Rol de los principios de administración de proyectos en el manejo de contratos de obras civiles

The role of project management principles for controlling civil works contracts

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Resumen

La gran cantidad de reclamos que habitualmente se genera en los contratos de construcción preocupa con toda razón a mandantes y contratistas. El informe analiza las causas que la literatura asigna a estos reclamos y concluye que ellas provienen fundamentalmente de la variabilidad que afecta a la ejecución de todo proyecto por su carácter de prototipo y a los imprevistos del medio externo. Concluye que la forma adecuada de manejar esta incertidumbre y prevenir reclamaciones es fijar bases contractuales con la flexibilidad adecuada para aceptar cambios con las compensaciones económicas apropiadas y aplicar procedimientos para estabilizar las condiciones de trabajo de modo que la programación de actividades sea confiable. Finalmente incorpora una descripción básica de la forma de trabajo que se recomienda para lograr una labor de equipo entre mandante y contratista que prevenga y resuelva a tiempo las incertidumbres que pudiesen dar origen a conflictos.

Palabras Clave: Contratos, mandantes, contratistas, conflictos

Abstract

The great amount of complaints that surge from construction contracts is a source of concern for both owners and contractors. This paper analyzes the causes that literature assigns to these complaints and concludes that they come fundamentally from the variety of issues that affect the execution of every project because of its character as a unique product or service and unexpected events that occur due to external factors. It concludes that an adequate way of managing this uncertainty and prevent these complaints is to fix contractual bases including the flexibility needed to accept changes with the appropriate economic compensations and to apply procedures that stabilize the work conditions so that the programming of activities is trustworthy. Finally, it incorporates a basic description of the recommended normalized team working between owner and contractor in order to prevent and resolve in time the effects of uncertainty that could give origin to conflicts.

Keywords: Contracts, owners, contractors, conflicts

1. Purpose of this study

The great amount of complaints that surge from construction contracts is a source of concern for both owners and contractors. This issue is often explained as a consequence of diverging thinking between the owner company, which would grant the execution work at the lowest possible price and; the contractor company, which objective is to execute the works at the lowest cost, so as to guarantee or increase its profits. Therefore, there seem to be antagonistic goals almost leading to disagreements between signatory parties, which could eventually end up in conflicts. In our opinion, however, conflicts are mostly generated by a deficient management effect on the uncertain environment where any project is developed, at a greater or lesser extent, which affects the total works costs and its execution time.

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That is to say contractual conflicts are mainly originated when the contract documents and their further application ignore or minimize such effects, thus making difficult to establish the responsibility between parties on the project risks and; the procedures to prevent and control such effects during work execution are not applied.

Consequently the main purpose of this paper is:

- a) Collecting the causes of contract conflicts in accordance with backgrounds provided by Chilean labor associations and by specialized biography.*
- b) Checking whether such backgrounds enable us to confirm that most of conflicts are generated by risks caused by unforeseen issues affecting the project execution.*
- c) Highlighting the way in which the application of project management principles is well able to improve risk control, by anticipating solutions, correcting negative effects and by avoiding conflicts between the owner and contractors.*
- d) Pointing out the practical way of applying such principles for different types of contracts, particularly, on those that transfer the risk on the contractor by assigning him with a set of activities including Design+Procurement of Equipment+Execution (EPC contract type).*
- e) Recommending standardized procedures to create a joint working group between owner and contractors, in order to avoid and solve disagreement and conflicts between them in due time.*

2. The management function on a contracted project

Let's remember that the French engineer Fayol H. (1916) distinguished six types of operations or functions in a company: the first five correspond to a functional or operative nature (technique, commercial, financial, security and accountant). The sixth operation is the management function required to link the previous functions. Fayol stated that a company's main role is to layout the general action plan, to build up a social body and to coordinate efforts to harmonize the actions. That is to say, the management function involves, at a greater or lesser extent, to everyone who has some kind of responsibility in the organization. Its purpose is that everyone acts as a group effectively developing the activities of the company sections or the tasks delegated to third parties.

