | Strongly Agree |
|---|---|---|---|---|---|
| 16. The owner level of involvement was appropriate. | ◘ | ◘ | ◘ | ◘ | ◘ |
| 17. The project team members were familiar with the project execution plan (PEP) and they used it to manage their work. | ◘ | ◘ | ◘ | ◘ | ◘ |

**Individual Input Measures**

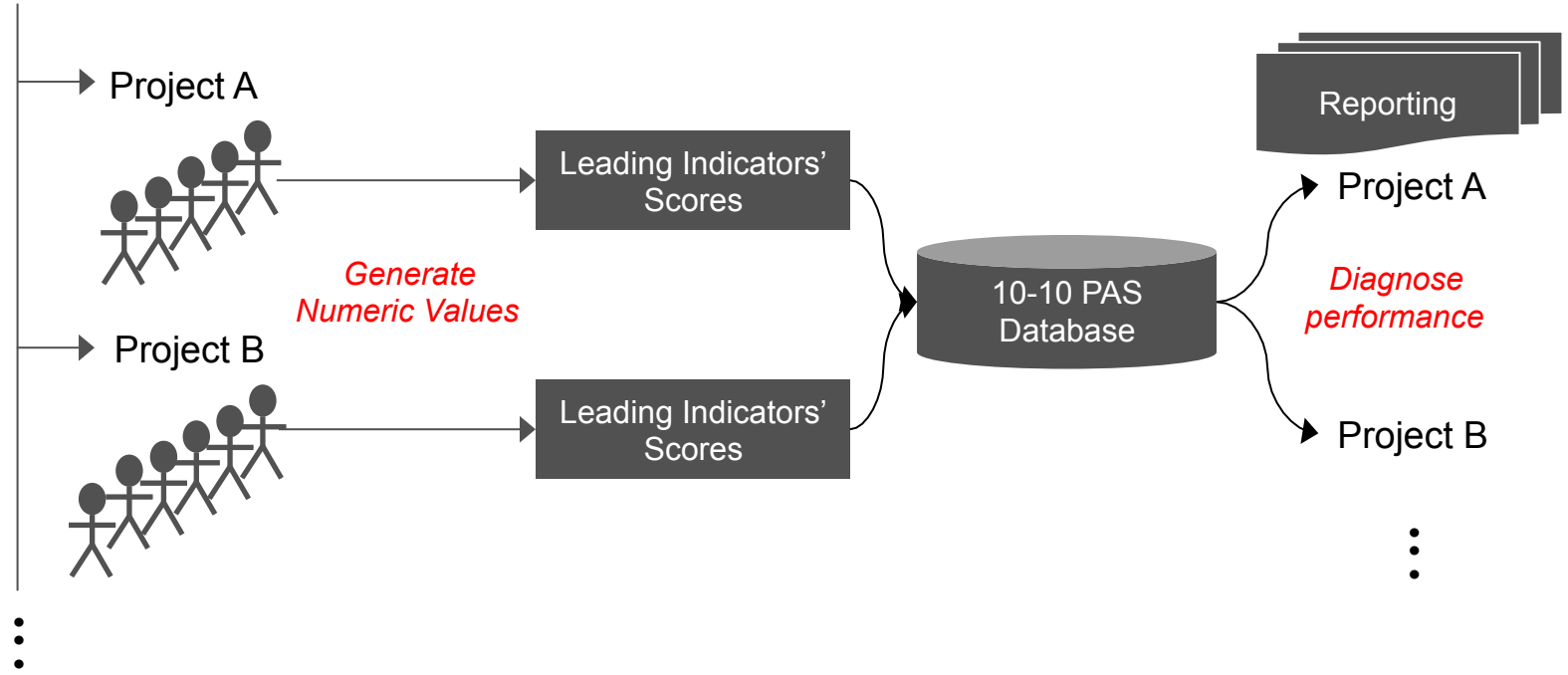


| | | Mean \| SD | | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|---|---|
| 29 | Project management team members were clear about their roles and how to work with others on the project. | 3.75 \| 1.16 | 8 | 25% | 50% | | | 25% |
| 38 | Leadership effectively communicated business objectives, priorities, and project goals. | 3.75 \| 1.49 | 8 | 50% | 13% | | | 38% |
| 31 | The project management team was adequately staffed. | 3.63 \| 1.41 | 8 | 25% | 50% | 13% | | 13% |
| 33 | The project experienced a minimum number of project management team personnel changes. | 3.63 \| 1.77 | 8 | 38% | 38% | 13% | | 13% |
| 45 | The project's work processes and systems (e.g., document management, project controls, business and financial systems) supported project success. | 3.63 \| 1.41 | 8 | 38% | 25% | | | 38% |
| 30 | The project team including project manager(s) had skills and experiences with similar projects / processes. | 3.38 \| 1.51 | 8 | 25% | 38% | 25% | | 13% |
| 28 | A formal Startup execution plan was developed which incorporated operations and maintenance philosophy. | 2.88 \| 1.89 | 8 | 13% | 50% | | 25% | 13% |
| 44 | The project's Startup objectives were appropriately communicated to the relevant project team members. | 2.63 \| 1.85 | 8 | 25% | 13% | 38% | 13% | 13% |
| 48 | The project team members attended sufficient professional training directly related to their work in Front End Planning. | 2.63 \| 1.51 | 8 | 25% | | 63% | | 13% |
| 37 | Project leaders recognized and rewarded outstanding personnel and results. | 2.50 \| 1.31 | 8 | 13% | 13% | 63% | | 13% |

# Framework: Overview

- How to generate representative scores of 10 Leading Indicators for a project based on respondents' answers on the 10-10, ?
- Then, how to provide the outcomes so that the project easily and reliably diagnose performance?

Taking Industrial FEP 10-10 Surveys



# Framework: Quantification Process for Leading Indicators

Step 1: Scoring

Step 2: Weighting

Step 3: Aggregation

Step 4: Normalization

**Step 1: Score Calculation of Individual Input Measure Question**

$$\frac{\text{Sum of Point Values}}{\text{Number of Respondents}} = \text{Individual Question Score*}$$

(for individual question)

* Single numeric value is obtained from multiple respondents of a project

**Step 2: Weighted Score of Individual Question**

Individual Question Score × Weight* = Weighted Individual Score

(for individual question)

* Level of Influence on a leading indicator

**Step 3: Aggregation**

Total Weighted Score*

(Sum of weighted individual scores mapped into certain leading indictor(s))

