The 10-10 Performance Assessment Campaign: New Theories Regarding the Benchmarking of Capital Project Performance

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ABSTRACT
This paper presents a recent initiative to revolutionize the benchmarking of capital projects. In the past 17 years, Construction Industry Institute (CII) has become a major source for the benchmarking of capital projects. While the value of benchmarking has been recognized by CII member companies, they find it difficult to implement it due to various issues. To address these issues, CII began working with industry experts to develop a new performance assessment system. This new system, known as the 10-10 Program, consists of input measures such as planning, organizing, leading, and controlling and output measures such as cost and capacity. This paper describes the new benchmarking theories deployed in the creation of CII’s new benchmarking system. This paper explains what the new measures are and how they were chosen. The 10-10 Program is substantially different from previous attempts to benchmark project performance by pairing high value metrics with a minimum effort concerning data collection. The new system is capable of measuring absolute metrics for specific industry sectors. Importantly, users of CII’s 10-10 Program can assess their projects at the conclusion of each of five phases from planning through startup. As a result, project management teams will be able to take proactive actions to enhance project results. It is expected that the new system will promote enhanced performance assessment through external benchmarking.

INTRODUCTION
The purpose of the Construction Industry Institute (CII) is to measurably improve the capital project delivery process (CII 2011). As a part of the effort aimed at achieving this purpose, CII has operated a comprehensive program to benchmark the performance of capital projects since 1995. The program, called the CII Performance Assessment (previously the CII Benchmarking and Metrics Program), has collected data from over 2,100 projects totaling $300 billion in total installed cost (TIC). Each project, submitted by more than 400 CII member companies, contains
various information for performance measurement and use of best practices endorsed by CII. In general, construction companies are hesitant to share their financial data (Lucko and Mitchell Jr 2010). As a result, it can be hard to collect data containing hard values such as actual project costs or durations from companies. Due to these challenges, the CII Performance Assessment (PA) database has been a unique source of project-level data in the construction industry. By protecting the confidentiality of the data, the CII Performance Assessment (PA) program has found success in collecting a large amount of data. With this data set, the CII member companies have been able to benchmark their projects. The data set also has proven that projects involving CII member companies result in significantly better project performance in terms of cost, schedule, and safety comparing than non-CII companies’ projects (CII 2009; Tucker 2007). In addition, the data set has been used for various research topics such as productivity (Liao et al. 2011), pre-project planning (Gibson et al. 2006), and impact of technology use on project performance (Kang et al. 2013).

While the value of the CII PA database has been recognized by the CII member companies, some issues have emerged. With time, the CII PA questionnaire has asked more information for newly endorsed best practices, productivity, and other project information such as project team size (in terms of full-time equivalent). This has increased the burden of data collection and entry. Over time, CII has noticed that their Benchmarking Associates (trained employees at CII member companies) needed a substantial amount of time to collect the required information. From their perspective, without strong corporate commitment, it has been difficult for them to spend enough time to collect data and properly submit it to CII.

Another typical benchmarking issue is the lack of information needed to support project decisions and influence project performance during planning and execution. The project-level data submission to the CII PA dataset has typically been conducted after project close-out. So, while the data can be used for benchmarking and benefit future projects, projects submitting data can’t attain direct benefits for their specific projects. CII’s 10-10 Program remedies this by providing results for each phase of the project.

Finally, for the most recent decade, there have been a number of CII member companies requesting that CII develops industry-specific benchmarking systems. To meet these companies’ needs, CII Performance Assessment staff has developed new benchmarking systems for the pharmaceutical, oil and gas, and healthcare industries—to name a few. While the existing CII PA benchmarking system uses relative metrics comparing actual and estimated values (e.g., cost growth comparing actual project cost with budgeted amounts) for performance measures, the new industry-specific metrics programs use absolute metrics computed from actual values (e.g., $/ft² for building) as industry practitioners believed that absolute metrics were often more valuable than relative metrics (Hwang et al. 2008).

RESEARCH APPROACH
The aforementioned issues motivated CII to develop a new questionnaire for performance measurement and benchmarking. Figure 1 illustrates the research approach. To develop the new 10-10 questionnaires, a broad range of literature review was conducted. All CII research studies as well as the existing CII PA benchmarking
questionnaires were reviewed. Also, academic papers discussing critical success factors for construction projects were also reviewed. In addition, various types of industry white papers and websites discussing how other industries conduct benchmarking and performance measures were extensively reviewed.

