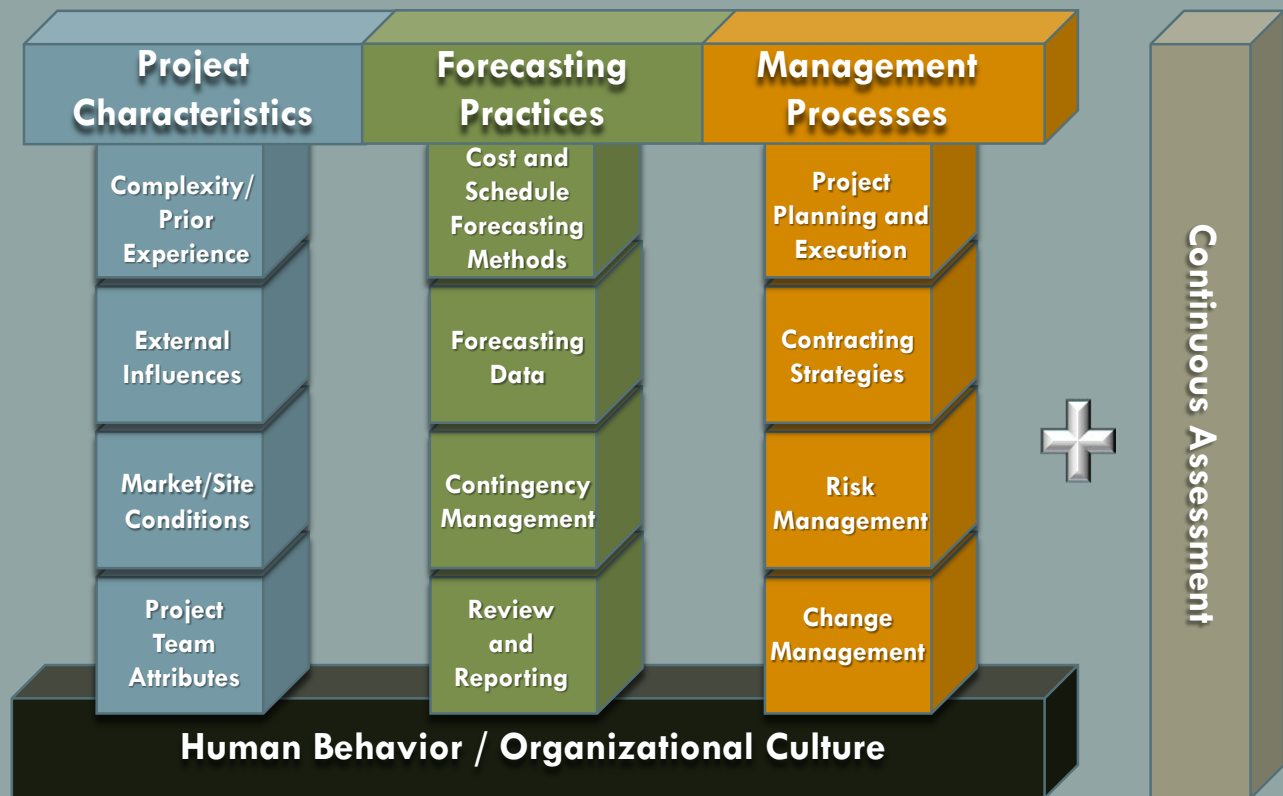


Four-casting for Early and Accurate Predictability



CII Member Companies

Abbott	AMEC
Air Products and Chemicals	AZCO
Ameren Corporation	Alstom Power
American Transmission Company	Audubon Engineering Company
Anglo American	Baker Concrete Construction
Anheuser-Busch InBev	Barton Malow Company
Aramco Services Company	Bechtel Group
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Statoil ASA	Tenova
SunCoke Energy	TOYO-SETAL Engenharia
TNK-BP	URS Corporation
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U.S. Department of Health & Human Services	Yates Construction
U.S. Department of State	Zachry Holdings
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Vale	
The Williams Companies	



Four-casting for Early and Accurate Predictability

*Research Team 291, Improving the Accuracy of Project Outcome Predictions
Construction Industry Institute*

Implementation Resource 291-2

December 2013

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Introduction

Today's projects are planned and executed in highly dynamic market environments. Projects are affected, either positively or negatively, by variability in worker productivity, material availability and price fluctuations, unforeseen changes in design and execution, geopolitics, globalization, and many other equally important influences. The reality is that regardless of how well planned a project may be, there are still significant events (both internal and external) that can determine the project's ultimate success in terms of its anticipated performance criteria. Yet, despite the inherent volatility of real world conditions, project teams are consistently asked to incrementally predict accurate future project outcomes. Moreover, these predictions need to have a high degree of accuracy and reliability in order to have meaningful benefit to the sponsoring organizations. Predictions set expectations of project outcomes, provide the basis for important financial adjustments across a portfolio of projects and for the execution of individual projects, and they drive project team decision making processes. Without the ability accurately predict, project teams are likely to be in a strictly reactive management posture during project execution, and project performance is likely to deviate from projected measures. Clearly, for the benefit of the overall project and of all project participants, these project outcome predictions must be accurate, defensible, and continuously generated, regardless of the project completion stage.

Despite these obvious needs, the reality is that tools, methodologies, and techniques designed to predict reliable and accurate project outcomes are lacking within the industry. Since the need for accurate project outcome predictions is a basic and fundamental need, project team personnel have resorted to a wide variety of approaches to address the issue. Some industry leaders argue that project teams simply lack the ability to make accurate predictions, which leads them to withhold corrective actions until there is stronger data verification or additional indicators to substantiate outcome predictions. The lack of confidence in outcome predictions—or the suspicion of significant inaccuracies—undermines the project team's ability to adopt proactive execution and corrective strategies. CII chartered Research Team (RT) 291 to address this need, and the team has produced deliverables that enable project teams to become effective predictors.

RT 291 concluded that project outcome predictability is actually influenced by factors across multiple core competencies intrinsic to capital project delivery. The research team concluded that the processes and tools utilized to generate, communicate, and revise a project's cost and schedule forecast are as diverse as any other techniques used within the profession to address challenges. Importantly however, the research

revealed that there were distinct and identifiable differences between effective and ineffective projects with respect to the practices they use to forecast final cost and schedule outcomes. The research team categorized these practices as follows: 1) human behavior and organizational culture; 2) project characteristics; 3) forecasting practices; and 4) management processes. These four categories form the basis of the team's *Four-casting* model. Of the four, human behavior and organizational culture was the category statistically shown to have the greatest influence on predictability. In this publication, the four categories of practices are presented serially in Chapters 2 through 5. Each chapter presents the practices with key “takeaway” findings, a list of potential predictability “derailers,” and recommended mitigation actions.

