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Benchmarking Project Success

Michele R Hamilton
Arizona State University
Tempe, AZ

Measuring project success is elusive. Most previous studies focused strictly on either a qualitative or quantitative measurement of success. This paper will present a powerful measurement system that combines the two. The system was developed through the study of 53 capital improvement projects. Data were gathered by way of project historical records as well as interviews with the major project participants. Project success variables were identified. Subsequently, meaningful measures of the variables were developed and the most probable data source was selected. Data analysis is in the form of index construction and validation. The success index includes the following objective measures: cost performances, schedule performance, plant utilization, and design capacity obtained after six months of operation. Variable weights were constructed using subjective data obtained through 131 interviews. With the combination of objective and subjective measures, a potent benchmark for project success was developed.

Key Words: Project Success, Success Index, Measuring Success

Introduction

The measurement of project success is an immense task. A comprehensive review of current literature identified many studies that have tried such a measurement. Several researchers have concluded that measuring project success in solely objective terms is an impossible task (de Wit 1986; Morris 1986; Stuekanbruek 1986). There are many reasons for the complexity of measurement of results. These include: project objectives that change ova time, the multitude of project participants and stakeholders and their different objectives, and the subjective nature of many desirable project outcomes (deWit 1986). This study defines a method for benchmarking project success that combines objective, historical data with subjective project data. First, project success measures and data sources were identified. Data were then collected from 53 industrial projects. Subsequent statistical analysis of the objective data and qualitative analysis of the subjective data resulted in a success benchmark.

A research team under the guidance of the Construction Industry Institute (CII) accomplished this research. CII is a consortium of large owner, engineering and construction firms. It was founded in 1983 to conduct research in the engineering and construction arena. Currently, it has 90 members and is considered one of the premier research organizations in the world dealing with project management issues. The specific research team that charged with defining project success consisted of approximately 16 industry personnel, split among owner and contractor personnel, along with an academic researcher.

Methodology

Because no clear definition of success existed for use in this study, the first step of the research team was to conceptualize success. Four initial broad categories of success were produced: business, project management, operations and social. These four concepts were further defined by nine categories. Business success consists of the sub-categories of marketing and financial success; project success consists of three sub categories: quality management consists of project controls and ease of E/P/C. Success in the area of operations consists of the sub-categories of construction/ operations transition, operating characteristics and maintenance. Lastly, social success is a category unto itself.

After determining the variable measures, the data sources with the highest probability of providing the best information were selected. Success variables are shown in column one of Appendix A. Data were available from one of four sources: business manager (BU) shown in column two, project manager (PM) shown in column 3, operations manager (OP) shown in column 4 or Project historical data (Historical) shown in column S. Data from the project representatives were collected through telephone interviews, whereas historical data were gathered using a project questionnaire. Categories of variables and data sources are indicated in Appendix A with an asterisk (Gibson, Kaczmarowki and Lore, 1993). As can be seen, multiple data sources were used wherever possible.

Variable Measurement

After the variables were defined and data sources identified, the specific measure of the variable was determined. This was a critical stage in the development process.
Only through examination of meaningful measures can any fruitful research results be discovered. Some general guidelines for a good measure, or metric, come from "The Metrics Handbook" developed by the U. S Air Force (1991). As stated in the handbook, "For a measure to be meaningful, it must present data that allow us to take action. It must be customer oriented and support the meeting of organizational goals and objectives. Metrics foster process understanding and motivate action to continually improve the way we do business." The success measures used in this study are shown in Appendix B and are detailed by the variables and measures in column 1, the objective measure in column 2, and the subjective measure in column 3.

Data Sample

In order to obtain data, we contacted all Construction industry Institute owner-members for possible participation. Twenty-two CII owner-member companies responded Table 1 shows how many of each type of company, by industry, responded to the survey. Column 1 exhibits the company type, while column 2 presents the number of respondents corresponding to each project type. Even though they represent different market sectors, all companies have a common need to build capital improvement projects to meet product and regulatory needs.

From the 22 companies, 62 projects were selected for study. Data on 53 of the projects was sufficient to evaluate success. These 53 projects represent 19 owner companies. Characteristics

of the sample 53 projects are shown in Figures 1, 2, and 3. Figure 1 shows that the majority of the projects, 24 (48 percent), are retrofit/expansions, with 18 (34 percent) being co-located and 11 (20 percent) being grassroots projects.

