ACHIEVING COLLABORATION IN THE CONSTRUCTION SUPPLY CHAIN: AN ONSITE SUBCONTRACTORS' EVALUATION METHODOLOGY

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ABSTRACT

Subcontracting in the construction industry has greatly increased in recent years. On one hand, subcontracting as allowed shifting some of the risk from the main contractor to the subcontractor and allowed some firms to become experts in specialized topics. On the other hand, inadequate subcontracting management has frequently resulted in an adversarial relationship between main contractors and their subcontractors. Subcontracting has also meant, in many cases, uncoordinated onsite execution and disappointing quality and time table fulfillment.

The development of new systems and tools to support subcontractor management is part of a collaborative research project carried out by the Production Management Center (GEPUC) from the Catholic University of Chile. This is a collaborative research project with participation of several construction companies and the Chilean Construction Chamber. The experience gained by testing prototype tools and systems in pilot projects has allowed the development of a methodology based on lean principles and partnering practices for evaluating subcontractors onsite.

This methodology allows main contractors to implement an onsite subcontractor evaluation system. This system enables a fast responsive and proactive performance attitude by conducting periodic evaluations. The system can also support subcontractor selection based on their onsite performance. In the long term, this system can lead to the development of collaborative relationships with selected subcontractors based on their sustained performance in many projects.

KEY WORDS

Construction supply chain, subcontractor management, lean construction.

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INTRODUCTION

Traditionally main contractors have executed most projects using directly hired labor. The development of the construction industry has resulted on a concentration on core activities by most contractors instead of integrating peripheral tasks associated with project completion (Miller et al, 2001). Nowadays up to 90% of the project value can be subcontracted (Lehtonen, 1998). This has led to an increase in the complexity of construction project management. It also gives contractors a wider range of alternatives for performing certain tasks and releases them from employment contractual liabilities. The contractor usually has the power to organize and direct the activities of the subcontractor. The transactional nature of this arrangement enables the contractor to effectively allocate risk outside its own organization (Miller et al, 2001)(Holt et al, 2000) (CDT, 2002). These characteristics help explain why this sector is so given to disputes and litigation (Holt et al, 2000). In this sense, it can be argued that small subcontracting firms are employees in all but name and associated benefits. Thus, it is contended that while the contractor adopts the management role (Lehtonen, 1998)(Miller et al, 2001), small subcontracting firms are perceived as subordinates in the decision making process. As a result, the small subcontracting firm not only struggles to retain identity, it also becomes increasingly divorced from management decisions (Miller et al, 2001).

The fact that the construction industry is cost led results in very small profit margins (Lehtonen, 2001) (CDT, 2002). This emphasis on cost minimization can be destructive in the long term as the need to minimize transactional costs tends to reduce quality and client satisfaction. Some maintain that, if 'Dutch Auctions' continue to dominate specialist selection, it is unlikely that the requirements of the small subcontracting firm will be satisfied (Miller et al, 2001) The argument is that the contractor enters into separate contracts with both the client and specialist subcontractors in order to fulfill the client's mandate. Thus, the margin between the price quoted to the client and the actual cost of subcontracting can be seen as the contractor's reward for the effective organization and coordination of the construction process (CDT, 2002).

Due to strong cost competition and the traditional adversarial customer-supplier relationship, the actors of the construction project usually change significantly from one project to another (Miller et al, 2001)(Latham, 1994). This complicates collaboration between these actors. In the delivery processes of the construction industry, the lack of information and of standard procedures is nowadays one of the main problems (Lehtonen and Pahkala, 1998). This is another cause for organizations becoming entangled in trying to solve past problems instead of concentrating on future management strategies for improved performance and business relationships (Holt et al, 2000).

