

# QUALITY BENCHMARKING IN CONSTRUCTION INDUSTRY

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**Abstract** - This paper focuses on the study of the differences among the industries, when performing the planning stage of projects. Project planning is a very critical stage during the project life cycle, since if planning is faulty; a proper execution following the approved plan will end with a faulty project. Studies have identified planning as one of the critical success factors in a project (i.e. Pinto & Slevin, 1989; Meredith & Mantel, 1995; Johnson et. al., 2001etc.). Thus, high-quality planning increases the chances that the project will be properly executed and completed. Responsibility for planning lies with the project manager, who must ensure that it is carried out properly, and to the complete

satisfaction of all relevant stakeholders. Following are the part of this study:

1. Construction and engineering organizations plan their projects better than other organizations.
2. Construction and engineering organizations succeed in their projects better than other organizations.
3. Production & maintenance organizations plan their projects worse than other organizations.
4. Production & maintenance organizations succeed in their projects less than other organizations

## 1. INTRODUCTION

Benchmarking is an important continuous improvement tool that enables companies to enhance their performance by identifying, adapting and implementing the best practice within a participating group of companies.

To identify the management practices that under in these performance differences, it is necessary to complement a quantitative benchmarking system with a qualitative one based on a structured industry questionnaire. Qualitative benchmarking provides information on different management dimensions to help identify best practices and explain observed performance differences.

Benchmarking is now regarded as a vital tool in the quality toolbox and the applications of benchmarking continue to grow in number and diversity as reflected in the literature. The last two decades have witnessed a surge in the quest for quality as the markets are shrinking due to stiff competition. This sustained interest on using the

technique of benchmarking to improve quality has resulted in a surfeit of articles and books. Decision-makers are constantly on the lookout for new techniques, to enable quality improvement. While benchmarking, as a technique for quality improvement is not new or unknown, it has now found more subscribers, and occupies a prominent place in the action agenda. Quite often, the benchmarking concept is understood to be an act of imitating or copying. But in reality this proves to be concept that helps in innovation rather than imitation, as stated by Thompson, *et. al.* (1997).to study the recent development in quality benchmarking.

## 2. Review of Literature

2.1. This paper presents the results of the first application of a management evaluation system for benchmarking management practices in the construction industry. The system supports a National Benchmarking System recently established in the Chilean Construction Industry by incorporating qualitative management aspects in addition to quantitative performance indicators. Different analysis were made to determine trends in the industry sector by correlating the qualitative evaluations from surveys with the performance indicators. Thirteen construction companies participated in the initial application of the benchmarking system. A correlation analysis found that safety performance was strongly related to companies having superior planning and control, quality management, cost control and subcontractor management policies. An factor analysis undertaken found that Central office priorities center on strategic management policies having longer term competitive impact, whilst site management emphasizes tactical management dimensions consistent with shorter term impact. There is scope to elevate the profile of continuous improvement initiatives to strategic significance at central office level.

2.2 In today's highly competitive construction industry, there is a critical need for managers to continuously improve their firm's efficiency and effectiveness. More specifically, managers need to know which performance

measures are most critical in determining their firm's overall success. Benchmarking, when done properly, can accurately identify both successful companies and the underlying reasons for their success. However, rigorous benchmarking within and metrics used traditionally in the construction industry and the benchmarking models developed to date for the industry. Based on the results of this analysis, benchmarking models using data envelope analysis are proposed the construction industry still remains an embryonic field. This paper analyzes and critiques both the performance measures that offer significant improvements over current models. The proposed models measure construction firm performance on a company-wide basis, foster trade-off analyses among various performance metrics, and tie the resources expended by construction firms to how well those firms perform overall. The models also provide managers guidance in determining how specific company resources can be reallocated to improve overall company performance.

2.3 Benchmarking can be an effective way of helping organizations to deliver better services through continuous improvement. The concept of benchmarking has been extensively applied to the construction industry in recent years to enhance the performance of the project delivery process. Success is hard to achieve, especially for a construction project delivered by an innovative procurement method – design and build, and the identification of critical success factors can enable project team leaders to make improvements in some particular areas. This paper aims to establish a conceptual framework of critical success factors (CSFs) for design build projects in construction. From the framework, it is hypothesized that project success of a design build project is a function of the interaction among project characteristics, project procedures, project management strategies, project related participants, project work atmosphere and project environment. The CSFs so identified can provide practitioners and academics with a better understanding of running a design build project successfully to develop a benchmark for the D&B project delivery process.