Table 1

Company Type

Company Type	Number
Petro-Chemical	6
Chemical	5
Pulp and Paper	2
Power	2
Consumer Products	2
Petroleum	2
Pharmaceutical	1
Communications	1
Government	1

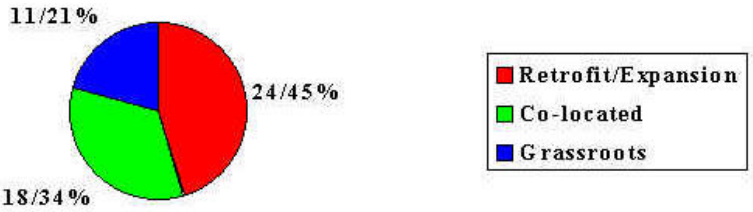

Figure 1. Sample construction type.

Figure 2 depicts the project types: 32 (62 percent), are chemical, petro-chemical or petroleum refinery, with power and consumer products making up 15 (28 percent) of the sample.

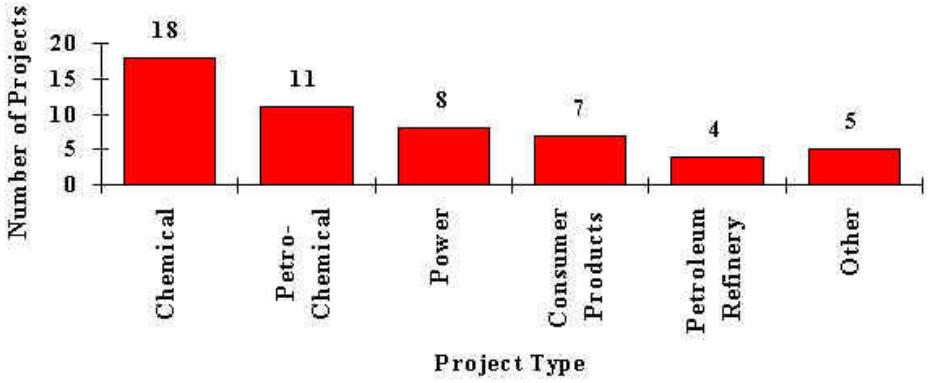

Figure 2. Sample project type.

Figure 3 shows the distribution according to project size. As shown in Figure 3, twenty-six (49 percent) of the projects had authorization budgets of $25 million or less with 13 (24 percent) in the $25 to $50 million dollar range and the remaining 14 (27%) in the range between $50 to $350 million.

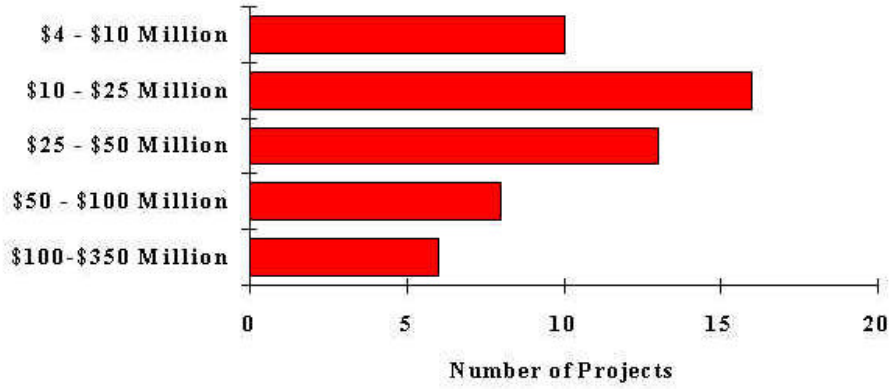

Figure 3. Project size.

Development of the Success Index

The success index was developed by first identifying the individual variables from Appendix A that qualified for inclusion. This was done through testing each variable by using a process that requires each variable step-wise insertion into a statistical procedure. This test measures the reliability and validity of an index and its value as a composite gauge of the concept being measured. The resulting variables forming the index measuring project success are listed below with their definitions and standards of measurement.

Budget Achievement

Budget achievement is defined as adherence to the authorization budget. It is measured by the percent of deviation from the authorization budget to the final project cost.