The Production Management Center (GEPUC) from the Catholic University of Chile is leading a collaborative research project that includes the participation of twelve construction companies and the Chilean Chamber of Construction. The general objective of the project is to allow companies to reach higher levels of productivity through systematic actions of research and implementation of changes in management practices. A group of 8 companies within this project focused on researching and developing new systems and tools to support subcontractor management. Prototype tools and systems were tested in pilot projects carried

out by the participating companies. The experience gained in these tests and the principles allowed us to propose the methodology presented in this paper.

CONSTRUCTION SUPPLY CHAIN

The construction industry is one of the most diverse and unstable sectors within the economy. It faces fluctuating demand cycles, project-specific product demands, uncertain production conditions, and it combines a diverse range of specialist skills within geographically dispersed short-term project environments. Over the past 20 years, a strong growth in subcontracting has further complicated this situation through the fragmentation of the production process and increase in complexity of the construction supply chain.

Many studies aim at describing supply chain networks and the value of various forms of strategic alliances. New supply chain management practices, such as supplier coordination and development, have led to improved performance in supply chains (O'Brien et al. 2002). The relationships that can be achieved between supply chain links can offer shared resources, staff and expertise, problem solving; reward in terms of economic performance and increased innovative capacity (Miller et al. 2001).

In recent years, the study of the construction supply chain has grown in importance. Of the many approaches that have been considered, Partnering and Lean Construction tend to be the most cited ones.

To carry out supply chain initiatives, it is important to identify the barriers that obstruct collaboration. Dainty et al. (2001) identified the following barriers to integration from the subcontractor point of view:

- Financial/cost-related issues: These are related to competitive tendering based on price, which has developed adversarial relationships that result in serious problems with regard to payments.
- Programming/time-related issues, such as false expectations on part of the main contractor and unrealistic program times
- Quality of information and related issues, such as poor information quality from the main contractor and inadequate management by main contractors
- Attitude-related issues, such as arrogant attitudes, exclusion of the subcontractor from the early involvement phases, lack of praise for good performance, poor site management practices, and lack of understanding of the subcontractors problems.

THE LEAN CONSTRUCTION APPROACH

There is a fundamental difference between lean construction and the conventional model of project optimization on an individual activity basis. In the conventional model, the emphasis is on increasing the speed and reducing the cost of each activity. In lean construction (Howell and Ballard 1999b), a reliable flow of work (throughput) is more critical than individual activity speed or individual activity cost. Some of the main features of lean construction are:

- Clear delivery process objectives

- Performance is maximized at the project level
- Product and process are designed concurrently
- Production control is applied throughout the project life.

The lean construction approach can be applied to solve many generic problems that have emerged from the fragmentation of the construction supply chain. Figure 1 illustrates how many of the problems that arise in projects are related to certain links of the supply chain (Vrijhoef et al. 2001). From a Lean construction point of view (Vrijhoef et al. 2001), the waste and problems within the construction supply chain can be classified in the following three types: those that arise in normal situations, those that are caused in another stage of the construction supply chain than where they were detected, and those caused by obsolete, myopic control of the construction supply chain, characterized by independent control of each stage of the chain.