In addition to composing these discussions, the team developed a *Four-casting* assessment tool to enable project teams to evaluate the effectiveness of their predictability processes as the project progresses, and to identify the categories and practices of influence that require attention. Chapter 6 describes the *Four-casting* assessment tool. Chapter 7 discusses the team's findings on classifying change reasons and evaluating the impacts of change. RT 291 also produced Implementation Resource (IR) 291-3, *The Predictability Index*, to support the predictability practices. This second tool provides a predictability measurement for benchmarking purposes. The remainder of this chapter introduces the model and its predictability practices, and briefly describes the purpose of the assessment tool.

Predictability Practices

The team used its extensive review of the research literature on forecasting and predictability to develop an initial list of factors with an influence on predictability. With this list in hand, the subject matter experts on the team conducted research charrettes during three face-to-face meetings to further identify and group the influencing factors. Research charrettes permit the dynamic, creative generation and communication of a large amount of information in a short amount of time. At these meetings, the team typically worked in small subgroups, which each reported the conclusions of their charrette sessions back to the entire team for further discussion and elicitation. Example of core factors included alignment, transparency, forecasting methods, reporting, information issues, risk, or changes, among others. Based on the identified factors, a total of 72 questions (most of them with a predefined set of answers) were framed for a facilitated survey to collect retrospective project data. Overall, the questions corresponded to practices in the four categories of the model: 1) human behavior and organizational culture; 2) project characteristics; 3) forecasting practices; and 4) management processes.

Once these initial 72 questions had been framed, the team developed its facilitated survey approach. This retrospective data collection effort was particularly comprehensive, eliciting both qualitative and quantitative responses, and addressing specific project characteristics and outcomes. It also inquired about forecasting practices utilized, management processes employed, and requested detailed information regarding project team behaviors, organizational issues, and company culture. First, four survey sections, corresponding to the four model categories, contained the initial 72 questions. These questions were framed around their corresponding influencing factors and related to industry practices, with both a pre-defined set of responses and an open-response option. For instance, to the question of whether contract incentives or performance-based fee adjustments had been used in a project, the following responses were available: positive incentives; negative incentives; both positive and negative incentives; and none. The open response captured comments and insights from the subject matter experts regarding the issue of inquiry. Second, in order to assess predictability, the team requested the actual forecast logs for both cost and schedule predictions along project completion timelines. The researchers requested the original authorization values or estimates for cost and schedule. This represented the baseline condition or the original commitment/plan, as approved by the project sponsor. Because incremental adjustments or revisions to project forecasts are nearly always made during project execution, the team requested the historical forecasting log. Final cost and schedule values at completion were also requested.

Once pilot tested, the survey was distributed among CII member companies. In all, 135 surveys collecting data for individual projects) were completed. Of the 135 projects, over 90 percent had been completed within the past five years. The total installed cost of the projects in the database was above \$28.88 billion, with an accumulated completion time close to 300 years. The median schedule deviation at completion was 7.91 percent, while the median cost deviation was 5.93 percent. Figure 1 shows that contractor organizations submitted 52 percent of the projects, and owner organizations contributed the remaining 48 percent. Figure 2 illustrates the nearly evenly divided presence of public and private sector projects in the database. There was also a wide representation of the various project roles played by the responding industry organizations and a representative mixture of industry sectors, as Figures 3 and 4 make clear.