Schedule Achievement

Schedule achievement is defined as of deviation from the authorization schedule by the actual project schedule.

Design Capacity

Design capacity is defined as the nominal output rate (i. e. tons per year, barrels per day, kilowatts, etc.) of the facility which is used during engineering and design-to-size equipment and mechanical and electrical systems. The measurement used was the percent of planned at authorization attained after six months of operation.

Plant Utilization

Plant utilization is defined as the percentage of days in a year that the plant actually produces product. The unit of measurement is the same as for design capacity: the percent of planned at authorization attained after six months of operation.

Variable Weights

To give the variables weights, a qualitative analysis of the interview data was performed. The exact, open-ended question asked of the project players was "What are your main reasons for your assessment of the project's level of success" One hundred and thirty-one responses were obtained and analyzed. They were categorized into factors using qualitative analysis techniques. This analysis revealed the specific variables and categories that participants considered being significant to success and their relative level of importance (Tortora 1993).

Project controls and operating characteristics were identified as the most important areas of success by the interviewees. An analysis of the responses revealed the index variables to have the weights shown in Table 2. The measurement category is shown in column 1 with its weight in column 4.

Table 2

Success Variable Weights

Success Category	**Variable**	**Variable Weight**	**Category Weight**
Project Success			0.60
	Budget Achievement	0.55	
	Schedule Achievement	0.45	
Total Variable Weight		1.00	
Operating Success			0.40
	Design Capacity Attained	0.70	
	Plant Utilization	0.30	
Total Variable Weight		1.00	
Total Category Weight			1.00

Each index variable weight is shown in column 2, with corresponding weights in column 3. The columns depicting weights (2 and 3) both add up to 100%. It should be recognized that this step, in itself, represents a unique contribution to success measurement. The index combines objective historical data with relevant and timely subjective criteria. This resulting formula, equation (1), was used to calculate the success index, which represents an industry benchmark for project success.

Success Index Value = 0 .60 * (O.55 Budget Achievement Value + 0.45 Schedule Achievement Value) + 0.40 * (0.70 Design Capacity Attained Value + 0.30 Plant Utilization Attained Value) Index values for success were calculated f or each sample project. A frequency distribution of these values indicated that the maximum value was 5.0 and the minimum was 1.0. The average

value was 3.2 and median value was 3.1. The standard deviation was 1.0. Since the lowest score possible was 1.0 and the highest 5.0, these statistics show a fairly even distribution.

Index Validation

In validating the success index, the hypothesis that there is a significant, positive correlation between a project's level of success, as defined by the success index, and whether or not the project exceeded, met, or fell short of its overall financial go also was tested. Using the k-independence test for significance, the relationship between the success index values and overall financial success was positive and significant at the 0.07 level. Therefore, as the success index value increases so does the likelihood that the project will meet or exceed its financial goals. This is an important finding because it tells us that by achieving the four performance measures comprising the success index, a project is very likely to exceed or meet its overall business goals, the bottom line. The fact at there was a significant relationship between the success index and achievement of overall financial goals, another success measure, is a good indicator that the success index is valid.

Summary

This research produced a composite measure, which can be considered an industry benchmark, for the level of success attained for a capital improvement project (see Formula 1).
The measure includes four baseline performance measures, which are shown in Table 3. Column 1 denotes each success variable, while column 2 provides the specific measure.

Table 3

Success Baseline Measures

Variable	**Measure**
Cost Performance	Percent Deviation from Authorization
Schedule Performance	Percent Deviation from Authorization
Design Capacity Attained	Percent of Planned Attained
Plant Utilization	Percent of Planned Attained

This research reveals that the resulting success of a capital construction project can be measured comprehensively. It uniquely combines factual data along with appropriate subjective opinion data to produce an industry benchmark. By using this measurement system a company can gauge its performance, and determine its weak areas and improve them, promoting continual improvement of performance and an increased competitive advantage.