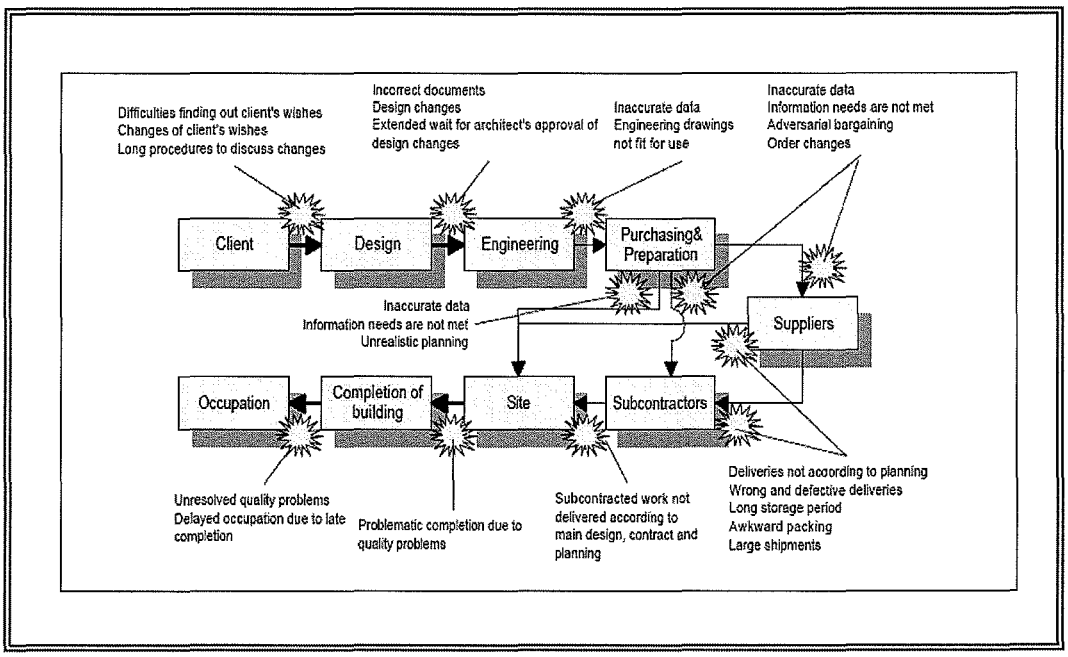

Figure 1: Relationship between project management problems and the construction

WORKING ON THAT TRADITIONAL ADVERSARIAL RELATIONSHIP: PARTNERING

The Egan Report (1998) suggested that construction supply chain is critical in driving innovation and in sustaining incremental improvements in the sector's performance. In order to achieve ambitious performance targets, the report recommended the adoption of methods, such as *partnering*, successfully used by the manufacturing sector. Partnering is the use of integrated production teams and continual monitoring of the effect of performance improvement measures (Dainty et al. 2001). Latham (1994) also suggests that assuming a

partnering approach would allow the achievement of the main contractor's overall program. A definition of partnering can be found in Latham's "Constructing the Team":

> *"Partnering is a contractual arrangement between the two parties for either a specific length of time or for an indefinite time period. The parties agree to work together, in a relationship of trust, to achieve specific primary objectives by maximizing the effectiveness of each participant's resources and expertise. It is not limited to a particular project."*

According to Latham, the basis for partnering success is continuous improvement and the construction of long-term relationships with suppliers and subcontractors. Partnering can be based on a single project called 'Project Partnering' or a long-term commitment that spans several years and several projects called 'Strategic Partnering'. When implementing partnering the Angus Council (2001) calls for mutual objectives agreement between the members of the partnering team, co-operative problem solving attitude, and continuous improvement as an organizational culture to achieve continuous performance improvement.

Although the partnering approach has revealed promising results, in some cases subcontractors have considered it doesn't add any value to them, while some main contractors have seen little benefit in forming alliances with companies that they did not work with regularly (Dainty et al. 2001). The collaboration mind-set, which is in the core of the partnering methodology, must be rescued for further investigation and implementation.

COLLABORATION APPROACHES, LEAN CONSTRUCTION AND COMMUNICATION

A study conducted on subcontractors of different industries, mainly manufacturing, showed that subcontractors were able to exploit the potential of advanced practices in the production management area, as well as in the general management area, and perform well both at the operational and business level. The need to focus on differentiating on their production system performance is probably a major incentive to optimize the efforts in this direction (Cagliano and Spina 2002).

Given that the lean construction approach aims to reduce waste while simultaneously adding value to the construction process (Howell and Ballard, 1999b) and that supply chain initiatives are considering methods such as partnering (Latham 1994), (Egan 1998) it is contended that the ability to adopt a lean construction approach is dependent upon the extent to which large and small contracting firms can form working relationships that effectively reduce transaction costs (Miller et al. 2001).