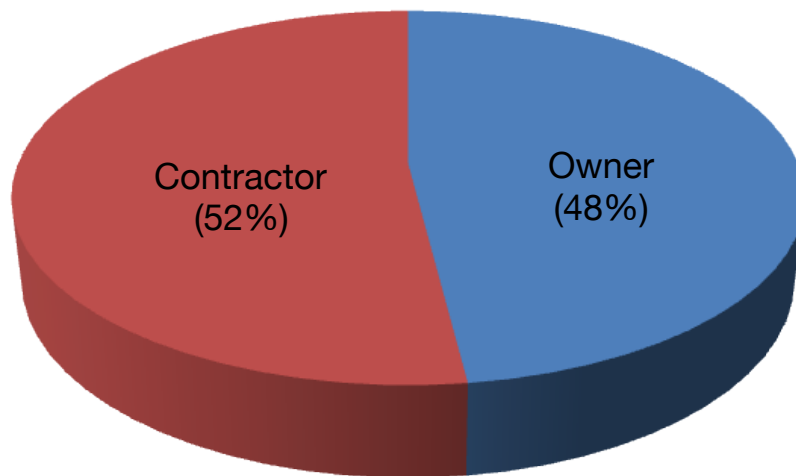


Figure 1. Owner versus Contractor Projects

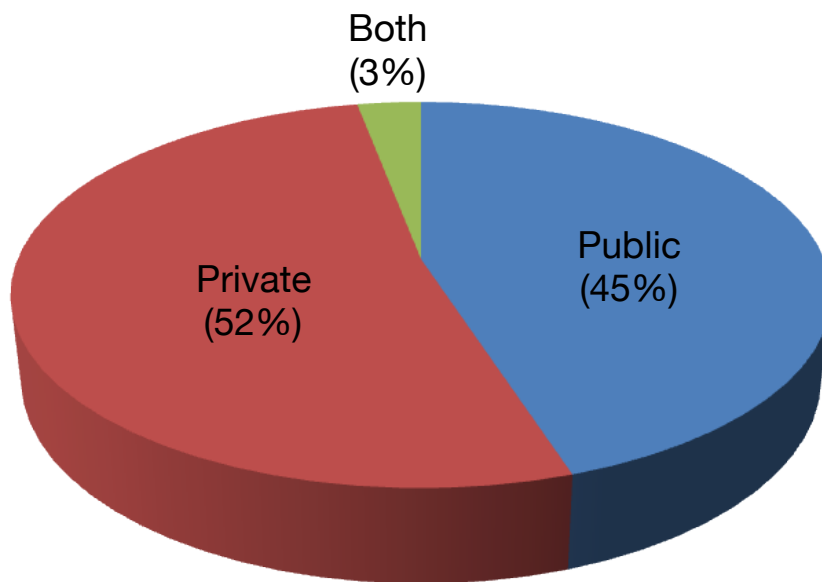


Figure 2. Private versus Public Projects

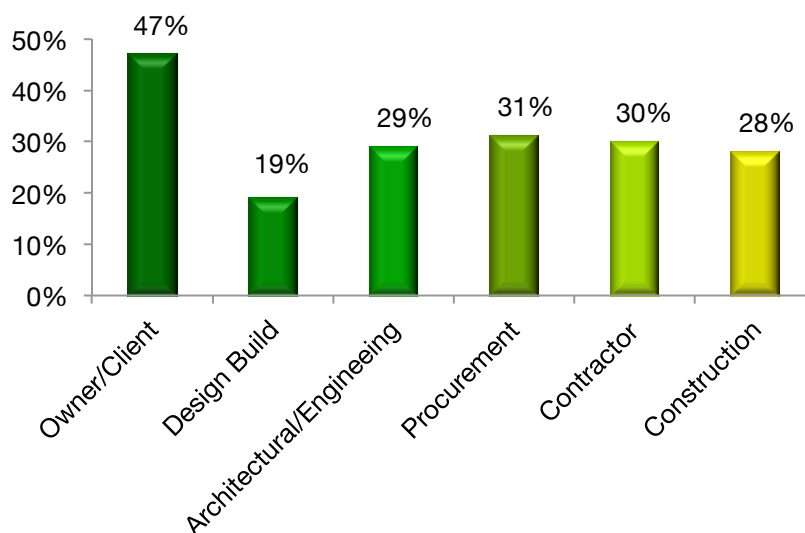


Figure 3. Role Function

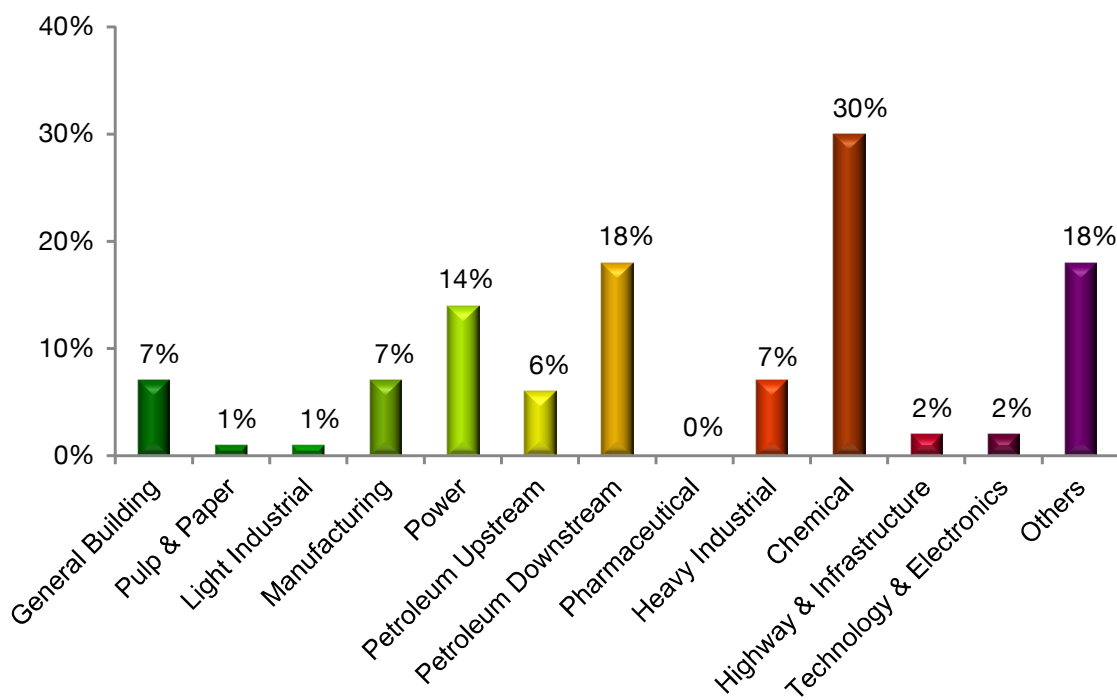


Figure 4. Industry Sector

The 135 completed projects in the team's database were segregated by quartiles on basis of their predictability performance—as measured with the RT 291 Predictability Index. This allowed practices used by first-quartile (very good) predictors to be contrasted with the practices used by fourth-quartile (very poor) predictors. See IR 291-3, *The Predictability Index*, for more information on the meaning and use of the Predictability Index scale. Through statistical analyses, the team identified numerous patterns between predictability performance and the responses to the initial 72 survey questions. When possible, the researchers further grouped together questions that were conceptually close to each other to formulate a general set of practices. In total, the team identified 43 distinct practices with a marked influence on predictability; 25 of them had a statistically significant correlation with predictability. Table 1 presents a comprehensive list of the practices grouped in categories and subcategories, and indicates whether or not each practice was statistically correlated with predictability.

Among the statistically significant practices with an influence on predictability, an aspect of human behavior and organizational culture was prevalent. This indicated the major influence of this category on predictability. Indeed, behavioral and cultural aspects were relevant to approximately 64 percent of the practices statistically correlated with predictability. The project characteristics, forecasting practices, and management processes categories accounted for 28, 44, and 48 percent respectively. The statistical analysis was further enhanced by the team's comparison of owners and contractors, as separate subsets, to determine differences that exist between the two with respect to practices and behaviors. Again, this was done for both cost and schedule predictions.

Table 1. Proposed Practices

Category	Subcategory	Related Practices (in <i>Italics</i> if Correlated with Predictability)	Absolute Correlation Value
1. Human Behavior and Organizational Culture		a. <i>Stressed but Aligned Reporting Environment</i>	0.184
		b. <i>Incentivized Project Functions</i>	0.218
		c. <i>Balanced Customer Influence on Forecasting</i>	0.255
		d. <i>Contractor versus Owner Predictability</i>	0.278
		e. <i>Early Trend Identification and Response</i>	0.233
		f. Accountability	
		g. Transparency and Trust	
		h. Scrutiny and Involvement	
		i. Project Team's Perception of Forecasting	
2. Project Characteristics	2.1 Complexity and Prior Experience	a. <i>Unfamiliar Geographic Project Locations</i>	0.377
		b. <i>Legal and Permitting Issues</i>	0.249
		c. <i>Project Complexity</i>	0.173
		d. <i>Project Duration</i>	0.117
		e. New or Unfamiliar Technologies	
		f. Project Scale	
	2.2 External Influences	a. <i>Third-party Financing</i>	0.271
		b. <i>Candidness with Key Stakeholders</i>	0.176
		c. Influence of Claims	
		d. Influence of Project Driver	
	2.3 Market, Economic and Site Conditions	a. <i>Market Volatility, Escalation, and Location Influences</i>	0.209
	2.4 Project Team Attributes	a. <i>Forecasting Team Experience and Skills</i>	0.197
		b. <i>Alignment</i>	0.447
		c. Transparency and Trust	
		d. Leadership	

Table 1. Proposed Practices (continued)