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2.5 This paper focuses on the study of the differences among the industries, when performing the planning stage of projects. Project planning is a very critical stage during the project life cycle, since if planning is faulty; a proper execution following the approved plan will end with a faulty project. Studies have identified planning as one of the critical success factors in a project (i.e. Pinto & Slevin, 1989; Meredith & Mantel, 1995; Johnson et. al., 2001 etc.). Thus, high-quality planning increases the chances that the project will be properly executed and completed. Responsibility for planning lies with the project manager, who must ensure that it is carried out properly, and to the complete satisfaction of all relevant stakeholders

## Research Hypotheses

Literature review presented above, introduced vast use of benchmarking in the project management environment. Much of these researches were focused on the differences in project management capabilities among industries. Since this paper is focused on project planning, hypotheses were based on previous findings and were adapted to the planning phase. The main question to be tested in this paper is whether differences found among industries exist in the planning phase as well. Following the above discussion, the following four hypotheses are raised and tested as part of this study:

1. Construction and engineering organizations plan their projects better than other organizations.

2. Construction and engineering organizations succeed in their projects better than other organizations.

3. Production & maintenance organizations plan their projects worse than other organizations.

4. Production & maintenance organizations succeed in their projects less than other organizations.

The study uses the Project Management Planning Quality (PMPQ) model, which was recently introduced by Zwikael & Globerson (2004), for analyzing the use of project planning process in each industry type. The next section describes the model briefly, followed by data analysis.

### 3. Methodology

#### 3.1 Purpose

To identify the industry in which projects are best planned and executed and use it as a benchmark for improving project planning in other industries.

#### 3.2 Methodology

Based on data collected from 280 project managers, project success and quality of project planning were evaluated and analyzed for four industries - construction & engineering, software & communications, services and production & maintenance

#### 3.3 Findings

Quality of project planning was found to be the highest in construction and engineering organizations and the lowest in manufacturing organizations. This is a result of a few factors, among them the intensive organizational support which is offered to project managers working in construction and engineering organizations. The other three industries limit their support mostly to tactical aspects, such as the purchasing of project management software. The high quality of project planning in the construction and engineering organizations resulted in their ability to complete projects by almost half the cost and schedule overruns, as compared to organizations belonging to the other industries.

#### 3.4 Research limitations

Findings are limited to the four industries included in the study.

### Practical implications

If organizations, not belonging to the construction industry, wish to improve the probability of success in project planning and execution, they should follow methodologies commonly used in the construction industry.

### 3.5 The PMPQ model

The PMPQ model evaluates the overall quality of project planning. It is based on the processes to be performed during the planning phase of a project, by both the project manager and the organization to which the project manager belongs to. The model analyses project planning processes that are defined by the Project Management Body of Knowledge (PMI Standards Committee, 2004), which is American National Standard Institute (ANSI). It is assumed that the more frequent a certain process is performed by an organization, the more competent the organization is recognized as the main body of knowledge in the project management area, and is accepted as a standard by the in that process. Since a process has products to be achieved at its end, a major product was identified for each of 16 planning processes. For example, the major product that project managers should generate as an output for the "scope definition" planning process is a Work Breakdown Structure (WBS) chart. The frequency, in which a planning product is generated, is easy to estimate and, therefore, was used to estimate the frequency in which a process is performed – the maturity level of that organization on that specific process. Yet, the quality of planning is not impacted only by processes that are performed by a project manager, but also depends on organizational support. Therefore, the second group of items in the PMPQ model includes 17 organizational support processes.

All together, there are 33 products in the PMPQ model. A questionnaire was used for collecting the required data. Participants were requested to evaluate the use intensity of the planning products, by using a scale ranging from one (low use intensity) to five (high use intensity). Participants were also requested to evaluate the following four project success dimensions: Cost overrun and schedule overrun, measured in percentages from the original plan; technical performance and customer satisfaction, measured on a scale of one to ten (1 representing low technical performance and low customer satisfaction, and 10 representing high technical

performance and high customer satisfaction). The model's reliability was calculated using a number of statistical tests, such as Cronbach alpha. Results were considerably higher (0.91 and 0.93 respectively) than the minimum value required by the statistical literature (Garzezy et. al., 1967), both for the entire model, and for its components. Results were also found to be independent of the person answering the questions, be it a project manager or a senior manager.

