LEARNING FROM COLLABORATIVE BENCHMARKING IN THE CONSTRUCTION INDUSTRY

Luis F. Alarcón[1], Alejandro Grillo[2], Javier Freire[2] and Sven Diethelm[1]

ABSTRACT

A collaborative research effort among construction companies has allowed the design and implementation of a performance measurement system in Chilean construction companies. This effort is starting to give preliminary results as new companies are adopting the system that is expected to reach critical mass in the Chilean construction industry.

In the future, international organisations are expected to join this effort to extend the potential impact to new countries and companies. The system database will be useful to develop third party benchmarking to contribute to the improvement of the industry as a whole.

The implementation of performance measurement systems, which include measures adapted to lean construction, is discussed in this paper. The paper discusses the development process, the performance measures selected and some implementation issues. The paper also shows some preliminary findings from the baseline data obtained from the companies and projects already included in the database. The paper illustrates the value that can be obtained for the companies and for the industry from this collaborative benchmarking effort and extends an invitation to companies world-wide to share their experience using this exciting methodology. This benchmarking project, currently underway, provides an excellent starting point for collaborative research carried out in different countries and locations.

KEY WORDS

Benchmarking; lean construction; construction performance measures.

[1] Universidad Católica de Chile, Escuela de Ingeniería, Casilla 306, Correo 22, Santiago, Chile, e-mail: lalarcon@ing.puc.cl sdiethel@ing.puc.cl

[2] Corporación de Desarrollo Tecnológico, CDT, Chilean Chamber of Construction. Marchant Pereira 221, Oficina 11, Santiago, Chile, e-mail: agrillo@cdt.cl jfreire@cdt.cl

INTRODUCTION

Members of the General Contractors Committee of the Chilean Chamber of Construction are working together with the Catholic University and the Technological Development Corporation (CDT) in a Collaborative Research and Implementation Project to introduce lean practices in Chilean construction companies. There are three basic areas of work:

- Waste identification and reduction
- Performance measurement and benchmarking
- Production planning improvement (Last Planner concept)

This paper describes the performance measurement and benchmarking effort where the collaborative research has allowed the design and implementation of a performance measurement system. This effort is starting to give preliminary results as new companies are adopting the system that is expected to reach critical mass in the Chilean construction industry.

The paper discusses the development process, the performance measures selected and some implementation issues. The paper also shows some preliminary findings from the baseline data obtained from the companies and projects already included in the database. The paper illustrates the value that can be obtained for the companies and for the industry from this collaborative benchmarking effort and extends an invitation to companies world-wide to share their experience using this exciting methodology. This benchmarking project, currently underway, provides an excellent starting point for collaborative research carried out in different countries and locations.

MEASURING PROJECT PERFORMANCE AND BENCHMARKING

"…. To manage you must measure, if you don't you are only practising..." (Chrysostomou 2000)

The construction industry has been practising construction for the last 4,000 years. At best, any measurement taken was for the purpose of self-defence or evidence for claims and counter-claims. As other industries have proven, performance measurement and benchmarking is the cornerstone of challenging any industry to become world class. A strategic benchmarking initiative has most to contribute towards their change of culture, process, improvement of performance and productivity. Benchmarking enables an organisation to identify its performance gaps and opportunities, and develop continuous improvement programs for all stages of their process.

To stay competitive, leading organisations regularly compare their own products, services and business processes against the best from within or outside their industry – seeking to unearth and implement best practice from whatever source.

PROJECT PERFORMANCE INDICATORS

The result of a project is the product of various processes and decisions that interact during its execution. Figure 1 (Grillo 1997) proposes a model that shows how the different processes and variables influence the result of a project.

This figure allows us to classify the performance indicators according to their type:

- Results: indicators that attempt to measure the level of success that a project has achieved, at the end of the project (post-mortem). Examples are cost deviation, schedule deviation.
- Processes: indicators that have the objective of measuring the performance of the most important processes that occur in construction processes, such as, design, construction, planning, and procurement. Lean Construction focuses in this type of measurement, with the objective of improving during the project's execution.
- Variables: decisions, strategies, and others that are not a process but affect the performance of the project. Examples are subcontractor ratio, type of contract.