Category	Subcategory	Related Practices (in <i>Italics</i> if Correlated with Predictability)	Absolute Correlation Value
3. Forecasting Practices	3.1 Cost and Schedule Forecasting Methods	a. <i>Forecasting Method</i>	0.334
		b. Forecasting Assessment and Reliability	
		c. Functional Responsibility for Forecasting	
		d. Reporting Frequency versus Continuous Forecasting	
	3.2 Forecasting Data	a. <i>Completeness of Input Data and Information</i>	0.284
		b. Functional Responsibility for Providing Data and Information	
	3.3 Contingency Management	a. <i>Risk Registry Review and Update</i>	0.238
		b. <i>Contingency Reconciliation</i>	0.257
	3.4 Review and Reporting	a. <i>Functional Role</i>	0.195
		b. <i>Forecasting Team Experience and Skills</i>	0.197
		c. <i>Timely Reporting of Deviations</i>	0.297
		d. Centralization of Project Control Function	
4. Management Processes	4.1 Project Planning and Execution	a. <i>Project Management and Controls Information Integration</i>	0.363
		b. <i>Effective Start-up and Commissioning Practices</i>	0.171
		c. <i>Alignment</i>	0.447
		d. Effective Front End Planning Practices	
		e. Centralization of the Project Management Function	
	4.2 Contracting Strategies	a. <i>Contractual Incentives</i>	0.313
		b. <i>Third-party Financing</i>	0.271
		c. Project Delivery Method	
	4.3 Risk Management	a. Effective Risk Management Practices	
	4.4 Change Management	a. <i>Effective Change Management Practices</i>	0.340
		b. <i>Influence of Requests for Information (RFIs)</i>	0.190

The *Four-casting* Model

Using its statistical results, observations, and SME opinions collected throughout the study, the team developed and documented its *Four-casting* model. (See Figure 5.) The model proposes and supports the implementation of practices for early and accurate predictability. It highlights how the practices in the project characteristics, forecasting practices, and management processes categories are all influenced and sustained by the practices in the human behavior and organizational culture category. It also illustrates the importance of the continuous assessment component for their evaluation and improvement. The relationships of the four main components of the approach led the team to name it the *Four-casting* model. The four main categories are divided into 12 subcategories, all of which contain the 43 distinct practices that the team found to have a marked influence on predictability.

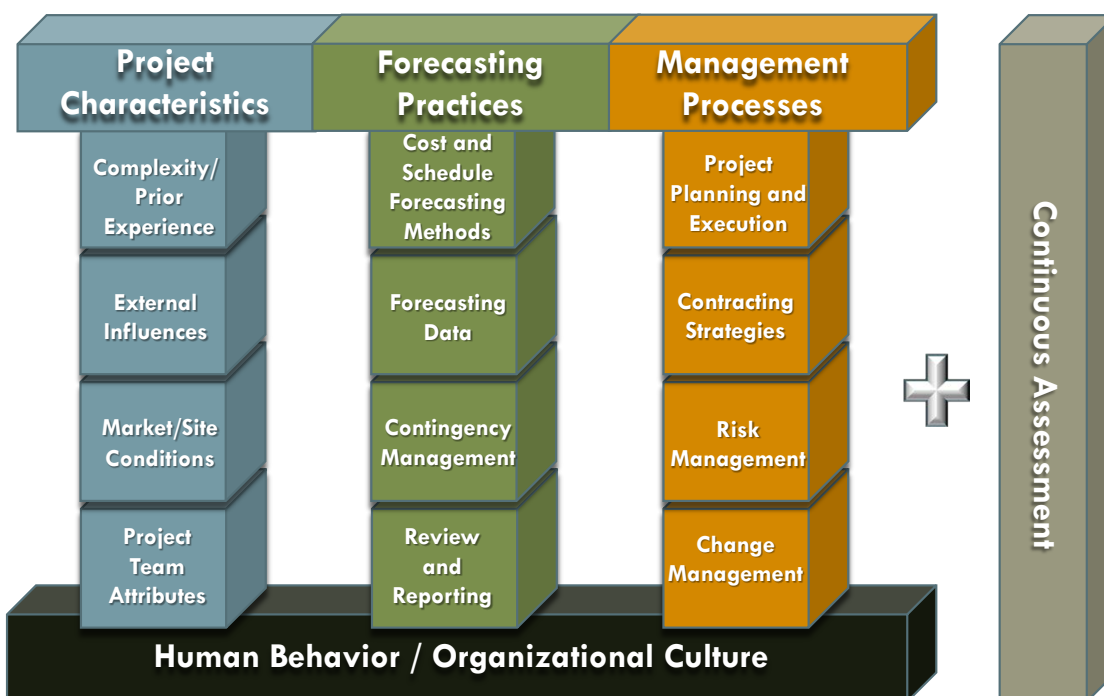


Figure 5. *Four-casting* Model

The *Four*-casting Assessment Tool

To enable project teams to evaluate the effective implementation of the predictability practices as their projects progress, the team developed the *Four*-casting assessment tool. The tool monitors their compliance with the recommendations and practices contained in the model. It also conveniently generates a dashboard gauge to illustrate compliance with the practices in each *Four*-casting category. (See the example in Figure 6.) The green part of the dashboard dial represents first quartile performance and indicates that practices are in place similar to those for projects that were highly effective in predicting cost and schedule outcomes. The red part of the dial corresponds to third- and fourth-quartile projects, the overall performance and predictability of which is highly undesirable. Teams and organization alike are encouraged to regularly evaluate their projects, with the goal of continuous improvement. Instructions and examples for utilizing the tool are detailed in Chapter 6.

The team externally validated the assessment tool through its correlation with the Predictability Index measure. Data were collected for 27 completed projects—these projects were in addition to the 135 initially analyzed. For these 27 projects, the team found a strong correlation between the outcomes of the *Four*-casting assessment tool and the Predictability Index tool. In other words, for a given project, the assessment of predictability practices with the *Four*-casting assessment tool proved to be proportional to its actual predictability performance. Such evidence validates the tool.

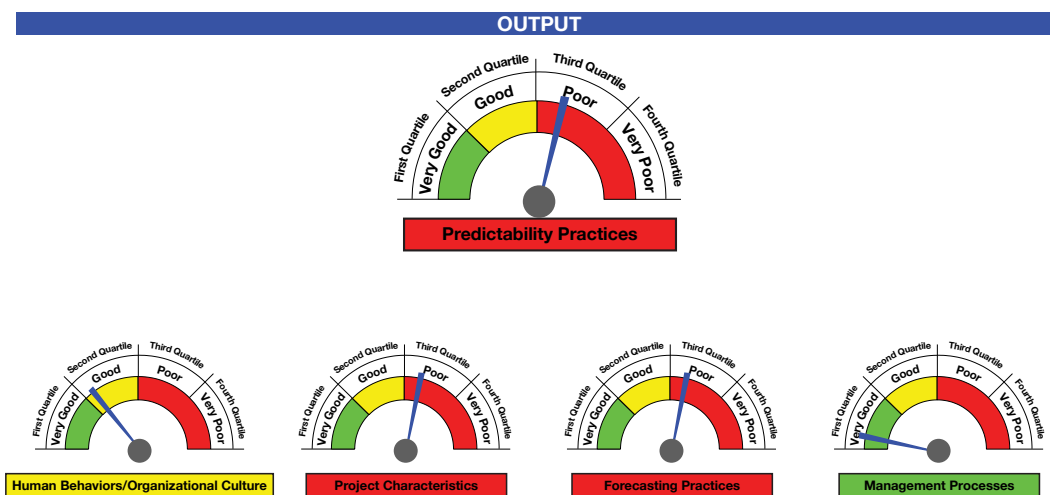


Figure 6. Sample Output with *Four*-casting Assessment Tool

Chapter 1

Human Behaviors/Organizational Culture

Behavioral science has long linked human behavior (i.e., what people say and do), to the contextual and environmental conditions that surround individuals and groups. Perhaps the most significant finding of this research is the recognition that human behavior and organizational culture have a profound, statistically significant influence on a project team's effectiveness at predicting future project outcomes, both in terms of timeliness and accuracy. This is equally true for owner and contractor organizations. The RT 291 research distilled the findings in this category down to the issues of organizational ethics, transparency, trust, alignment, and personal attitudes and motivations.