When implementing a collaborative approach, the coordination must be achieved through communication (Taylor 1993). This kind of communicative coordination has previously been defined as: 'communication mediated co-ordination of human action' (Habermas, 1984), or 'communication by feedback' (March and Simon 1958). Vrijhoef et al. (2001) describe how communication in organizations can be viewed from two perspectives: the informational perspective, implying just the exchange of facts, opinions and descriptors (informative communication), and the organizational perspective, including notions of obligations, responsiveness, communication-imposed actions, etc. (performative communication). They emphasize that communication must have representational, functional, and action

characteristics, which aim to coordinate future objective action by one of the actors involved and must agree on the results of the objective action.

PERFORMANCE MEASUREMENT

Competitive bidding, where the lowest bidder gets the contract, is deeply rooted in construction tradition. Other measures of performance, which relate to the process itself, are neglected or at least assigned to a distant secondary position of importance (Ellis 1997)

Performance measurement is a current issue in research and practice. However, in the construction industry its use as a tool for improvement and control of logistics has so far been limited (Lehtonen 2001). In Hong Kong, a Performance Assessment Scoring System (PASS) of public housing construction for quality improvement has been used (Tam et al. 2000). Although the use of tendering opportunities to reward contractors bearing high PASS scores is not yet adequate, and a direct financial incentive is recommended to encourage contractors to attain the targeted quality levels, the initiative shows that the regular tendering process selection based on the lowest cost can be replaced while improving quality.

There are several methods for productivity measurement, most of which are based on quantitative data on operations. Whenever possible, standards should be based on facts and data rather than on intuition or subjectivity (Tam et al. 2000). However, when there is a lack of tradition of measuring operations, quantitative data for productivity measurements may not be available. In this case, subjective productivity measurement is one possible solution (Kemppilä and Lönnqvist 2003). Kemppilä and Lönnqvist (2003) provide the following definition for subjective productivity measurement:

> *"Subjective productivity measurement is a method for acquiring productivity information by gathering and analyzing the assessments of relevant stakeholders regarding direct or indirect productivity of the measurement object".*

DESCRIPTION OF THE RESEARCH DEVELOPMENT

The dynamic flow between practice and theory, and vice versa, is one of the keys for the disciplines that relate to production management. Active experimentation leads to new ideas and insights that are then transformed into theories. These theories, in turn, help other practitioners facing similar problems (Santos et al. 2002).

Several activities were performed in order to develop a procurement and subcontractor management methodology compatible with the Chilean reality:

1) Brainstorming sessions with representatives of the participating companies to detect which were the main problems with the subcontractors.
2) A survey for the subcontractors of the participating companies, to have their side of the story.
3) Companies to developed individual criteria and qualification systems to evaluate subcontractors.
4) Researchers developed a focus group with the representatives of the participating companies to get their impressions of their experience with their system.

5) As a result of the process, GEPUC elaborated a detailed document proposing a method to implement pre-qualification systems.

Since the attempts to put into practice such methods and proposals failed, it was concluded that a new methodology was necessary in order to replace the traditional tendering based on price approach. This new methodology should not depend on data difficult to obtain and analyze (such is the case of financial references, pendent litigations information, economic capacity, and others) and it should only require information that could be gathered at the work site itself in a fast and convenient manner.

ON PROPOSED PREQUALIFICATION METHODS

Many detailed and highly developed prequalification and selection methods for contractors and subcontractors have been proposed in the literature. These methods seem to solve the problem of tendering based solely on price using different approaches. Some used multicriteria utility theory models (Hatush and Skitmore, 1998), cluster analysis (Holt 1996), evidential reasoning (Holt et al, 2002), decision criteria (Russel and Skibniewski 1988) or performance modeling (Alarcon and Mourgues 2002). Although all these proposals are interesting, the required information makes them difficult to implement by most companies. The authors promoted a simpler method, which uses information that can be acquired rapidly from the subcontractor's history and background. The method should facilitate work site performance information gathering and should allow onsite managers to use the system to support their decisions.