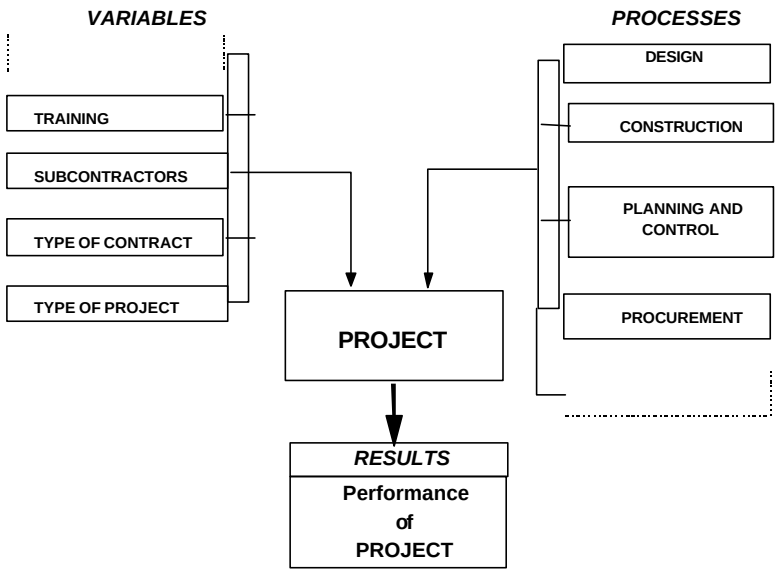

Figure 1: Performance Indicators of a Construction Project (Grillo 1997)

Measurement alone is not enough to improve performance. It is necessary to analyse these indicators, with the objective to detect the problems and their causes. In general terms, the analysis of the performance indicators enable managers to: a) determine the actions that should or could be made in the short term to improve performance, b) identify the strong and weak areas within the company, and c) help the construction industry to learn as a whole. Figure 2 shows how measurement and analysis of performance indicators help managers to make more effective decisions.

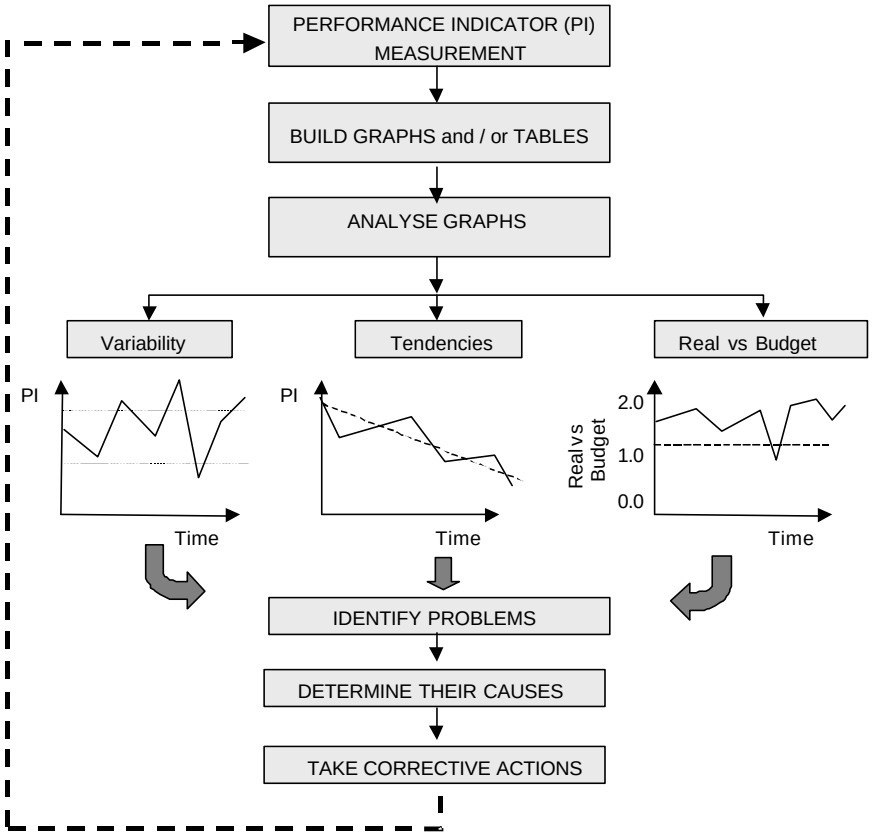

Figure 2: How Performance Indicators Support Management Actions (Grillo 1997)

SELECTION OF PERFORMANCE INDICATORS

It is also important to note that traditional performance parameters measured in projects, namely costs and schedule, are not appropriate for continuous improvement because they are not effective in identifying causes of productivity and quality losses. These parameters do not provide an adequate vision of the potential for improvement and the information obtained usually arrives too late to take corrective actions. Nearly all non value-adding activities become invisible within traditional control systems since these center their attention in conversion activities and ignore flow activities. For this reason it is of great importance to incorporate performance measures that promote continuous improvement in company processes and make visible non value-adding activities.

