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

Jiyong Choi, Sungmin Yun*, Stephen Mulva, Daniel Oliveira, and Youngcheol Kang

Sungmin Yun, Ph.D.

Construction Industry Institute
The University of Texas at Austin
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

Existing Benchmarking

FEP  EPC  SU  OPS

10-10 Program

FEP  E  C  SU  OPS

New Project Benchmarking Platform

• Process
• Practices

• Organization
• Process
• Practices
10-10 Program: Phase-Based Benchmarking
10-10 Program: Multi-Perspective Assessment Framework

- **Phase-wide Assessment**
  - **Leading Indicators**
    - Industry Group
    - Infrastructure
    - Building
    - Industrial
  - **Phase-focused Assessment**
  - **Construction-Specific Functions**
  - **Basic Management Functions**
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)

15. Were multiple design offices involved on this project? **Yes** | **No**

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Mean</th>
<th>SD</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>Project management team members were clear about their roles and how to work with others on the project.</td>
<td>2.75</td>
<td>1.16</td>
<td></td>
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<tr>
<td>30</td>
<td>The project team including project manager(s) had skills and experiences with similar projects / processes.</td>
<td>3.00</td>
<td>1.51</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>38</td>
<td>Leadership effectively communicated business objectives, priorities, and project goals.</td>
<td>3.75</td>
<td>1.49</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>31</td>
<td>The project management team was adequately staffed.</td>
<td>3.63</td>
<td>1.41</td>
<td></td>
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</tr>
<tr>
<td>33</td>
<td>The project experienced a minimum number of project management team personnel changes.</td>
<td>3.63</td>
<td>1.77</td>
<td></td>
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</tr>
<tr>
<td>45</td>
<td>The project’s work processes and systems (e.g., document management, project controls, business and financial systems) supported project success.</td>
<td>3.03</td>
<td>1.41</td>
<td></td>
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</tr>
<tr>
<td>28</td>
<td>A formal Startup execution plan was developed which incorporated operations and maintenance philosophy.</td>
<td>2.80</td>
<td>1.89</td>
<td></td>
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</tr>
<tr>
<td>44</td>
<td>The project’s Startup objectives were appropriately communicated to the relevant project team members.</td>
<td>2.05</td>
<td>1.85</td>
<td></td>
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</tr>
<tr>
<td>48</td>
<td>The project team members attended sufficient professional training directly related to their work in Front End Planning.</td>
<td>2.63</td>
<td>1.31</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>37</td>
<td>Project leaders recognized and rewarded outstanding personnel and results.</td>
<td>2.50</td>
<td>1.31</td>
<td></td>
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</tr>
</tbody>
</table>
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**

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

(for individual question)

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

**Step 2: Weighting**

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

(for individual question)

* Level of Influence on a leading indicator

**Step 3: Aggregation**

$$\text{Total Weighted Score}^*$$

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

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

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

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

* 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.
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

\[
\text{Sum Point Values} / \text{Number of Respondents} = \text{Individual Question Score}^* \\
\]

* 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))
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

\[
\text{Total Weighted Score} / \text{Total Weights} = \text{Normalized Input Measure Score}^* 
\]

• 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)