Among the findings, it was observed that there is often a reluctance to react to and/or report minor or moderate deviations/trends early in the project. This hesitancy is due to expectations that compensating factors will somehow emerge in the future or, alternatively, that effective project management can mitigate consequential impacts to the overall project. Of course, such project management strategies are reactive by nature and, regrettably, often prove inadequate or ineffective.

The research team found that projects correlated with first-quartile forecasting performance had a higher utilization of personal incentives or bonuses with the project team. In essence, these projects required personal accountability for the generation, review, and reporting of project forecast; and rewards and recognition were tied to this performance. In contrast, projects with poor forecasting performance often had inadequate accountability for the forecasting process at an individual level. In some cases, project managers and project controls managers were reported to fear reprisals for reporting cost and schedule deviations, to the point that the process ultimately lacked credibility, trust, and candor. On poor predictor projects in both owner and contractor organizations, poor transparency in the reporting of cost and schedule deviations was observed to be a frequent underlying issue.

Significantly informal, unaligned, divisive, or unsupportive environments, in which new project forecasts were reported to senior management and/or project sponsors, were similarly correlated with poor predictability of cost and schedule outcomes. Organizations that appreciated and rewarded candor and transparency did a better job of forecasting outcomes than those that created an atmosphere in which only hopeful—rather than actual—forecasts were welcomed. Fear in such a context often led to poor forecasting performance. Predictions of final outcome were not accurate, timely, or credible, and they ultimately diminished overall performance against project objectives and sponsor

expectations. The remainder of this chapter discusses the influencing factors of the following types of environments for and approaches to reporting forecasts: stressed but aligned reporting environment; incentivized project functions; balanced customer influence on forecasting; contractor versus owner predictability; early trend identification and response; accountability; transparency and trust; scrutiny and involvement; and project team's perception of forecasting.

a. Stressed but Aligned Reporting Environment

Key Takeaway

A healthy tension in the reporting of forecast information to upper management or the client is statistically correlated with early and accurate predictability. In the research study, five degrees of cordiality were identified: 1) comfortable, cooperative, and relatively informal; 2) structured, professional, and supportive; 3) high-pressure, stressful, and aligned; 4) tense, adversarial, critical, and negative; and 5) divisive, political, and lacking alignment. Forecasts need to be very consistently framed, structured, and formal, so that the reported values are non-biased, informative, and timely. Informality and casualness, as opposed to a tense but aligned environment, can lead to a “new story” every reporting period. Formality requires structure and defined expectations. A reporting environment that is divisive, political, or lacks alignment is likely to hinder predictability. It is a matter of trust in the rigor of the process. Overall, a certain amount of tension in the reporting function drives accountability and improves transparency. Care must be taken to not sacrifice alignment, cordiality, or cooperation by exerting an excessive amount of pressure.

Insights from the Research

Forecasts may be reported in a structured, professional, but supportive manner, or optionally in a comfortable, cooperative, and relatively informal manner. Both degrees of cordiality are included in the research database and do not seem to be determinants themselves regarding predictability. However a stressed, but aligned reporting environment appears to significantly increase the cost and schedule predictability for both owner and contractor projects. Such influence exists, with minor differences, for both owner and contractor organizations and for both cost and time metrics.

b. Incentivized Project Functions

Key Takeaway

Incentivizing performance of core competencies related to project management and control functions is correlated with effective predictability practices. For both owner and contractor organizations, well-designed incentive programs were shown to increase, but obviously not guarantee, cost and time predictability. The research showed that incentivizing the project management function in particular increased the chances for cost and schedule predictability for both contractors and owners. Incentivizing project managers is a strategy that appears to drive accurate and early predictability more than incentivizing the project control functions. The research provided evidence that most owner organizations fail to incentivize their project functions, and, as a result, may be missing an important opportunity to implement an effective strategy to improve predictability.

Incentive programs may be positive, negative, or both. Incentive programs must be carefully designed and effectively implemented to prevent surprising or unforeseen effects. An incentive program should help to maintain motivation and foster a commitment to excellence from all participants in the forecasting functions. Incentives must be fair, and must be awarded when performance is achieved.

Incentives should also be clearly understood from the beginning and fully transparent. Otherwise they can actually have very demotivating effects. A case was reported in which a project team worked overtime, even during weekend days, for over half a year to achieve an incentive bonus, the details of which had not been clearly disclosed. An immediate, strong demotivation developed within the team, once its members discovered that the bonuses were significantly less than the expectation. Team members have the right to know the details of the incentives they are expected to pursue.

Insights from the Research

This study found that incentives sometimes result in either positive or negative effects on the motivation of individuals and teams. Thus, it must be understood that the implementation of an incentive program, by itself, does not necessarily render a positive motivation to seek exceptional performance, and, indirectly, very good (Q1) predictability.

c. Balanced Customer Influence on Forecasting

Key Takeaway

A balanced influence of customer/vendor input on forecasting should be sought to drive early and accurate predictability. A balanced influence among key stakeholders helps ensure that expectations are clearly set and that accountability is sufficiently defined. A loss of customer influence on forecasting can easily occur and may prove detrimental to overall effectiveness. A project on which undue or extreme influence dictates practices and outcomes may also prove detrimental. The project team must feel accountable while still practicing inclusiveness with regard to input and review. This balance of roles in the forecasting process is also valid for the relationship between contractor and subcontractor organizations. The integration of project controls and management information across organizational boundaries will help ensure that all stakeholders are referencing common and correct information. Furthermore, a properly balanced process will help ensure the credibility of the predictions, and reduce the bias that may otherwise be introduced into the process.

Insights from the Research

The statistical evidence collected in this study determined that the amount of customer/client influence is influential to the forecasting process and the prediction of project outcomes. Organizations must work cooperatively to achieve an adequate and appropriate balance of input and participation in the forecasting process.

d. Contractor versus Owner Predictability

Key Takeaway

Contractor organizations are project-oriented. Their market survival ultimately depends on their ability to effectively and efficiently deliver capital projects for owner and client organizations. Their skills and expertise are their core competencies and are developed to satisfy the project delivery process. Contractor firms continuously build experience, since their whole business revolves around the delivery of projects. In contrast, owner organizations typically view capital projects as the means to accomplish their strategic business objectives. For example, owner organizations may require an acceleration of the project completion timeline if their products' time-to-market factors have an impact on the success of their business ventures. This study revealed that most contractor organization viewed the forecasting process as a core competency and worked continuously to improve their capability. Owner organizations did not always see forecasting as a core competency.