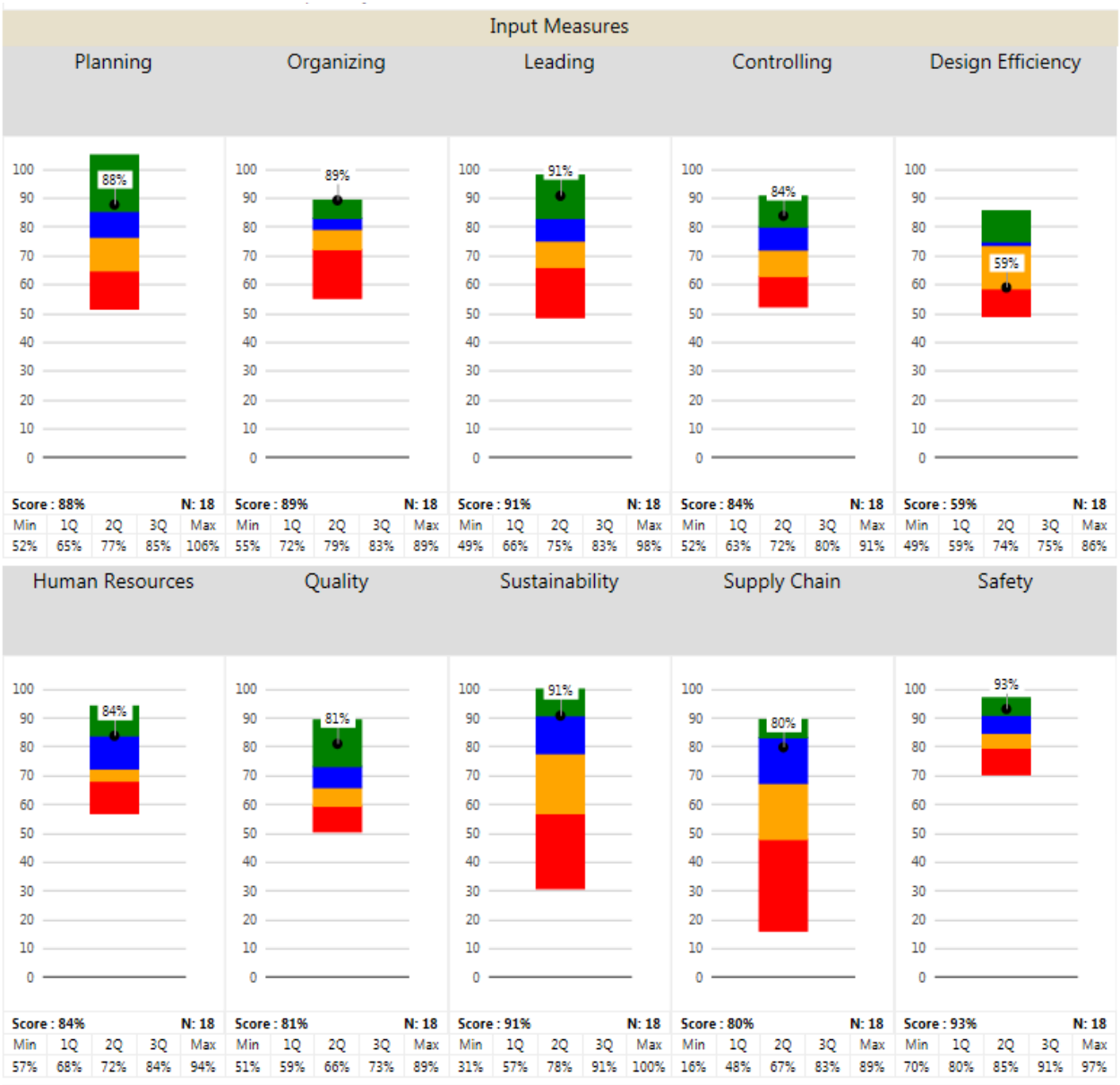
* All questions are grouped into at least one of leading indicators

**Step 4: Normalization of Total Weighted