![Diagram of research approach](image)

**Figure 1. Research Approach**

Industry experts’ inputs were also collected at various CII activities and events in late 2012 and early 2013. First, CII holds their Board of Advisors (BoAs) meeting twice a year. The Board members are senior management representing their organization to oversee CII and commit their resources to CII activities (CII 2013). During the BoA meeting in April 2013, a roundtable discussion was held for the 10-10 Program. More than 60 board members attended the session to specifically address the types of metrics they need to support their capital project delivery. Participants were grouped by industry sectors such as midstream and pipeline, oil and gas, pulp and paper, petrochemical, metals and mining, power generation and transmission, and healthcare and building sectors. During this session, the participants discussed the common input and output measures in their industry sectors. The second source of information for the 10-10 Program was the CII Performance Assessment Community of Practice (PACOP). In CII, various Communities of Practice (COPs) were created to promote knowledge sharing and interchange amongst experts on various topics across all CII members (CII 2013). The Performance Assessment COP (PACOP) is recently launched for enhanced project performance through benchmarking and performance assessment with over 50 participants. The PACOP participants were asked to provide the output measures widely used within their organization. From this, more than 70 output measures from nine companies were identified.

In total, more than 200 factors were obtained from the literature review and from industry experts’ inputs. Not surprisingly, many factors were commonly
identified by multiple sources. Some examples can be seen in Table 1. Multiple sources indirectly reflected the importance of setting clear project objectives. Indeed, having clear objectives has been regarded as one of the most important factors from the comparison of various critical success factors for construction projects (Hwang and Lim 2013; Yu et al. 2006). Two CII publications, one concerning project health leading indicators and one comprised of CII’s PA questionnaire, focus on shared project objectives amongst project team members (CII 2006; CII 2012). The CII BoA members proposed to ask whether a business objective letter was developed and distributed to project team members. Similar to project objectives, multiple sources identified that the availability of skilled labor is one critical factor influencing to project outcomes.

### Table 1. Topics Referred by Multiple Sources: Examples

<table>
<thead>
<tr>
<th>Topic</th>
<th>Source</th>
<th>Factor Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Objective</td>
<td>CII (2012)</td>
<td>The key project team members understood the owner’s goals and objectives of this project</td>
</tr>
<tr>
<td></td>
<td>Egan (1998)</td>
<td>Construction must put in place a means of measuring progress towards its objectives and targets</td>
</tr>
<tr>
<td></td>
<td>BoA Meeting</td>
<td>Objectives met? (operability)</td>
</tr>
<tr>
<td></td>
<td>CII (2006)</td>
<td>Business goals, project objectives and priorities, and critical success factors are not being consistently used by project team members and key stakeholders to guide decisions</td>
</tr>
<tr>
<td></td>
<td>Hwang and Lim (2013)</td>
<td>Realistic obligations/clear objectives and scope</td>
</tr>
<tr>
<td></td>
<td>Yu et al. (2006)</td>
<td>Clear intention and objectives of client, clear project goals and objectives</td>
</tr>
<tr>
<td>Skilled Labor</td>
<td>CII (2012)</td>
<td>Availability of skilled labor</td>
</tr>
<tr>
<td></td>
<td>CII (2006)</td>
<td>The project lacks sufficient skilled craft and is experiencing high craft turnover due to competition from other projects, low wages, and/or undesirable work schedules</td>
</tr>
<tr>
<td></td>
<td>BoA meeting</td>
<td>Craft availability vs. staffing plan</td>
</tr>
</tbody>
</table>

In order to address more than 200 factors appropriately, factors were grouped based on certain topics as seen in Table 1. After this, another group of practitioners, CII PA committee members, participated in developing the five 10-10 questionnaires (i.e., one each for Front-End Planning, Engineering, Procurement, Construction, and Start-up). The PA committee develops policy, procedures, and key definitions for CII’s collection, analysis, and dissemination of industry data (CII 2013). The purpose of their participation was to prioritize the factors for each phase and ultimately develop questions for the resulting 10-10 Program. For each factor, committee members evaluated their importance using a 1 to 5 likert scale where 1 is useless, 3 is
moderately helpful, and 5 is critical. The majority of the CII PA committee members participated in the survey.