Fayol states that the management function comprises 5 classic elements:

- Forecast: scrutinizing the future and elaborating an action plan*
- Organize: establishing a double body: material and social in the company*

- *Command: making the company social body work*
- *Coordinate: linking, grouping and harmonizing the actions and efforts*
- *Control: surveying the actions to meet the regulations and commands ordered*

Such concepts are still valid nowadays for companies as well as for the execution of their projects. Particularly, it is worth mentioning that the modern trend of asking third parties to develop specialized tasks involved in the final product (design, construction, and equipment procurement and assembly for a given project) makes the task of integrating (coordinating and controlling) assigned works even more necessary.

We will further see that the management function, defined by the previous terms, is fundamentally significant for the solution and mitigation of frequent conflicts, which are originated under the third party execution layout, as it is the case of contracted works or services. How does it work? It simply works by applying these five elements on the site management: avoiding difficulties, looking for solutions, coordinating everyone's efforts and controlling results.

Although the management function corresponds to the owner as well as the contractor on their own tasks, the limit between these activities will depend on the type of contract which has been signed. Defining such limit is fundamental, however, in spite of that, there will always be overlapped or undefined zones that the management function shall foresee and solve in due time.

3. Origin of project risks and the role of management function for their solution or mitigation

Every human activity involves a risk, as it is developed in an ever-changing environment, i.e., it is subject to uncertainty.

Industrial companies are not exempt from such risks. Therefore, they often try to procure a steady environment for their production processes by means of the assembly line production. This process enables companies to accurately calculate the amount of materials and resources to be employed by each unit; so they determine costs, ensure the same quality for each product and; additionally, the standardization of the productive process (elaborating identical pieces and assembling them) shall guarantee a delivery time. Finally the process enables them to trust the quality, cost and delivery time for the product to be used or sold. Nevertheless, projects have a feature that differentiates them from an assembly line product: its singularity. Each work (a building or an electric power plant) may be similar to another, but it is hardly identical. Design or construction processes may be the same for different projects, but they face different realities (different loads, similar grounds but not identical, different technical and human resources). Additionally, each work demands the integration of multiple activities, parallel or consecutives, executed by different parties, which might be connected by a chain of command or they might be independent in accordance with the company layout.

The acceptance of such reality, in the project execution, will enable us to forecast risk management procedures to solve conflicts for each particular case. Consequently, we will try to find out if there is a cause/effect relation between the environment variability or uncertainty and the most frequent risks, which are identified as the origin of conflicts on the projects described by the specialized literature.

Figure 1 shows the cause of conflicts which take place during the construction projects execution, in accordance with some local reports and the international literature we list as follows:

1. Responsibility Matrix in Construction Contracts. Contracts Revising Board for the Cement and Concrete Institute (2006).
2. Working Day on Early Mechanisms of Conflict Solutions between Owners and Contractors. Construction Institute (2000).
3. Tools for the identification and reduction of waste in construction projects. Luis F. Alarcón. Article from the book *Lean Construction* (1997)
4. Construction Contract Claims, Changes and Dispute Resolution, Paul Levin, ASCE 1998.
5. Evaluation of Risk Management Practices of the General Contractors in Florida. Syed Mahood, Salman Azhar, Irtishad Ahmad, *Engineering and Construction Journal UC*, 2002.

In the following figure we have sorted the risks identified from the backgrounds, in accordance with their origin: from external or internal situations of the project.

Origen externo al proyecto (variaciones del medio) External origin to the project (environment variations)			Origen interno al proyecto (cambios de diseño o de ejecución) Internal origin to the project (adjustment of design and execution)		
Fuerza Mayor Force majeure	Políticos Political	Financiero y económico Financial and Economical	Relacionado con la organización Related to the organization	Relacionado con el diseño Related to design	Relacionado con la construcción Related to construction
Inundación Floods	Cambios leyes y reglamentos Law and regulations modifications	Inflación Inflation rate	Atraso en permisos para iniciar Delays of construction permit	Diseño incompleto Incomplete design	Trabajos adicionales Additional works
Terremoto Earthquake	Huelgas y desórdenes Strikes and disturbances	Disponibilidad de fondos Release of funds	Atraso de suministros del mandante Delays of supply from the owner	Diseño defectuoso Defective design	Cambios de diseño Design adjustments
Incendio Fire	Permisos y autorizaciones Leaves and authorizations	Fluctuación tipo de cambio Foreign exchange exposure	Deficiencias del contrato Contract deficiencies	Errores y omisiones Errors or omissions	Condiciones de terreno Job site conditions
Viento Wind	Normas ambientales; seguridad Environmental regulations; security		Deficiencias de coordinación Coordination deficiencies	Especificación inadecuada Inadequate Specifications	Trabajo defectuoso Defective work
Rayos Lightning	Expropiación Expropriation		Deficiencias de Control Control deficiencies	Condiciones de terreno distintas Different job site conditions	Modificación de programas Schedule modifications
	Embargos Foreclosure		Atraso en soluciones Solution delays		Solución de diferencias Disagreement solutions