PROBLEMS WITH SUBCONTRACTORS REPORTED BY PARTICIPATING COMPANIES

The main problems with subcontractors, reported by participating companies in the brainstorming sessions were the following:

- Lack of training, compromise and professionalism.
- Lack of subcontractor involvement.
- Lack of subcontractors' finance capacity.
- Lack of main contractor integration.
- Lack of formal contracts (main contractor)
- Lack of knowledge of the contracts to be signed (main contractor)
- Lack of useful contracts that allow real usability and fine applying.
- Lack of planning assistance and management tools delivery (main contractor).
- Lack of subcontractors' evaluation in the long run. Lack of externalities evaluation that the subcontractors generate.
- Lack of fulfillment and control (system of control).

It was found that there were at least two types of subcontractors: one with sufficient financial support capable to solve its own problems and another composed of small firms that need

more support due to their limited resources and knowledge. The methodology should be able to deal with both types of subcontractors. Another conclusion of this session was that the evaluation system should be a motivating rather than a punishing tool.

RESULTS FROM THE SUBCONTRACTOR SURVEY

The survey aimed at subcontractors had the objective of determining the opinion that these companies have of the main contractor's management methods. The survey was applied to 38 subcontractors of different types.

The surveyed were asked about their companies' organizational structure, area of expertise, and financial capacity. In the survey itself, they had to answer about the quality of the projects' definition, the levels of existing collaboration and communication with the main contractor, and aspects on the work they realize, such as quality, security and fulfillment of terms. The analysis of the survey showed key differences between the different types of subcontractors, especially between large and small subcontractors. The classification by size was based on the budget of the projects they managed and the number of workers in the company.

All the surveyed agreed in positively valuing the initial processes of the construction work: early establishment of schedules, information sharing and quality and safety requirements presentation.

With respect to what happens during the execution, the opinions were much more dissimilar. Nevertheless, it clearly comes out that there was lack of planning in the case of the construction sites that do not have periodic planning meetings. The surveyed indicated that periodic feedback was absolutely necessary. It was also clear that the subcontractors appreciate the effort in terms of resources on which the main contractors incurs. With respect to security, the answers were quite different. While some considered safety measures to be extremely hard, others considered them too soft. The survey shows that the contractor is quick when responding to doubts or problems presented by the subcontractors but only some considered that they were effective.

With respect to the end of the construction period, the subcontractors agreed on the main reasons for failing in fulfilling the contracted duration. Most had to do with lack of onsite inventory and lack of space assigned for the subcontractor (shower rooms and other dependencies). With respect to quality problems, the subcontractors blamed the main contractors, mainly due to last minute changes and design problems. Most surveyed also indicated that very seldom fines or penalties indicated in the contract were applied.

The survey clearly showed important cultural and educational differences between the subcontractors. The results tend to show that the main contractor also shares some responsibility, especially with respect to coordination, planning and cooperation with the subcontractor. In addition, the main contractor must make a greater effort in the design area. It is also clear that the system of fines and penalties is not used and that a new system to stimulate the fulfillment of terms is necessary.

PROPOSED METHODOLOGY OF SUBCONTRACTOR EVALUATION

A simplified depiction of the project management cycle, from the main contractor's point of view, is shown in Figure 2. Note that "Subcontractors and Providers Selection" appears before the "Master Plan Formulation" in order to incorporate all the agents involved from the design phase, as suggested by the partnering approach. It can be easily recognized that for the next project one could use the experience in other past projects in order to select the subcontractors and providers. Therefore the evaluating process must be accurately defined.