Selection of performance indicators was based on previous studies that included extensive literature review and empirical research (Alarcón and Serpell, 1996) (Grillo 1997). These studies led us to propose various performance indicators, focused on the general objectives of this project: promote continuous improvement and benchmarking between companies. Initially there were over 30 performance indicators that were analysed in several meetings with company representatives. The indicators were later prioritised by the participants at a seminar

with a larger audience with the purpose to reduce the number of indicators, adjusted by the experience and needs of the companies' personnel.

Nearly 20 performance indicators were selected and developed by the CDT and further refined with the companies. These indicators were adjusted to the specific needs and control systems of the different companies. Table 1 shows the final performance indicators that were chosen for measurement. Some of the indicators are useful for the internal, continuous improvement of the productivity of the companies and some of them are aimed for the benchmarking initiative between them.

Table 1: Selected Performance Indicators

RESULT	NAME	UNITS	LEAN OBJECTIVE
Cost	Cost Variation	(Actual Cost – Budgeted Cost) / Budgeted Cost	Benchmarking Continuous Improvement
Time	Schedule Variation	(Actual Duration – Planned Duration) / Planned Duration	
Quality	Cost of Client Claims	Cost of Repairing Claims (Defects) / Total Project Cost	Benchmarking Continuous Improvement Reduce Variability
		Number of Claims	
Project Scope	Change in Contract Sale	Final Contract Sale / Initial Contract Sale	Benchmarking
Safety	Accident Index	(Nº of Accidents)*100/ Total Number of Workers	
	Risk Rate	(Nº Work Days Lost)*100/ Annual Average of Workers	
Labour (Man-hours)	Efficiency of Direct Labour	Planned Man-hours / Actual Man-hours	Benchmarking Continuous Improvement Reduce Variability
		Budgeted Cost of Man-hours / Actual Cost of Man-hours	
PROCESS			
Construction	Productivity – Output	Monthly Sales / Monthly Man-hours Sold	Benchmarking Continuous Improvement
		Monthly Sales / Relevant Units Sold (of each project)	
Procurement	Urgent Orders	Number of Urgent Orders / Total Number of Orders	Benchmarking Continuous Improvement Increase Transparency
Planning	Planning Effectiveness	% Planned Completed (PPC) = Planned Activities Completed / Total Number of Planned Activities	Benchmarking Continuous Improvement Reduce Variability Process Improvement Waste Identification
Company Management	Administration Productivity	Cost of General Administration / Monthly Sales	Benchmarking Continuous Improvement
VARIABLE			
Work Force	Training	Training Indicator = Man-hours of Training / Total Man-hours	Benchmarking
Subcontractors	Subcontractor Ratio	Subcontracted Costs / Total Project Cost	

In the current first phase of the project, the construction companies are measuring a series of indicators that are fairly to measure, with their actual control systems and organisations. One of the principal difficulties was to use indicators that were easy to measure for all of the companies in this project. For example, not all of the companies had quality systems that would allow them to easily measure re-work. Also, every company uses different procurement systems that may or may not represent interesting measurements or even allow possible and easy measures based on existing control systems (not becoming too difficult to implement).

However, in the near future it is contemplated to incorporate new indicators that come from the waste identification and reduction area of work. These indicators are more "lean" based, concentrating in the main construction processes. Examples are cycle time in material delivery, waste measurement and others as shown in Table 2. The essence in this approach is to create a "measurement culture" within the organisations that will facilitate future implementations. Most of the companies had difficulties beginning the measurements and involving all of their workers in this initiative. Therefore, it was extremely important to begin with few performance indicators that were easy to measure and afterwards focalise in the principal processes.

Table 2: Indicators for Future Measurement

PROCESS	NAME	UNITS	LEAN OBJECTIVE
Construction	Re-Work	Man-hours used in Rework / Total Man-hours	Benchmarking Continuous Improvement Waste Identification
	Waste	Cubic Meters of Waste per Month	Benchmarking Process Improvement Waste Identification
	Transportation	Hours of Equipment used in Transport	
Procurement	Cycle Time	Time Elapsed between Material Order and Delivery on Site	Benchmarking Continuous Improvement Reduce Cycle Time
	Mean Delay Time	Average Time of Delays (Actual Delivery is after Scheduled Delivery Date)	Continuous Improvement Reduce Variability
Engineering / Design	Quality of Design	Number of Client Non-Conformities / Total Project Cost	Benchmarking Waste Reduction
	Design Errors	Number of Design Errors / Total Number of Drawings	

PRELIMINARY RESULTS

To have a reference for future benchmarking initiatives, the development of a "baseline" was proposed. This baseline mainly includes performance indicators of project results, from the last 5 projects of the 7 construction companies that were initially involved in the benchmarking initiative. These projects can be classified as follows:

- 13 Process Facilities Projects (>10 million US$)
- 11 Building Projects
- 10 Industrial Projects (< 5 million US$)

Figures 3 and 4 show the distributions of cost variation and schedule variation from the preliminary baseline. The histograms are useful to visualise the variability in the indicators, as well as the maximum and minimum values.