The model's validity was evaluated by comparing the overall project planning quality indicator derived from the model, with the projects' success, as estimated by a separate set of questions. It was found that quality of planning index was highly correlated with the perception of projects' success, as measured by cost, time, performance envelope and customer satisfaction, as well as with the perceived quality of planning. The correlation remained very high and significant for several other options of weighting. A summary of the analysis is presented in Table 1. All results are statistically significant with p-values under .01.

Success Measure	The Intersect	Regression Slope	R	p-value
Cost Overrun	108%	-25%	0.52	< 0.001
Schedule Overrun	94%	-18%	0.53	< 0.001
Technical Performance	6.2	0.5	0.57	=0.001
Customer Satisfaction	6.1	0.6	0.51	<0.001

Table 1 – Validity Tests for the PMPQ Model

The quality of planning was correlated with each of the project's final results and with the subjective assessment of the project manager regarding the quality of planning. The conclusion from the above statistical analysis is that the PMPQ model is reliable and valid and can be used to evaluate the quality of project planning.

### Data Collection

The questionnaire was administered to 282 project managers in Israel, in 19 different workshops, of which nine were administered as part of an internal

organizational project management-training program. Each of these nine workshops included an average of 13 individuals. The other 10 workshops were open to project managers from different organizations. A questionnaire was dropped from the final analysis, if less than 80% of its data has been completed. Using this criterion, 201 questionnaires remained for the final analysis. Based on these questionnaires, an analysis of project results and the use intensity of different project processes are described below.

## 4. Results and discussion

The questionnaires were divided into the following four industries:

Construction & Engineering (i.e. building companies), Software & Communications (i.e. telecommunications companies), Services (i.e. banks) and Production & Maintenance (i.e. food industry). In this section, the use intensity analysis of the planning processes will follow the comparison of project success among the industries.

### 4.1 Project Success Analysis

This section introduces overall success results followed by a comparison among the four industries. The analysis of technical performances and customer satisfaction indices will follow the analysis of cost and schedule performance of projects.

**Cost and Schedule Overruns.** The average cost overrun quoted by the participants was 25%, ranging from savings of 20% and up to spending 400% more than the original budget. The average schedule overrun was 32%, ranging from 5% ahead of time, up to a schedule overrun of 300%. The frequency distribution of cost and schedule overrun is presented in Figure 1.

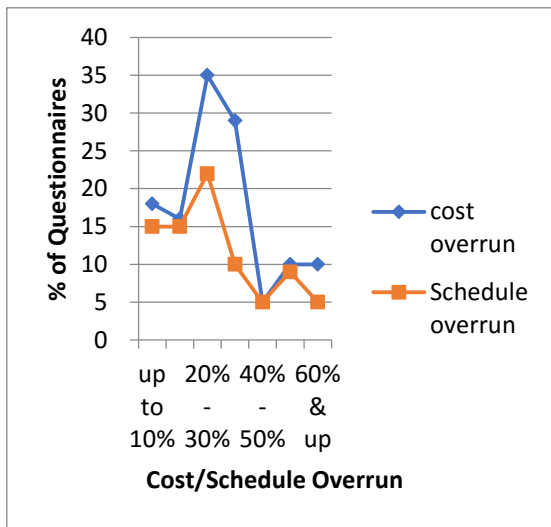


Figure 1:- Frequency distribution of cost & schedule overrun

Most project managers reported cost deviations within the range of 20% to 30% and 30% to 40% in duration deviation, while a few showed significantly larger deviations, thus leaving a long tail at the right side of the graph representing overruns. Similar overrun findings were found in previous studies (i.e. Johnson et. al, 2001). The R square to the linear correlation between cost as the dependent, or the effected, variable and schedule overrun as the independent one was found to be 0.57 (p value<0.001), showing a strong relationship between the two, with the following linear equation between the two:  
 $Cost\ Overrun = 0.76 * Schedule\ Overrun$

The interpretation of the equation shown above is that the value of the cost overrun is 76% of the schedule overrun, when the two are presented in percentages. A major reason for the relationship between increase in duration and cost increase stems from the additional cost required for the supporting the required infrastructure; as long as a project is running it requires a certain infrastructure per unit of time. Such infrastructure items are the project manager, quality assurance support, data processing support and so on. A good example is a crane in a construction site; as long as construction is going on, the crane is needed. In other words, a significant portion of the infrastructure resource is paid per unit of time. The above finding is also supported by previous findings (i.e. Chittister & Haimes, 1996).