DEFINING AN ONSITE EVALUATION SYSTEM

An acknowledged approach for solving social problems, called small wins (Weick, 1984), consists of redefining large problems into small, more approachable ones; so instead of dealing with an overwhelming problem, controllable opportunities of improvement can be identified. This approach has several distinctive features: it names the problem; it combines changes in behavior with changes in understanding; it has a way of snowballing (one small win begets another). We propose to apply the small wins approach to the productivity problem in the construction industry. In order to detect smaller problems, the current situation must be assessed. This requires keeping a constant critic eye on what happens on the construction site. This critic eye needs several filters to be able to isolate smaller (more specific) issues. Performance can now have several faces, or dimensions. Some may be performing quite well, while others will reveal where the problem really is. In the case of subcontractor management, several criteria can be defined so the subcontractors are evaluated in different dimensions.

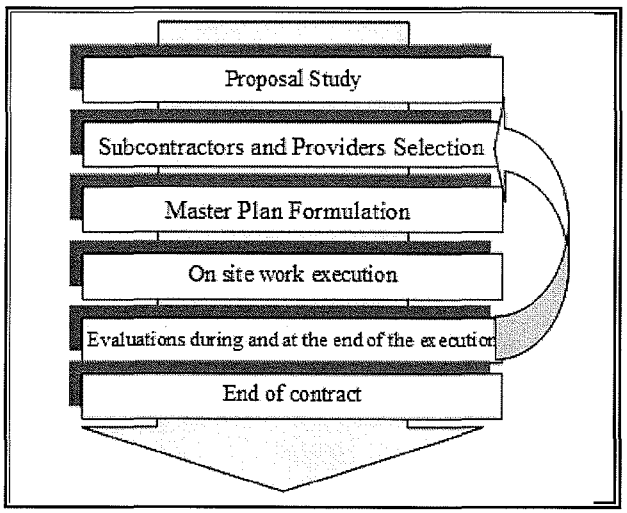

Figure 2: Project summary from a main contractor point of view

Subcontractors should be given tools so they can be proactive instead of reactive (Holt et al. 2000). This requires periodic and timely evaluations. If an evaluation is conducted at the end of the project execution, there is little a subcontractor can do to improve. If periodic evaluations are presented to the subcontractor as feedback, there is an opportunity for continuous improvement during the project execution.

In order to increase transparency (Koskela 1992, Koskela 2000), a visualization tool should be used to show the results of the evaluation. This tool should work as a reminder and as a disseminating tool among the workers. It should stimulate competition among the subcontractors and allow prompt reaction to bad evaluations. It should also stimulate a proactive attitude towards future performance evaluations. It must be easy to "read" or to interpret. The effect on people is directly proportionate to how easy it is to understand. The evaluation must be conducted professionally and by people who really know what goes on at the work site.

ON SELECTING THE RIGHT CRITERIA FOR EVALUATION

An evaluation system should keep in mind a framework for performance measurement. Improvement measures are applied infrequently and they aim at finding a present performance level and its improvement potential. Monitoring measures are used for screening and controlling the companies' operations continuously (Lehtonen 2001). Figure 3 shows in black, the dimensions that apply to subcontractors' evaluation. Therefore, some criteria must fit into the "improvement" dimension and others must be of the "Monitoring" type.

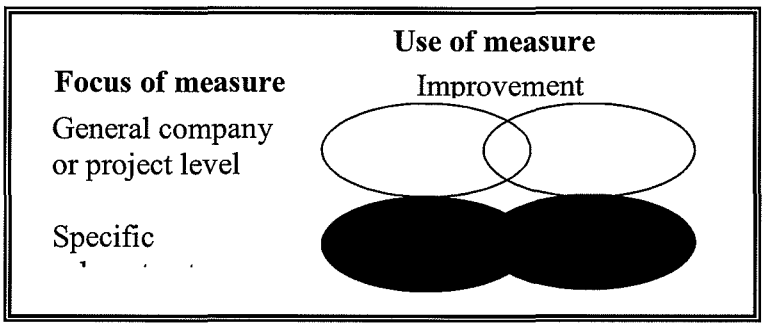

Figure 3: Lehtonen's framework for performance measurement in construction logistics.