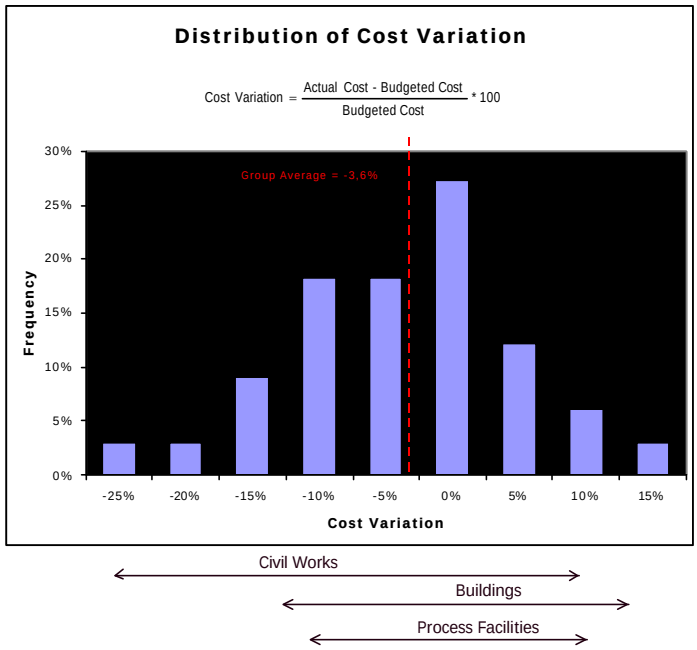

Figure 3: Distribution of Cost Variation

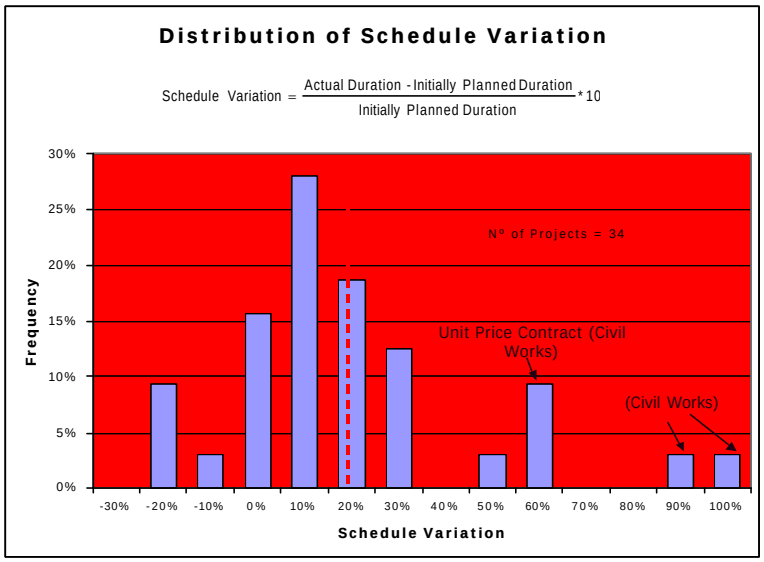

Figure 4: Distribution of Schedule Variation

Also, it was possible to benchmark and compare the variability of the different projects within each company. Figure 5 shows, for the cost variation indicator, the company's average compared with the results of the different projects. The behaviour of the indicators was

common in all the construction companies: high variability. Nevertheless, this exercise helped to focus on performance measurement and control the important processes within their organisations (not included in the preliminary baseline – based on historical information) that are currently being measured.