Based on the factors and their scores determined by the CII PA committee members, five different questionnaires representing five project phases, front end planning (FEP), Engineering, Procurement, Construction, and Startup, were drafted. With the draft questionnaires, a charrette was conducted to refine the questionnaires. The approach is useful for facilitating data collection between industry practitioners and academic researchers (Gibson and Whittington 2010). The drafts of each questionnaire were subsequently distributed to more than 70 participants during the CII Performance Assessment Workshop (PAW) held in June 2013 in Memphis, Tennessee. After each individual reviewed each questionnaire, the participants were divided into five groups to discuss a questionnaire for a particular project phase. Next, each group summarized their comments on a flipchart and picked one moderator to explain their work to the other groups. In turn, each group went around the meeting room to learn about what every other group had accomplished. The moderators for each questionnaire explained the comments to the groups and requested comments on their work. In this way, all participants were able to provide comments on all five questionnaires. Finally, each questionnaire was finalized based on these comments.

10-10 QUESTIONNAIRE

Based on the process described previously, a set of five 10-10 questionnaires for industrial projects was developed. 10-10 stands for 10 input measures and 10 output measures. The measures themselves can be seen in Figure 2. Notably, when a questionnaire is completed, 10 input measures and 10 values for output measures are calculated and returned. These values are then benchmarked with values from other similar projects in the CII database.

![Figure 2. 10-10 Input and Output Measures](image)

The 10-10 questionnaires are based on the concept of anonymously surveying members of a project’s management team regarding their project’s performance, team dynamics, and organizational relationships. Since the 10-10 questionnaires use simple statement-based questions, leading indicators are obtained throughout a project’s development that can warn Senior Management of impending problems. This diagnostic capability aids the development of remedial plans and
implementation of CII research and tools. Outcome measures provide certainty that the project is proceeding on target.

Each questionnaire consists of three sections. The first section focuses on general project information such as project location, nature, and selected delivery method. This information is necessary to group similar projects for benchmarking. The second and third sections, input measures and output measures, are discussed in the next sections.

**Input Measures**

The 10-10 obtains input measures by asking various types of questions such as yes/no and sliding-scale (likert-scale) responses from ‘strongly agree’ to ‘strongly disagree.’ Each phase-level questionnaire has different numbers of questions, ranging from 38 to 58 questions. Some example questions can be seen in Figure 3. As can be seen in the figure, some questions in this section are intentionally subjective by design. It is likely that different respondents may have inconsistent responses. In order to control this phenomenon, the decision was made to obtain responses from at least 5 respondents for each project analyzed. Also, the fact that respondents don’t need to collect ‘hard’ values to fill out each questionnaire will contribute to ease of data collection. Secondly, if multiple responses from each project are returned, issues related to answer consistency become effectively eliminated and may also highlight the possible misalignment among team members.

![Figure 3. 10-10 Input Measures Examples](image)

The questions are used to generate 10 scores representing 10 input measures which can be seen in Figure 2. Planning, organizing, leading, and controlling have long been taught in management textbooks as core managerial functions (Frandsen 2006; Tsoukas 1994). The other input measures have been recognized by the literature review and industry experts in this study. Currently, the task of mapping each question to each input measures is ongoing.
Output Measures

The third section of the 10-10 questionnaires asks about project output measures. As described in the previous section, the CII PACOP participants were asked to provide the output measures widely used within their organization. It was found that metrics consisting of cost, schedule, capacity, quantity, and safety are most widely used amongst the collection of CII member companies. Based on this information, the 10 output measures shown in Figure 2 were developed. Table 2 also contains the definitions for each metric. As can be seen in the table, the output measures consist of absolute and relative metrics by phase and by project. The questions incorporated in each questionnaire were designed to collect relevant information for these metrics. For project-level metrics, forecasted values (i.e., forecasted total project cost, forecasted total duration) were used except the Start-up phase. For capacity efficiency, the concept of a reference project was used. The concept of a reference project is based on the work of one of CII’s first research projects, the CII Model Plant. Out of use for decades, the CII Model Plant continues to represent a “typical” or “standard” industrial project – one that could also be used for detailed construction productivity measurement (CII 1986; Goodrum et al. 2011).