When choosing the criteria, the main contractor should try to cover only areas that have, or may have, a direct effect on performance. The criteria can be only as specific as the culture allows them to be. Since Chilean industry is very far from having a culture of measurement, subjective measurement may be the best alternative. Therefore, only a few criteria may be enough to cause the expected actions.

If a culture of measurement is present, then the designer of the evaluation system must have in mind that interferences between criterions must be avoided. In this way, criterions are kept independent of each other. Keeping independent criterions is useful to detect root problems. It is therefore easier to determine corrective actions and promote a proactive attitude.

COLLABORATING WITH THE SUBCONTRACTOR AND GENERATING COOPERATION AMONG THEM

The importance of communication for coordination has already been mentioned. Latham (1994) also calls for collaboration with the subcontractor:

> *"The performance of specialist subcontractors is crucial to the success of our organization. If we can improve the quality of support we give to specialists, then the quality of product and service will be measurably superior... It will also reduce conflict."*

He also wrote:

> *"Utilize the skill and knowledge of the subcontractors more fully and better, and recognize that subcontractors can and want to make a greater contribution."*

Therefore, subcontractor onsite management requires periodic instances for dialogue, where evaluations can be openly discussed. Dialogue (communication for cooperation) among the participants fosters continuous improvement on critical issues for the main contractor. Rewards should also be considered for motivating fulfillment and excellent performance. PASS fails in achieving its goals, mainly because it lacks rewards and praising (Tam et al. 2000). Praising the best performer promotes competition among subcontractors.

DISCUSSION

One important objective of the proposed methodology is to change the widespread practice of pre-selecting and selecting subcontractors based solely on the price. The methodology supports an interlinked relationship between onsite management and the pre-selection/selection system. Furthermore, a selection/evaluation system based on this methodology should allow:

- Improving subcontractors' industry performance.
- Improving main contractor's overall performance.
- Identifying new areas for subcontractors' management improvement.
- Identifying critical areas for subcontractors' performance improvement.
- Generating a subcontractors' database with their performance.
- Benchmarking.

The proposed methodology allows strengthening the relationship with those subcontractors that actually add value to the productive process. This value can be determined by their onsite performance (periodic evaluations) and a pre-qualification system. This can lead to a collaborative relationship between the main contractor and the subcontractor based on team building, trust, dedication to common goals, and an understanding of each other's individual expectations and values. Expected benefits from this type of relationship include: improved efficiency and cost effectiveness, increased opportunity for innovations, and the continuous improvement of quality products and services (Lehtonen 1998).

In figure 4, an adaptation from Lehtonen and Pahkala's (1998) approach steps for cooperative development is shown. In the proposed methodology, the "measuring current practices" step that is proposed by Lehtonen is replaced with the onsite evaluation phase and the usage of the pre-qualification method to identify possible long term partners (Measuring and selection of subcontractors). Figure 5 summarizes the methodology presented in this document.