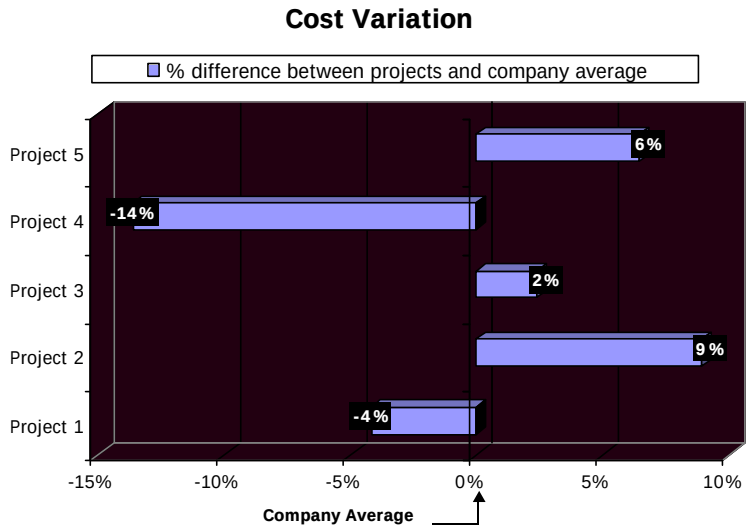

Figure 5: Example of Internal Benchmarking in Companies

The size of the sample is still very small to identify any correlation between the different indicators, but it is large enough to indicate some tendencies. From the preliminary analysis it can be concluded that there is a high dispersion in all the performance indicators, both within the companies as well as in the different projects.

Within the context of the companies that have participated in the development of the performance measurement system, the joint analysis of these preliminary results has already developed a new area for collaboration and interactive learning. This preliminary baseline database is growing as more projects are being added, and new companies are joining to this benchmarking initiative. In the future, this will allow grouping indicators according to the specific characteristics of each project and companies and the development of new types of analysis. Also, the "measurement culture" was created within the different organisations that are now ready to implement performance indicators that are more relevant to the construction processes. Even more so, they are changing and adapting their organisations that will allow innovations and improvement actions to be easily implemented with the results and tendencies that the indicators reveal. This produces a real time response to the progress of the construction, thus allowing changes and improvement actions.

INTERNATIONAL BENCHMARKING OPPORTUNITIES

The UK Construction Industry carries out an intensive benchmarking and productivity improvement program in which government, public and private sectors have joined forces to improve performance (KPI 2000). Even though most of the KPI (Key Performance Indicators)

that they measure are results based, there are advanced talks with a governmental and private organisation to conduct an international benchmarking initiative with the companies involved in the KPI measurement. Similarly, this initiative could be extended to companies working with LCI and other IGLC researchers for mutual benefits of researchers and companies.

CONCLUSIONS

This paper has summarised the main aspects of a performance measurement and benchmarking research effort currently underway. The project lends itself to an international collaborative research effort.

This research comprises the implementation of project performance measurement systems in construction companies. Performance indicators were selected to support management decisions and benchmarking between companies. The implementation team from CDT is currently adding new companies to generate a database with empirical information on projects, which will be useful to develop third party benchmarking. Benchmarking parameters include the measurement of processes and other intermediate factors present in projects.

The practical use of this information would inform the industry about the causes of results and would allow a better understanding of the reasons that lead to better or worse performance. The application of the model would allow identification of the processes with greater impact on the projects performance and the better practices required in those key processes. In addition, the implementation of a database with information on project performance can provide a very important information source for future research in different areas.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Universidad Católica de Chile, the Corporation of Technological Development (CDT) of the Chilean Chamber of Construction, and Fondef for supporting this research. Thanks are extended to the construction companies Bravo Izquierdo y Fuenzalida, Comin, Echeverría e Izquierdo, Precon, Queylén, Sigdo Koppers, and Vial y Vives for participating and funding the research program.

REFERENCES

Alarcón, L. F. and Serpell, A. (1996). "Performance Measuring, Benchmarking and Modeling of Project Performance," *5th International Conference of the International Group for Lean Construction*, The University of Birmingham, UK, August, 1996.

Alarcón, L.F., and Serpell, A. (1996). "Performance Indicators for Chilean Construction Companies", *Proyecto Productividad en la Construcción, Informe de Investigación a la Corporación de Investigación de la Construcción*, Escuela de Ingeniería, Pontificia Universidad Católica de Chile, Marzo (in Spanish).

Camp, R.C. (1989). *Benchmarking: The search for the Industry Best Practice that Lead to Superior Performance*. Quality Press.

Chrysostomou, Vassos (2000). KPIs and Benchmarking for the Housing Sector. Construction (PPT Presentation) Benchmarking Centre, BRE, Bristol, UK.

Construction Task Force (1998). *Rethinking Construction. The Report of the Construction Task Force to the Deputy Prime Minister*. Department of the Environment, Transport and the Regions. U.K.

Fisher, D., Meirtschin, S., and Pollock Jr., D. (1995). "Benchmarking in Construction Industry", *Journal of Management in Engineering*, January/February.

Grillo, A. (1997). "Methodology for the Measurement, Evaluation, and Analysis of Performance Indicators in Construction Projects". *MSc thesis*, Universidad Católica de Chile, Santiago, Chile (in Spanish).

KPI Working Group (2000). *KPI Report for The Minister for Construction.* Department of the Environment, Transport and the Regions. U.K.