Insights from the Research

Since contractor organizations depend on their competency to effectively and efficiently deliver projects, the research team observed that contractor teams were more likely to have consistent implementation of practices and procedures leading to credible and reliable forecasts. Interestingly, the team also observed that, with almost an equal number of contractor projects (70) and owner projects (65) in the database, contractor projects were approximately twice as likely as owner projects to be very good predictors (Q1), while owner projects were twice as likely as contractor projects to be very poor predictors (Q4).

e. Early Trend Identification and Response

Key Takeaway

A late, reactive approach to cost and schedule trends during project execution is detrimental to early and accurate forecasting. Late sharing of information on events and trends is obviously detrimental to forecasting accuracy and timeliness. Organizations should actively support and reward practices for forecast revision at continuous or frequent intervals during the project delivery process. This study has determined that the proactive reporting of cost trends in early phases of construction is correlated with early and accurate predictability. Late reporting or identification of negative trends and events can lead to a sustained financial “bleeding” of the project. For example, one project included in the research database reported an additional \$500K cost overrun at each forecast or reporting period, ultimately resulting in a \$10 million cost deviation for the project. Most senior managers would agree that it would have been much better to hear a truthful and candid forecast as early as possible, rather than a slow, incremental reporting of the bad news. Such behaviors result in the organization forfeiting the opportunity for meaningful corrective actions.

Insights from the Research

For both contractor and owner organizations, and for both cost and time measures, the proactive and early response to progress trends, either negative or positive, was statistically correlated with early and accurate predictability.

f. Accountability

Key Takeaway

Accountability, at both the individual and organizational levels, is a key underlying factor that drives predictability. Forecasts are more credible and accurate when individuals understand that they are accountable for the information generated, and when they have an appreciation for the strategic nature of the decisions that result from the information. Some organizations view forecasts as a “promise,” driving home the personal accountability of the activity. When accountability is lacking, the overall credibility of the information is compromised.

Project teams should implement mechanisms for auditing the client organization’s reported values and input data. Management is encouraged not just to “listen to the story,” but to probe for information and test the quality of the data. A culture of accountability may be reinforced by a process of verifying the information being reported, the generation process, and the input data. Verification requires the understanding of the methods by which the forecasts are generated.

Accountability is also potentially influenced by properly implemented incentives for key stakeholders and participants. Incentive strategies may promote personal and organizational accountability, and will communicate the level of importance ascribed to the forecasting process and the deliverable that results.

Insights from the Research

This study found evidence that when forecasting accuracy was a referenced measure in performance evaluations, there was a corresponding positive influence on the accuracy and credibility of project forecasts. This observation held true for both project management and project controls personnel. Several participants in the research study reported that being held accountable in public was an effective mechanism for developing personal accountability.

g. Transparency and Trust

Key Takeaway

Transparency and trust were found to be particularly important factors; without them the ability to make timely and accurate predictions can be seriously compromised. Transparency and trust are key project team and inter-organizational attributes necessary

in functions essential to forecasting. These key functions include change management, forecasting generation, forecasting reporting, and contingency management. Transparency ensures that either good or bad news is reported.

Transparency is a “two-way” street for owners and contractors, as well as for contractors and subcontractors. All stakeholders should work to ensure the candid generation and reporting of forecasted values; all parties should also embrace practices that scope control or rapid recognition of changes.

Insights from the Research

A condition of non-disclosure of “bad news” and overall lack of transparency is not uncommon in the industry, according to many subject matter expert opinions participating in this study. However, the research clearly showed that the attributes of transparency and trust are important drivers of predictable outcomes. Expectations for the level of trust and transparency should be defined early in the project and then effectively communicated to all project team participants. Team building, long-term organizational partnering, and the development of collaborative, strategic relationships are practices that naturally improve trust and transparency among project stakeholders.

h. Scrutiny and Involvement

Key Takeaway

The research team determined that organizations that encourage scrutiny and involvement promote an atmosphere of personal and team accountability, and, thus, generally benefit from improved predictability. Conversely, project cultures that are based on fear of reprisal have poor predictability. Scrutiny and involvement, in effect, force improved transparency in the forecasting process, since they have been observed to be either 1) an ongoing practice or 2) a response mechanism to the reporting of negative trends or forecasts. As ongoing practices, scrutiny and involvement can commonly be achieved by a project controls function that is either centralized or mixed (i.e., involves a combination of central office and field office). However, scrutiny and involvement as a response to negative trends or forecasts actually drive the undesirable tendency to hold back information. The forecaster’s first reaction is to question data. The second common reaction is to believe that, “I can overcome this issue.” For instance, a common observed excuse or justification for a project manager not reporting a negative forecast is to expect an improved performance later in the delivery process. Over-optimism can be a personal trait or a reflection of the organizational culture.

Trust must be established so that those in charge of generating, reporting, or reviewing the forecast do not need to fear negative consequences when they produce negative forecasts. A fundamental rule for fostering early and accurate predictability is not to “shoot the messenger.” The researchers observed a hesitancy to expose data to the central office for fear of the home office “helicoptering in.” If subjective scrutiny and involvement promote fear over trust, a lack of transparency will prevail. In establishing such an environment, organizations almost guarantee that forecasted results will be biased, and thus, that predictability will suffer. Scrutiny and involvement must be impartial and cannot be negotiated according to the circumstances. To fail to establish impartial and reliable scrutiny and involvement is to encourage a non-transparent set of forecasting practices that will result in arbitrary reporting, over-optimism, or hidden pockets of information.

Insights from the Research

The practice of increasing the degree of scrutiny and involvement is correlated with early and accurate predictability for both owners and contractors, and for both cost and time measures. Results indicate that projects with very poor (Q4) cost predictability suffer from a lower degree of scrutiny and involvement. Even though scrutiny and involvement cannot guarantee very good (Q1) predictability, the results indicate that they significantly increase the probability of favorable outcomes.

i. Project Team’s Perception of Forecasting

Key Takeaway

The project team’s perception of the importance of the forecasting process is mostly set by management expectations, contract requirements, or a combination of the two. Both drivers can be used to ensure the project team’s positive attitude toward forecasting and to communicate both personal and team accountability to the people involved in the forecasting process. Accountability must be established—either through the contract or through management—among the people providing the input data, generating the predicted outcomes, and reporting/reviewing various deliverables and products. Management must avoid any misalignment between the demands and/or expectations of the forecasting team and the contractual requirements. Contract terms and all organizational requirements regarding forecasting should be clearly communicated through a top-down approach.