Figura 1. Tipos de riesgo en proyectos de construcción

Figure 1. Type of risks in construction projects

By examining the conflict causes that identified summarized backgrounds in the previous figure, it is possible to prove that each one may affect several conflicts simultaneously (a ground different to the one expected may demand a design change, schedule adjustments, resources adjustments, etc.). Figure 2 depicts the interconnection of effects, which leads us to sort risks origins in three major categories: Process Uncertainties; Management Deficiencies and Contract Deficiencies, as analyzed below:

Figura 2. Interconexión de efectos

Figure 2. Interconnection of effects

3a) Process uncertainty due to environmental variability

Most identified risks can be directly related to environmental variability. There isn't the slightest doubt about those unexpected events, which origin we have classified as external to the project. Referring to the internal risks, they take place due to the changes of the selected ground physical conditions or due to the required design adjustments, which are needed to cope with discovered reality as the work execution goes by. Such risks also come from the uncertainty determined by the amount of backgrounds in the project. Some schedule adjustments can also be a direct result of the above mentioned reality adjustments, which is often a complaint source. Consequently, such environmental uncertainty leads to necessary adjustments to the project activities, so it becomes important to foresee, organize, command, coordinate and control the management function provided by responsible organizations (owners and contractors), as further explained in the section 4 below.

3b) Management deficiencies

Other risks, as those caused by a deficient organization or command, design errors, defective works or delays on disagreement solutions, may be also attributed to management deficiencies from the owner as well as from the contractor, who failed to provide a proper control of the project activities (lack of proper work methods or poor command ability, coordination or control deficiencies, etc.).

3c) Contract Deficiencies

Although the project variability feature is known since long ago (Bilbao A. et al., 1987), nowadays it is easy to find out that some poor projects results are caused by leaving out variability effect on the execution activities, which were scheduled for static environments. Such deficiency is even clearer when the works are executed by means of contracts, which documents:

- They wrongly assign the responsibility on foreseeable uncertainty effects derived from the level or quantity of available backgrounds when tendering a project Campero M., (1992).
- They do not consider flexibility clauses (schedule adjustments; Price adjustments; Modification order; Changes of physical conditions; Timely notification The Federal Publication (1981), that fit the introduction of necessary adjustments to ensure the fulfillment of the project function with the fair cost/time compensation to the contractor, so as to maintain the balance of the contractual relationship.

The origin of such deficiencies is previous to the work execution itself, since they are born when preparing the tender documents. However, the negative effects could be moderated if during the execution process, there would be an early desire to detect them and to reach solution agreements between the owner and contractor in due time. Once again the function management is responsible for this task.

4. Application of management functions according to the company organization layout

Figure 3 shows the project layout according two classic organization kinds:

Figura 3a. Proyecto bajo una organización independiente

Figura 3b. Proyecto bajo una organización maricial

Project layout in the company organization

Figure 3a. Project under an independent organization

Figure 3b. Project under a matrix business organization

Each layout shows that specialized units undertake their own tasks, but are they really independent? Particularly, in the case of a project, the answer is definitely no, because at some point the activities shall be settled-in to form only one body. It means that if during the execution of such tasks, the environmental variability will force them to adjust themselves to the new reality, and then the adjustments made have to be reported to the officers responsible for other activities, in order to consider the possibility of mitigating negative effects. This is a global coordination task assigned to the project manager (either owner or contractor) and the heads of areas involved must accept it as a requirement, which is derived from the project special feature, although it may affect the economic profit of their own activity. If this prevention and coordination task is not undertaken but it is neglected, a delay in making the necessary adjustments to integrate the activities will lead to additional resources expenditures or will affect delivery times, which the parties will difficultly accept to solve.