Score**

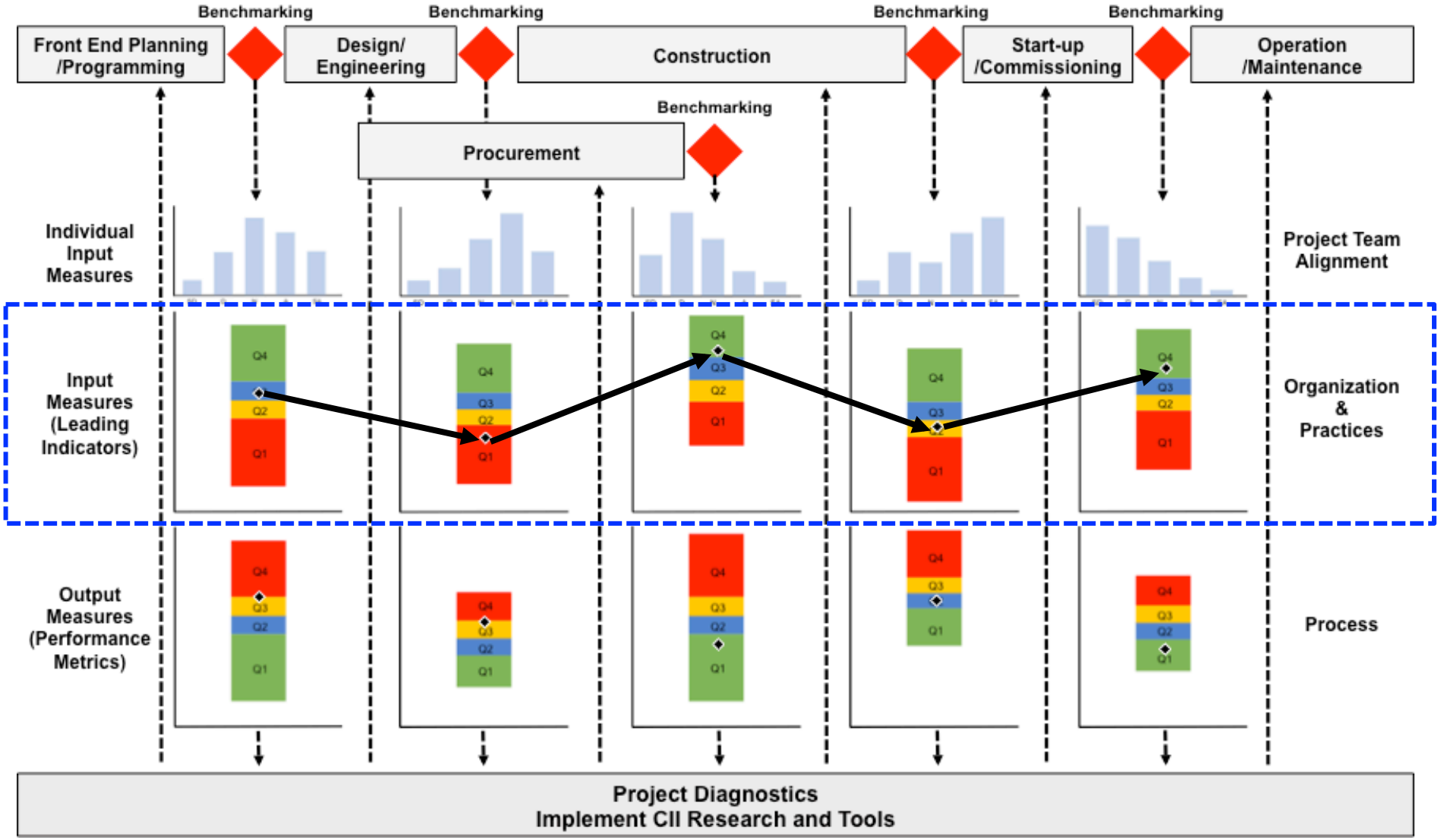
$$\frac{\text{Total Weighted Score}}{\text{Toal Weights}} = \text{Normalized Input Measure Score*}$$