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Appendix A

Sources of Success Data

Variables	BU	PM	OP	Historical
BUSINESS SUCCESS				
Capture/Maintain Market Share	*			
Enhance Future Position	*			
Gain Competitive Advantage	*			
Financial Authorization Objectives	*			*
PROJECT SUCCESS				
Owner Cost				*
Owner Procured Equip/Material				*
Engineering Design Cost				*
Construction Cost				*
Commissioning and Turnover Cost				*
Start Up Costs				*
Teamwork Effort	*	*	*	
Customer Satisfaction	*	*	*	
Project Personnel Turnover		*		
Professional Performance		*		
Guidance From Management	*	*		
Rework		*		
Extent of Punchlists		*	*	
Budget Achievement	*	*		*
Schedule Achievement	*	*		*
Change Management		*		
Number/Magnitude of Changes		*		*
Effective Communications	*	*		
Risk Management		*		
Basis of Design		*		
Scope Definition		*		
Execution Strategy		*		
Constructability		*		
SOCIAL SUCCESS				
Achieves Legal & Regulatory Compliance	*	*	*	*
Labor Relations	*	*	*	
Safety and Health	*	*	*	*
Craft Labor Turnover		*		
Craft Labor Absenteeism		*		
Equal Employment Opportunity	*	*		*
Environmental	*	*	*	*
Community Relations	*	*	*	*
Noise		*	*	

Education/Training	*		*		
OPERATION SUCCESS					
Ease of Turnover		*	*		
Ease of Startup		*	*		
Spare Parts Availability		*	*		
Operator Training		*	*		
Equipment Documentation Availability		*	*		
Ease of Operation	*	*	*		
Availability	*	*	*	*	
Flexibility	*		*		
Production Quality	*		*	*	
Performance (cost to manufacture)	*	*	*	*	
Plant Utilization				*	
Design Capacity	*		*	*	
Unanticipated Retrofits			*	*	
Maintainability			*	*	

Appendix B

Measure of Success Variables

Variables	Measure	
	Objective	**Subjective**
BUSINESS SUCCESS		
Capture/Maintain Market Share		Objectives Achieved
Enhance Future Position		Objectives Achieved
Gain Competitive Advantage		Objectives Achieved
Financial Authorization Objectives	Objectives Achieved	Objectives Achieved
PROJECT SUCCESS		
Owner Costa	Deviation from Authorization	
Owner Procured Equip/Material	Deviation from Authorization	
Engineering Design Cost	Deviation from Authorization	
Construction Cost	Deviation from Authorization	
Commissioning and Turnover Cost	Deviation from Authorization	
Start Up Costs	Deviation from Authorization	
Teamwork Effort		Participation
Customer Satisfaction		Needs were Satisfied
Project Personnel Turnover		Frequency of Change
Professional Performance		Performance Quality
Guidance From Management		Quality of Guidance
Rework		Amount
Extent of Punchlists		Amount
Budget Achievement	Deviation from Authorization	Objectives Achieved
Schedule Achievement	Deviation from Authorization	Objectives Achieved
Change Management		Quality of Management
Number/Magnitude of Changes	Percent of Total Cost	Magnitude
Effective Communications		Communication Level
Risk Management		Project Impact
Basis of Design		Success Contribution
Scope Definition		Smooth Execution
Execution Strategy		Actual v. Planned
Constructability		Use of
SOCIAL SUCCESS		
Legal & Regulatory Compliance	Any Unanticipated Encountered	Requirements Achieved
Labor Relations		Quality of Relations
Safety and Health	OSHA Recordables	Goals Achieved
Craft Labor Turnover		Turnover Rate
Craft Labor Absenteeism		Frequency
Equal Employment Opportunity	Percent of Target Achieved	Goals Achieved
Environmental	Percent of Attainment of Goals	Goals Met
Community Relations	Percent of Attainment of Goals	Goals Met

Noise		Goals Met
Education/Training		Goals Met
OPERATION SUCCESS		
Ease of Turnover		Smooth Turnover
Ease of Startup		Phase Well Executed
Spare Parts Availability		Available as Needed
Operator Training		Level Adequate
Equipment Documentation Availability		Available as Needed
Ease of Operation		Goals Met
Availability	Percent of Planned Attained	Goals Met
Flexibility		Goals Met
Production Quality	Percent Requirements Attained	Goals Met
Performance (cost to manufacture)	Percent of Planned Attained	Goals Met
Plant Utilization	Percent of Planned Obtained	Goals Met
Design Capacity	Percent of Planned Attained	Goals Met
Unanticipated Retrofits	Yes/No; Cost	
Maintainability	Percent Obtained	