<table>
<thead>
<tr>
<th>Metric</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost Efficiency = Total Project Cost / Capacity</td>
<td>Absolute</td>
</tr>
<tr>
<td>Phase Cost Efficiency = Phase Cost / Capacity</td>
<td>Absolute</td>
</tr>
<tr>
<td>Phase Cost Growth = (Actual Phase Cost – Planned Phase Cost) / Planned Phase Cost</td>
<td>Relative</td>
</tr>
<tr>
<td>Project Schedule Efficiency = Total Duration / Capacity</td>
<td>Absolute</td>
</tr>
<tr>
<td>Phase Schedule Efficiency = Phase Duration / Capacity</td>
<td>Absolute</td>
</tr>
<tr>
<td>Phase Schedule Growth = (Actual Phase Duration – Planned Phase Duration) / Planned Phase Duration</td>
<td>Relative</td>
</tr>
<tr>
<td>Capacity Efficiency = (Capacity / Reference Project Capacity) / (Installed Quantity / Reference Project Installed Quantity)</td>
<td>Absolute</td>
</tr>
<tr>
<td>Phase Burn Rate = Phase Cost / Phase Duration</td>
<td>Absolute</td>
</tr>
<tr>
<td>Full-time equivalent (FTE) / Total Project Cost</td>
<td>Absolute</td>
</tr>
</tbody>
</table>

10-10 Report

Figure 4 contains an illustration representative of what reports generated by the 10-10 Program will look like. It is CII’s intention for each report to contain 20 scores representing 10 input measures and 10 output measures. Similar to the previous CII PA benchmarking Key Report, those scores were plotted with quartile information (i.e., different colors in the figure for each of four quartiles). Given the new structure of the 10-10 Program, it is also possible to investigate potential relationships between the 10-10 Program’s input and output measures. In addition, the CII’s body of knowledge is currently being re-organized based on many of the 10 input measures shown in Figure 2. Thus, the 10-10 Report will help users to diagnose
their projects, identify input measures they need to improve, and easily identify the CII resources available to help improve project performance. For example, if the report revealed that the project is experiencing control issues (and issues with schedule efficiency during the construction phase are apparent), the report will show which CII implementation resources should be considered for implementation.

Figure 4. 10-10 Sample Report

CURRENT STATE AND FUTURE WORK
Currently, the set of questionnaires for the industrial projects were developed and launched in July 2013 at CII’s Annual Conference. Two more sets of questionnaires for building and infrastructure projects, respectively, are under development. In addition, the task of mapping each question in the input measures section to the 10 input measures is ongoing. For the absolute metrics in the output measures, a process for normalizing cost is being developed. All of these tasks will provide a higher level of information to stakeholders at an accelerated pace. It is the authors’ belief that the CII 10-10 Program will revolutionize the benchmarking of capital projects. The 10-10 Program will also enable the holistic understanding of project work processes and what works and what doesn’t.

The contents and the questions in the 10-10 Program questionnaires have been validated by industry experts chiefly from the CII member companies. However, the applicability of each specific questionnaire will be validated in an ongoing effort as CII collects questionnaire submissions. For the previous benchmarking questionnaires, CII has updated them based on the guidance of the CII Performance Assessment Committee. Similarly, the 10-10 questionnaires will be updated on an as-needed basis going forward to ensure that they accurately measure the right input and output measures of all types of non-residential capital projects.

CONCLUSION AND RECOMMENDATION
This paper chronicles recent research undertaken to develop new theories concerning the benchmarking of capital projects. The 10-10 Program was developed based on a wide range of literature review as well as industry experts’ knowledge. The 10-10 Program is poised to make several important contributions. First, although the importance of the 10 input measures has been stressed significantly in various sources, their impacts haven’t been quantitatively investigated with actual performance data. While multiple countries such as Brazil and Chile have developed
benchmarking systems for construction projects (Alarcón et al. 2001; Costa et al. 2006), their systems also are not capable of measuring such input measures. The 10-10 program will be the first study able to investigate them in a consistent way for different types of construction projects. With these relationships, companies can develop corrective action plans to improve their projects’ performance. Second, the 10-10 Program will reinvigorate CII’s benchmarking effort by addressing the issues discussed in the Introduction section (i.e., extensive data collection efforts, project-level questionnaire, and preference on using absolute metrics). Indeed, industry practitioners’ responses for the new 10-10 Program have far exceeded expectations; the level of interest in this program is very high. Consequently, it is expected that the CII PA dataset will be even more plentiful in the future. This will contribute to many CII research studies since the dataset is used extensively for many research studies. Overall, there are reasons to believe that CII’s 10-10 Program will significantly contribute to the improvement and the effectiveness of capital projects.

REFERENCES