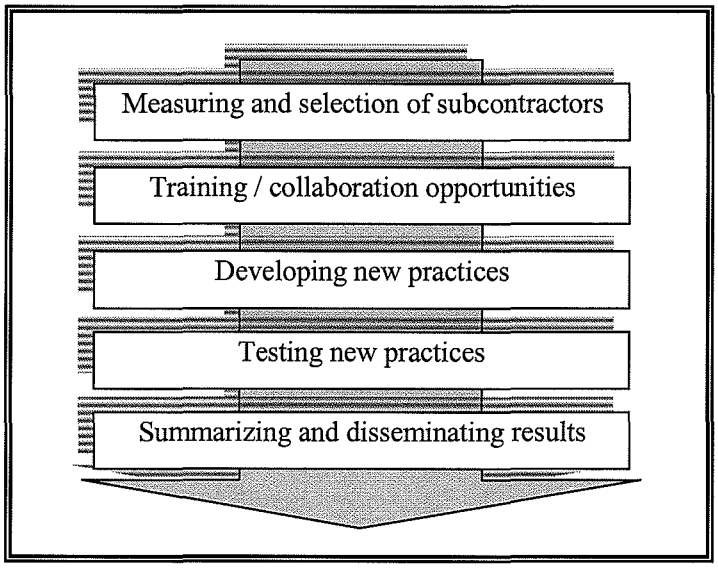

Figure 4: Steps for a collaborative relationship development.

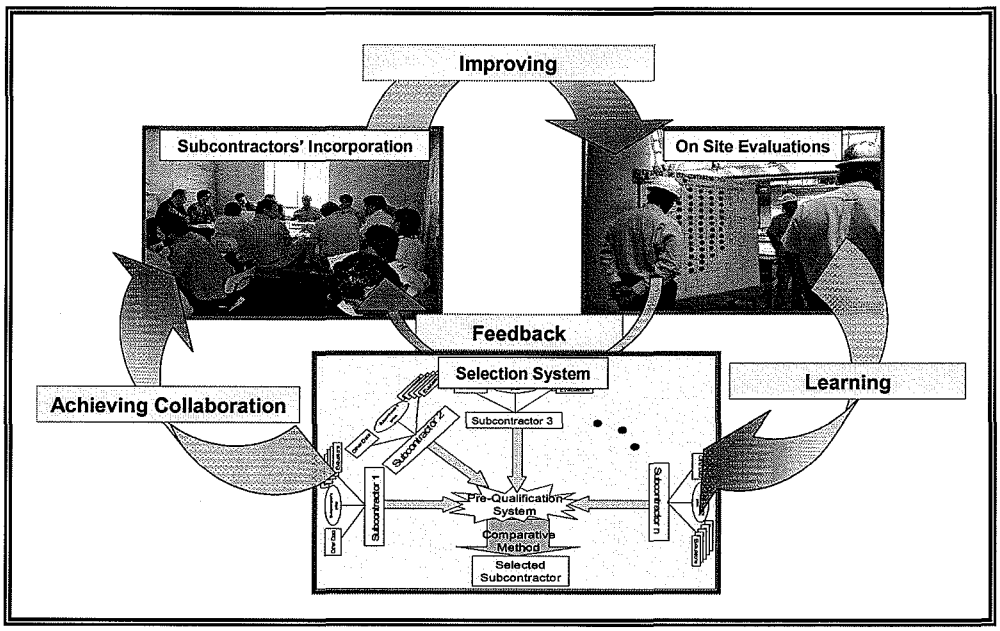

Figure 5: Complete cycle of the proposed approach

CONCLUSIONS

The traditional construction firm is being replaced by firms with strong technical offices capable of generating winning proposals and managerial teams capable of successfully managing small or medium subcontracting companies, which deal with 80%, 90% or even 100% of the processes at the work-site. The Main Contractor is becoming an intermediary who must deal with the subcontractors' prerequisites (to finish on time) and with the client demands to meet the client's and his own expected costs.

The proposed methodology allows for the implementation of an onsite evaluation system that, in summary, allows:

- Reducing Subcontractor-generated uncertainty.
- Delivering feedback to the subcontractors.
- Learning to work collaboratively with subcontractors.
- Learning about subcontractors' performance.
- Improving onsite performance
- Coordinating efforts to develop collaborative work among subcontractors and with the main contractor.

A prototype of this methodology has been implemented as a part of the ongoing research project led by GEPUC with the collaboration of the Chilean Construction Chamber (CChC). Currently, the authors are developing a common, objective, and standardized evaluation system, which will allow information to be shared among main contractors. For good subcontractors it may be an opportunity to promote themselves throughout the industry.

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