* Weighted Scores are normalized to a total of 100

# Framework: Reporting (Sample)



# Conclusion: Application of Leading Indicators



# Conclusions and Path Forward

- Leading Indicators measure project organization and practices implemented throughout capital project delivery
  - Help identify potential problems through Leading Indicators
  - Allow project teams to set up proactive strategies for subsequent project phases based on linkage of Leading Indicators with CII-Project Execution Knowledge Structure

- Future Studies
  - Relationship between Leading Indicators and Performance Metrics
  - Company-level dashboard for utilizing Leading Indicators for strategic planning
  - Data-driven modification of Leading Indicators, when database is matured.

# Thank you!

# Research Background: 10 Leading Indicators

- Are based on CII's knowledge areas utilized during project planning and execution (the CII-Project Execution Knowledge Structure (C-PEKS))

1. **Planning:** The work a manager performs to predetermine a course of action. The function of planning includes the following activities: Forecasting, Objective Setting, Program Development, Scheduling, Budgeting, and Policies and Procedures Development.
2. **Organizing:** The work a manager performs to arrange and relate the work to be done so people can perform it most effectively. The function of organizing includes the following activities: Development of Organization Structure, Delegation of Responsibility and Authority, and Establishment of Relationships.
3. **Leading:** The work a manager performs to cause people to take effective action. The activities involved in the function of leading include: Decision-Making, Communications, Motivation, Selection of People, and Development of People.
4. **Controlling:** The work a manager performs to assess and regulate work in progress and completed. Management controls are achieved through the following activities: Establishment of Performance Standards, Measurement of Performance, Evaluation of Performance, and Correction of Performance.

# Research Background: 10 Leading Indicators

5. **Design Efficiency:** Measures if the project team is exhausting all techniques to optimize the design in its use of material quantities to provide maximum capacity at minimum cost.
6. **Human Resources:** Examines if the project is staffed correctly, with a minimum amount of staff turnover and appropriate training. Measures if people are capable of achieving project goals.
7. **Quality:** Measures if the project team is strictly conforming to project requirements. Analyzes if programs are pursued to assure the delivery of material goods as intended.
8. **Sustainability:** Evaluates steps taken by the project team to reduce the environmental impact of the project during construction and operation.
9. **Supply Chain Management:** Examines the strategies used by the project team to promote enhanced working relationships amongst all project stakeholders including those in the project supply chain.
10. **Safety:** Measures the steps followed by the project team to eliminate any possibility of personal injury or property damage on the project.