4.1 Application of management functions on projects executed under specialized service contracts

When the company executes a project under a specialized service contract system (designs, equipment supply, construction, assembly), the coordination task developed by the project manager is still very important. There are several reasons:

- a) The features of the Project prototype generate uncertainties, which are cleared and solved as long as the execution works take place and the whole necessary information is obtained to develop a proper task. Therefore, there is a need to develop adjustments or modifications, either because designs need corrections, schedules are to be adjusted or resources are to be modified in accordance with the job site reality. It is necessary to be attentive to delivery times of resources required for construction items or the project equipment, etc.

- b) The project manager must create working schedules foreseeing such adjustments, mitigating negative effects and timely coordinating information broadcast and also agreeing a new schedule among the parties involved in the short term. Additionally, the necessary price reductions shall be agreed.
- c) Each contract has its own purposes, which determine the Bidding Terms and Conditions prepared by the owner. The contractor proposes his own methodology (when, how and resources) and his economical expectations (prices) in the Bid accepted or agreed with the owner. The modifications required during the execution process may affect such expectations and, the Project Manager is the one who has the best viewpoint of the contracts set on how to coordinate and integrate the adjustments involved by them in due time (design, procurement and execution). Furthermore, he has the authority and responsibility to agree the required terms and prices compensations derived from such adjustments.

The Figure 4 depicts the coordination functions already described. Koch J.E., Molenaar K.R. (2006).

Figura 4. Funciones de autoridad y coordinación

Figure 4. Authority and coordination functions

A line depicts the authority relationship between the parties and, the segmented line shows their necessary activities coordination. The Figure 4a shows the work executed by the company own forces. Coordination among functional units is achieved by the ability the Project Manager has to reach agreements (horizontal coordination) and, at last, by applying the formal authority the organization has assigned to him (vertical coordination). If the work is executed under contracts (Figure 4c), vertical-type coordination is harder to fulfill, since the owner's authority (segmented line) is limited to the contract conditions. Besides, if there are several contracts involved including consecutive or overlapped activities, coordination among them is a must so as to avoid inefficiencies or conflicts. The coordination between parties, which we have called horizontal coordination, is easily achieved when a standardized work procedure has been agreed to stabilize the job site management, Alarcón L.F. (1997).

4.2 Application of management functions on contract systems including integrated activities

Over the past few years, contracts integrating the activities of design, production equipment supply and works constructions in only one manager are being employed, due to several reasons, such as technical complexity, project size, frequency in the Company or the owner's policies (transferring risks). The contracts that only include design and construction tasks are the so called DB, Gransberg et al. (2006) (Design and Build). The contracts that include all activities are called contracts type EPC, FIDIC (1999) (Engineering, Procurement, and Construction).

Figure 5 shows the basic organization chart for a project executed under an EPC type contract.

Figura 5. Esquema de contrato Tipo EPC

Figure 5. Chart for an EPC type contract

The great difference between above contract and the independent contract layout shown by Figure 4c, is that the company assigns the management functions to the new EPC entity, including coordination and control of activities contracted by the project. If the project activities such as Design and Construction are in turn sub-contracted by the General Contractor with other specialized companies; then the lay out does not differs from the previous chart. However the EPC entity is the one to manage the contract and the corresponding sub-contracts, undertaking vertical coordination functions with the sub-contractors and, primarily the horizontal functions among them, as shown on Figure 6:

Figura 6. Esquema Empresa/Contrato EPC

Figure 6. Company Layout/EPC Contract

In this paper our main concern is to highlight the importance of properly assigning the EPC contractor's responsibility for the management of the project variability and the coordination of its effects on different specialized sub-contracts integrating it, so as to harmoniously complete schedules without conflicts. Besides, the Bid Terms and Conditions shall include a compensation clause for the sub-contractor when agreements or instructions affect delivery terms or costs of the work to be executed, which exceed the "clearance" limits fixed by the contract. Gonzalez V., Alarcón L.F. (2003).