A commitment to good planning practices will support the forecasting process and help produce reliable and credible data. The value of a good forecast is positively improved by a good plan, as opposed to a good schedule or estimate alone. Thus, a positive team perception of the value of front end planning must be promoted through the cultural values of the organization.

Insights from the Research

Both owner and contractor organizations should give careful consideration to the alignment of contract terms to organizational expectations during project execution. Management should help establish positive attitudes and a climate of trust and candor. Teams should understand the importance of data quality and have an appreciation for the value of project planning. Forecasting must be understood to be much more than an algorithm.

Derailers – Human Behaviors and Organizational Culture

- Ineffective use or absence of personal incentives or bonuses within the project team
- Ineffective use or absence of personal incentives or bonuses within an organization's management or executive structure for project performance
- Reluctance to react to and/or report minor or moderate cost and time deviations/trends early on a project due to expectations that offsetting trends will emerge in the future, or that impacts to the overall project can be mitigated by effective project management
- Inadequate accountability of the forecasting team for cost and time forecasting accuracies
- Inadequate accountability of individuals parties (or functions) responsible for reviewing the accuracy of the generated project forecasts
- Poor reflection on the project manager of a forecast with a negative cost and/or time trend
- Poor transparency, candor, or disclosure in the reporting of project forecasts
- Highly pressured, extremely tense, or divisive environment under which new project forecasts are reported to senior management and/or project sponsor
- Lack of trust by the project team regarding the forecasting process

Mitigating Actions – Human Behavior and Organizational Culture

- Develop a positive culture of early and accurate disclosure.
- Develop a positive culture of transparency and trust.
- Build team alignment.
- Build alignment among stakeholder organizations.
- Build appropriate team skills and experience.
- Establish a culture of accepting risks, changes, and surprises. (Do not shoot the messenger.)
- Build strong team leadership.
- Clearly define team roles and responsibilities to generate, review, and report cost and time forecasts.
- Tailor proper contractual incentives or bonus compensation plans to reward early and accurate predictability of project outcomes.
- Establish a culture that enhances the value of early and accurate forecasting.
- Design and offer incentives that maintain motivation and alignment throughout project execution.
- Establish a moderately tense but aligned, cooperative, and supportive environment for the forecasting process.
- Include the evaluation of past schedule and cost performances against guaranteed schedule dates and completion costs as part of the regular qualification process.
- Establish a culture of accountability—within the organization and across its boundaries—among those that provide data, generate, report, and review the forecasted values.
- Establish expectations of transparency and trust early in the project.
- Establish the accountability of the forecasting team for cost and time forecasting accuracies.
- Establish the accountability of individuals parties (or functions) responsible for reviewing the accuracy of the generated project forecasts.

- Establish a culture that ensures the timely reporting of cost deviations/ trends early in the project in spite of expectations that offsetting trends will emerge in the future, or that impacts to the overall project can be mitigated by effective project management.
- Establish a tense but aligned, cooperative, and supportive environment for the forecasting process.
- On projects on which new project forecasts are reported to senior management and/or project sponsor, avoid a pressured, tense, or divisive environment. Understand and transmit contractual terms and requirements regarding forecasting.
- Include the evaluation of past schedule and cost performances against guaranteed schedule dates and completion costs as part of the regular qualification process.
- Develop long-term partnering and/or collaborations with other organizations.

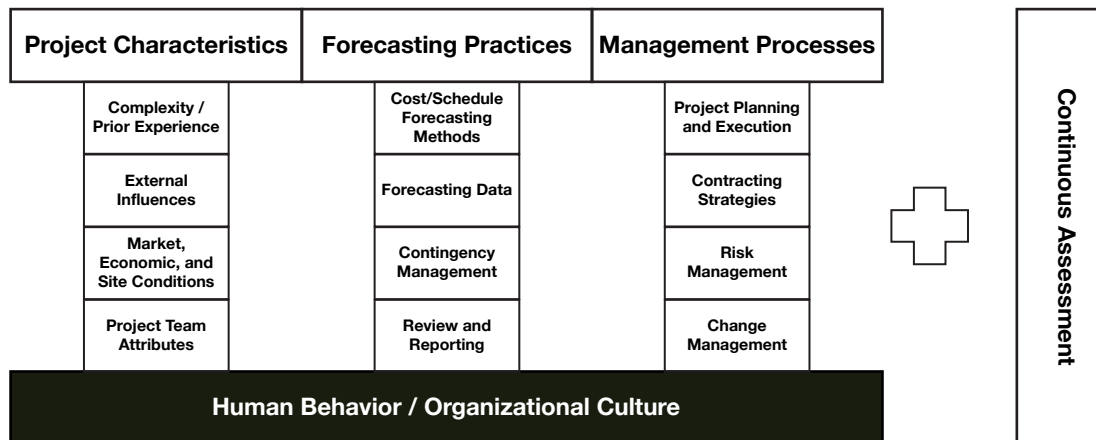
Chapter 2

Project Characteristics

The project characteristics category includes a wide variety of influences that can have significant impacts on the ability to accurately predict project outcomes. Some project characteristics may be described as conditions or attributes that are not directly controllable by the project team. Other characteristics may be more favorably influenced by direct, proactive management strategies that are designed to mitigate potential negative impacts. Regardless of how controllable they are, or the degree to which their effects can be mitigated, all project characteristics should be understood, and their potential for influencing predictability of cost and schedule performance should be recognized and addressed.

Project characteristics have been grouped into four broad categories of interest. These include the following: 1) complexity and prior experience; 2) external influences; 3) market, economic, and site conditions; and 4) project team attributes. The research team clearly determined that elements within each of these categories can have statistically significant influences on the predictability of project outcomes. The team also found numerous strategies that may be undertaken by project teams to proactively address the potential negative influences on predictability. This chapter addresses each of these individually and provides research findings, key insights, potential derailers, and mitigation strategies.

2.1 Complexity and Prior Experience



Project complexity can take many forms and involves a multitude of interacting and significant project variables. These may be due in part to the inherent considerations associated with brownfield, renovation, or even certain greenfield project delivery

conditions and requirements. Other considerations include such items as the organization's lack of experience in the delivery of similar projects, the design and specification of new, unproven, and/or unknown technologies, and owner/contractor familiarity with the geographic location of the project. Thus, the following influencing factors are discussed: unfamiliar geographic project locations; legal and permitting constraints; project complexity; project duration; new and unfamiliar technologies; and project scale.

a. Unfamiliar Geographic Project Locations

Key Takeaway

Undertaking projects in unfamiliar locations adds to the complexity of the project delivery process, and has been observed to negatively affect predictability of project outcomes. Many uncontrollable or unknown factors are associated with the delivery of projects in unfamiliar geographic locations. Such factors will not only hinder project success, but also negatively affect project predictability. The research team isolated two types of risks associated with unknown or unfamiliar locations. First, there is a high-level risk inherent to the unknown location or country, such as corruption, terrorism, currency, and natural threats, just to name a few. Secondly, there is risk more specific to the project, which includes those factors that directly affect project operations; these factors include labor, site security, and currency. Major factors to consider include the following:

- labor issues, inclusive of productivity ratios, local regulations, or availability of workmanship
- tax regulations
- currency fluctuations
- geology issues, e.g., for drilling operations
- cultural impacts
- health and safety regulations
- equipment costs
- in-country laws
- local customs

- infrastructure and logistics, e.g., harbors, electricity, gas, water, and bridges
- bureaucracy
- permitting and corruption
- distances and remoteness
- natural threats.