### 4.3 Technical performance and customer satisfaction.

Both measures are of a similar frequency pattern, as presented in Figure 2.

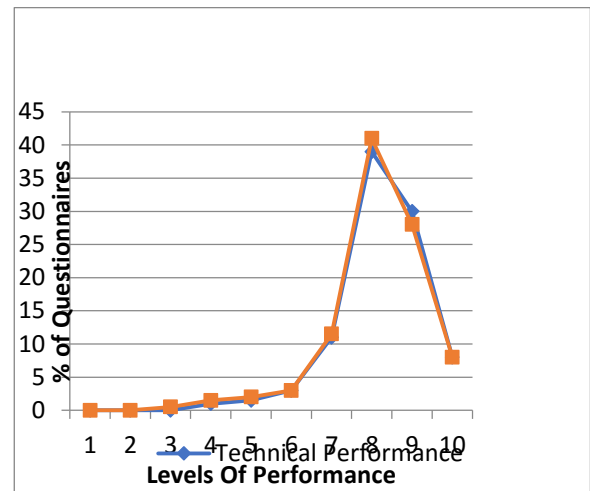


Figure 2- Frequency Distribution Of Technical Performance and Customer

The horizontal coordinates represent the performance level of either technical performance or customer satisfaction, on a scale of 1 to 10, where "1" is the lowest level. The distributions of both are of a similar nature with an average of around 8, which is considered a high performance level. The R square to the linear correlation between technical performance and customer satisfaction was found to be 0.37 (p value< 0.001), showing a strong relationship between the two. The high score on these two measures, as compared to the relatively poor performance on cost and schedule, points out that customers may be more interested to achieve high technical performance rather than to keep the project on schedule and without cost overrun.

In order to explore the differences in project success among the industries, results were separated accordingly and are presented in Table 2.

Industry Type	Number of Questionnaires	Cost Overrun (%)	Schedule Overrun (%)	Performance Envelope (1-10 scale)	Customer Satisfaction (1-10 scale)
Construction &	35	17%	19%	8.1	8.1



Engineering					
Software & Communications	98	27%	33%	8.2	8.3
Services	8	23%	27%	8.3	8.3
Production & Maintenance	10	26%	32%	7.9	7.9

Table 2: Project Success Indices for Four Industry Types

As can be observed from Table 2, construction & engineering organizations finish their projects with significantly ( $p$ -values $<0.01$ ) lower cost and schedule overruns, compared to other organizations belonging to the other three industries. These results fit findings quoted of other studies (e.g. Pennypacker & Grant, 2003; Ibbs & Kwak, 2000), in which construction & engineering organizations have the highest level of project maturity. Software & communication organizations, as well as services ones, usually do not reach cost and schedule targets. However, performance envelop of their projects is relatively high and their customers are more satisfied. These results may derive from the customer service orientation of these companies.

Production & maintenance organizations were found to be the poorest performer in all four criteria, which may result from the fact that projects are not part of the regular operation of such companies as they focus on operations. The next section will evaluate the ability of companies within each industry to plan the project, and relates their planning ability to their end results in project execution.

#### 4.4 Planning Processes Analysis

The quality of planning was calculated as the weighted average of the frequency in which each of the 33 planning products was executed, as execution frequency is an indicator of quality of planning. Figure 3 presents the quality of planning of the four industries.