# Framework: Score Calculation

- Step 1: Score Calculation
  - Define point values for each question with regard to respondent's answers
  - Tendency to choose "agree" or "yes" indicates high degree of effort or better implementation for all questions
  - Five Point Scales used for Likert-Scale questions (taking over 70%): penalty for negative answers

| Scale | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Point | 0 | 1 | 2 | 4 | 5 |

  - Other types: relative influence of statement in a given question. (max 5, min 0)
  - Not answered question: point value is recorded as zero *(De Vaus 2001)*
  - Project's average score for a question

$$Sum\ Point\ Values\ /Number\ of\ Respondents =$$
Individual Question Score*

* Numeric value is obtained from multiple responses of a project

# Framework: Weighting and Aggregation

- Question Mapping and Weighting: Grouping question into relevant LIs
  - CII's event and activities held in 2013 and 2014 (e.g., Performance Assessment Workshop and Benchmarking training)
  - Each participant provide opinion regarding relationship between question and LI with relative strength of them (H, M, and L scales)
  - All questions are grouped into at least one of LIs

$$\text{Individual Question Score} \times \text{Weight*} = \text{Weighted Individual Score}$$

* Level of Influence on the certain leading indicators

- Aggregation
  - Weighted individual scores are summed up to produce scores of LI (total weighted score)
  - Total weighted score (sum of weighted individual scores mapped into certain LI(s))

**10-10 Program**

Question – Input Metric map

| | Industrial Projects – Construction Phase | Planning | Organizing | Leading | Controlling | Design Efficiency | Human Resources | Quality | Sustainability | Supply Chain | Safety |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G | What was the typical foreman to craft ratio? | | ■ | | ■ | | ■ | | | | |
| G | Overall how many workers per safety professional were typically (i.e., in terms of the average workforce) on site? | | | | ■ | | ■ | | | | ■ |
| 4 | Did the project objectives change during Construction? | ■ | | | | ■ | | | | | |
| 5 | This project experienced a high number of: | ■ | | | | | | | | | |
| 6 | Was a turnaround involved in the scope of this project? | ■ | | | ■ | | ■ | | | | |
| 7 | Please characterize how project meetings were conducted. | | | ■ | ■ | | | | | | |
| 8 | Which of the following statements characterized the decisions made by the manager(s) of this project? | | | ■ | | | | | | | |
| 9 | This project used the following methods. | ■ | ■ | ■ | ■ | ■ | | ■ | | | ■ |
| 10 | Formal (classroom) safety training was attended: | | | ■ | | | | | | | ■ |
| 11 | Did the original primary contractor(s) complete the project? | | ■ | | | | | | | | |
| 13 | Was safety performance a criterion for contractor and subcontractor selection? | | ■ | | | | | | | | ■ |
| 14 | Were safety toolbox meetings held daily? | | | | | | | | | | ■ |
| 15 | Were accidents including near misses formally investigated? | | | | | | | | | | ■ |
| 16 | The availability and competency of craft labor was adequate. | ■ | | | | | ■ | ■ | | | ■ |
| 17 | The owner level of involvement was appropriate. | ■ | ■ | ■ | | | | | | | |
| 18 | The owner and primary contractor(s) maintain a long-standing partnering arrangement. | ■ | ■ | ■ | | | | | | ■ | |

# Framework: Normalized Scores and Report

- Normalized scores are needed
  - Different number of questions and weights were used for generating total weighted score of each LI.
  - Each LI has different scale by phase and industry group.
  - Weighted scores are normalized to a total of 100

$$\textit{Total Weighted Score} / \textit{Total Weights} = \text{Normalized Input Measure Score*}$$

- Report
  - For benchmarking purpose, distribution of LI scores of similar projects is required
  - Comparisons are made at the same industry group and phase level by default
  - Difference in processes and characteristics of project and respondent types (appropriate grouping is crucial for performance comparison) *(Hwang et al. 2007)*
  - When necessary, further comparison is made by secondarily respondent and project type (e.g., within projects of natural gas processing projects executed by owner companies)