Insights from the Research

For owner organizations, the delivery of projects in new geographic locations was statistically correlated with the ability to make timely and accurate cost and schedule predictions. For contractor organizations, the totality of the projects executed in the first quartile in terms of schedule had been executed in the U.S.

b. Legal and Permitting Issues

Key Takeaway

The research showed that legal and permitting constraints can, and often do, have significant influence on a project team's ability to accurately predict project outcomes. Legal and permitting issues vary widely across industry sectors and geographic locations, and they can significantly influence projects, whether domestic or international. Legal and regulatory requirements can be extensive and affect all phases of project delivery. Similarly, permitting issues may influence nearly every key strategic project decision, from project planning to start-up of operations. It is important to note that legal and permitting constraints can particularly influence schedule performance or a project team's ability to predict schedule performance. The research determined that timely and accurate schedule predictions were unlikely when legal and permitting constraints were not identified, controlled, or managed effectively.

All projects contend with legal and permitting constraints to a certain extent. However, for some projects, these issues have the potential for extreme negative impacts. In fact, the research provided evidence that legal and permitting issues constitute an area of potential influence that might produce infrequent, yet major, problems. Therefore, legal and permitting constraints may be thought of generally as low-frequency, high-impact issues.

Insights from the Research

As stated above, most of the subject matter experts that contributed their insight to this research agreed that legal and permitting issues are actually always present at varied levels in a project environment. However, when examining the research data set, the team saw clear evidence that very good (Q1) performing projects simply do a much better job of proactively addressing such issues and mitigating their potential negative influence. This finding was consistent for all first-quartile projects when their ability to be predictive about cost and time performance was evaluated. In contrast, projects that were seemingly ineffective at mitigating the negative effects of legal and permitting constraints were often in the fourth-quartile. It is important for project teams to strategically, and proactively address legal and permitting constraints.

c. Project Complexity

Key Takeaway

Renovation and brownfield projects generally make it more challenging to effectively predict cost and schedule outcomes. Indeed, the complexity associated with the nature of the project (i.e., greenfield, brownfield, or renovation) was statistically correlated with predictability. Renovation projects are particularly difficult to plan and often must contend with many unknown or poorly defined conditions. Environmental constraints, geographical issues, and labor force issues also need to be carefully addressed.

Insights from the Research

The research revealed that the early and accurate prediction of project outcomes was more difficult for renovations than any other types of projects. This was particularly true for owner organizations; the majority of owner projects that were poor predictors were renovation projects. Renovation projects are much more difficult to plan, and owners are perhaps inclined to keep the majority of scope risks associated in such projects. Thus, for owner organizations, the more complex the project is, the more uncertain the cost and time predictions are going to be. In contrast, the nature of the project (i.e., greenfield, brownfield, or renovation) seems not to affect predictability for contractor organizations.

d. Project Duration

Key Takeaway

Project duration affects the ability of contractors and owners to predict cost and time performance accurately. The influence of project duration on early and accurate cost forecasting seems more relevant to owner organizations, however. Industry experts indicated that projects with shorter durations (e.g., turnarounds and revamps) are likely to be schedule-driven. Thus, cost control, especially for owners, is likely to become a secondary objective that is more difficult to predict reliably. Short-duration projects can challenge the project team's ability to forecast actual project completion outcomes with the accuracy often required by project sponsors. This challenge is particularly prevalent when design and construction overlap. But, when design is almost completed, short-duration projects show a lower exposure to design changes, escalation, or currency exchanges. Contractors are more likely to understand how critical of cash flow is to successful short-duration projects. Hence, contractors become better cost predictors for such projects.

In some cases, a long-duration project seemed susceptible to more changes and a less defined scope. However, longer-duration projects also had the benefit of more float, and had more time to address performance and forecasting derailers. They also had more time to exercise corrective actions as deemed necessary.

Insights from the Research

The research indicated with statistical significance that owners are better able to predict cost outcomes on projects with longer durations than are contractors. Indeed, longer lasting project were shown to negatively affect the ability of contractor organizations to predict cost outcomes.

e. New or Unfamiliar Technologies

Key Takeaway

New or unproven technologies negatively affect early and accurate predictability. Industry experts observed the potential of new or unproven technologies to negatively affect forecasted outcomes. Such influence may vary with the level of “technology readiness.” Testing and technology readiness are also related to the ability to scale up a new technology for its project implementation. Certain industry sectors, such as chemical, petrochemical, or manufacturing, are sources of proprietary technologies and limit the utilization of known technology to serve the purposes of the project.

Insights from the Research

The U.S. nuclear industry may offer a good example of the impact of new or unfamiliar technologies to the project delivery process. The U.S. Department of Energy has developed a “test readiness” scale from 1 to 9; when a mock-up of the technology passes a test run, it is rated a 6 on the scale (a rating of 9 is equivalent to the full implementation of the technology). Still, the team found evidence that testing a technology through a mock-up (level 6) does not guarantee the prevention of scalability issues during the project implementation of the technology.

f. Project Scale

Key Takeaway

For both owners and contractors, the research team observed that the total installed costs on small projects are more difficult to predict than on larger projects, with respect to final cost outcomes. Since small-dollar projects often have an inherently lower cost risk, they do not perhaps always have the dedicated effort or emphasis on predictability that is characteristic of higher-risk large projects. Also, the size of a small project may not benefit from the organizational investment of core competencies for the delivery the project. Such projects often have fewer dedicated human resources, and frequently less overall experience. A resource constraint is frequently prevalent on small projects.

The fact that small projects have a short completion time further aggravates their cost predictability. (See the discussion below in the *Project Duration* section.) Trends are difficult to establish, since time is not available in a short project. However, it was noted that small projects are often critically or strategically important to the sponsor.

Potential Derailers – Complexity and Prior Experience

Following are the potential derailers associated with complexity and prior experience:

- the complexity associated as a result of greenfield/brownfield/renovation project delivery conditions
- design and specification of new, unproven, and/or unknown technologies
- unfamiliarity with project location
- owner’s lack of experience in the delivery of similar projects
- contractor’s lack of experience in the delivery of similar projects.