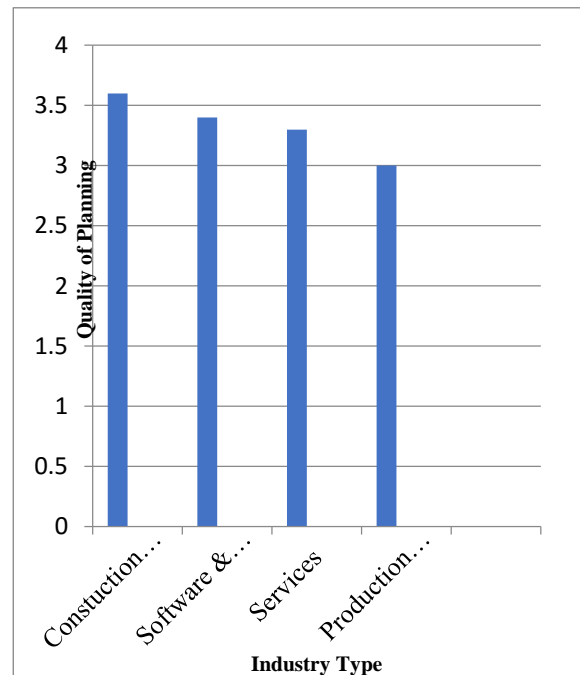


Figure 3: Quality of Planning, by Type of Industry

Similar performance ranking on project's success that was found among industries was repeated in ranking the industries on the level of quality of planning. Construction and engineering organizations, which scored the highest on project success, also obtained the highest score on quality of planning. Production and maintenance organizations, which scored the lowest on project success, received the lowest quality score as well. This performance deviation among the industries is probably due to the difference in the nature of their operations. While construction and engineering companies are project oriented, as most of their work involves initiation and execution of new projects, production and maintenance organizations are engaged mostly with day-to-day operations, and their planning is oriented to that rather than to project planning.

It may be surprising to note that despite a high quality level of planning in software & communications organizations, these organizations still often conclude projects with poor results. The reason for this may be due to a riskier technology and environment, poor control or too ambitious commitments taken during the initiation phase.

Although the data in Figure 3 shows possible differences among the industries, a statistical analysis should be used for reliable analysis. A cluster analysis was performed for this purpose. The  $p$ -values that support a significant

difference between two industry types was calculated using t-tests are presented in Table 3.

Industry Type	Construction & Engineering	Software & Communications	Services	Production & Maintenance
Construction & Engineering	-			
Software & Communications	0.04	-		
Services	0.07	0.49	-	
Production & Maintenance	0.003	0.02	0.49	-

Table 3: p-values representing Differences in Quality of Planning among Four Industry Types

The cluster analysis places the construction & engineering organizations as the leaders in project planning, and the production & maintenance organizations as the ones having the worst quality of project planning. The analysis described in this paper was repeated for a cluster of eleven organizations in Japan, with the participation of 88 project managers from those companies. Sixty of the project managers were from software organizations, 19 more from production organizations and nine others from other organizations. The next paragraphs will compare project results and quality of planning in both countries and analyze the findings.

Cost and schedule overruns in Japanese production organizations were the highest among production organizations (20% and 10% respectively) and lowest among Software & communications organizations (5% and 3% respectively). While the ranking is similar to the ones found in Israel, the values are quite different between the countries. Average overruns in Japan are significantly lower than in Israel and may be a result of the importance of meeting objectives, as is reflected in the Japanese culture.

Japanese production organizations also scored lower in the quality of planning, compared with software organizations, although results came out statistically non-significant due to the small number of questionnaires addressed in Japan. Still, industry ranking found in Israel, was identical to the one found in Japan, serving as an indication that the above finding may be a general one and not dependent on culture.

### 5. Conclusion

By analyzing the quality of project planning in different industries, it was found that construction and engineering organizations maintain the highest quality of planning, both in the organization level and the project manager level. It is probably due to the project-oriented nature of these organizations. Its greatest weakness is risk management, which may stem from lack of managerial know-how. The other extreme industry is production and maintenance organizations, which plans their projects at the lowest level of quality, perhaps due to the difficulty they have in comprehending the basic difference between managing a project and carrying out their day-to-day tasks.

The organizational support processes were found to have a great influence on the quality of the processes performed by project managers. An organization that does not make enough effort to support its projects gets in return low-quality project plans, such as the situation in the production and maintenance industry. On the other hand, construction and engineering organizations that support projects effectively, obtain higher quality project plans from their project managers.

A correlation between the quality of planning and the success of the project at its conclusion was also found. For example, construction and engineering organizations have the greatest project success, compared to other industries. Finally, the impact of improving project plan may improve project management at the entire life cycle of the project. Once processes are performed correctly at the planning phase, it will be easier for the project manager to continue manage the other project phases at the same level of quality, until the project's successful conclusion.

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