5. Standardized work procedure employed to apply the management function on projects executed under contracts

So as to apply the management function, which will coordinate and harmonize all the parties' efforts, the project manager has to take into account the authority the organization has assigned him and the rights granted by the contract. As shown on Figure 4, coordination shall be achieved by the ability the project manager has to reach agreements with the contractor; and the latter with sub-contractors (horizontal coordination) or at last, by applying the formal authority (vertical coordination). Such coordination will be easier if a standardized work procedure has been agreed, which purposes are:

- Stabilizing the job site conditions Alarcón L.F. (1997) (Figure 7)
- Coordinating the tasks among contracts (eliminating idle times, etc.)
- Preventing conflicts and finding appropriate solutions in due time

Figura 7. Estabilización del campo de trabajo
Figure 7. Stabilizing the job site conditions

If owner and contractor share the same vision on below issues, the design procedure and its further application will be simplified:

a) Precaution

The expert staff dealing with project execution is probably well able to state that most of risks related to the project itself as indicated on Figure 1, are likely to be foreseen or anticipated, so that their effects can be controlled as long as the organization has a precaution attitude, Campero M., (1992); included in its processes in regards to the first symptoms of risk birth. Contrarily, external unexpected events or risks are difficult to foresee during the project life time. Maybe an exception could be inflation rate or currency exchange rates, which are well controlled under contract appropriate clauses¹.

b) Planning under uncertain conditions

Being aware that the Project is executed under an environment having some kind of variability level (due to unexpected events, disagreements between planning and reality and, due to unavoidable human mistakes), it compels us to accept that project planning, Vidal T., Bidot J., et al. (2002), must be adjusted to such condition. Under a stable environment, planning can include the total project execution period. Therefore, all necessary details are required to properly coordinate the tasks connected to another, which sequency is obligatory, such as design and construction. Under a non-stable environment, such static planning is likely to become overruled; if it is based on supposed events (such as design delays, supply delays, for instance). Consequently, elaborating a dynamic planning procedure becomes essential, which has three levels. Campero M., Alarcón L.F., (1999):

- 1) Master Plan, which covers the total execution term of the project and describes all obligatory gross activities to be executed to meet the corresponding goal.
- 2) Medium or short term plans (quarterly, monthly), which are regularly updated according to new backgrounds provided by the activities, which uncertainty is overcome by means of a further research effort (soil quality, design adjustments, activities delays, etc.) At this planning level it is essential to include management activities to solve uncertainties and to stabilize the job environment for the forthcoming period.
- 3) Short term plans (weekly, two-weekly), which cover the activities or tasks, which uncertainty no longer exists or has been reduced to a minimum by the previous process (static environment).

This work site stabilization is essential to obtain a trustworthy planning, which once again falls on the management function developed by the activities responsible staff.

¹ "Criteria used to determine Contract Adjustment Formulas", Department of Construction Engineering and Management of the Engineering Faculty, PUC, December 1995

c) Common objective among the owner and contractors

National and international experts highlight the negative effect of changes of design or methods during the construction process. However, even though they are awkward changes, they might become necessary to apply and to accept as long as they are essential to ensure the function to be fulfilled by the project. Then it is natural that the contractor accepts the Owner's right to introduce such changes, provided that the owner compensates the constructor for the corresponding period and cost.

That is to say, when signing the contract, willingly and in good faith, both owner and contractor accept the variations inherent to the project nature, which effects will be solved as a team, according to the rights and duties provided by the contract.

6. Conclusions

The main conclusions drawn from the former analyses are:

6.1 Every project must be managed as an activity executed under an uncertain environment.

6.2 This acceptance enables the development of management methods based on:

- a) Contract documents properly defining the parties' responsibilities on risks derived from uncertain activities, applying flexibility clauses to introduce the necessary changes by keeping the equity on the contractual relationship (Types of Contract Support for government or labor institutions)¹⁵²
- b) Prevention attitude, to detect in due time the birth of abnormal situations (delays, lack of definitions, criterion disagreements, design mistakes or omissions), so as to find and agree on solutions.
- c) Dynamic planning so as to stabilize the short term planning period, by means of an agreed procedure, which is applied as a work regulation.

6.3 Properly appraising the management function by all the parties involved in the Project, which leads to integrate the single knowledge of the team, in order to coordinate shared activities, to optimize the contractual relationship and to improve effectiveness avoiding conflicts.

6.4 Classic Project management functions (planning, organizing, commanding, coordinating and controlling) are absolutely required for contracts management; especially to calm down the variability environment where the project takes place.

6.5 In the case of an EPC contract type, the owner transfers most management responsibilities on the general contractor (EPC), however the owner is permanently coordinating, controlling and approving the responsibilities determined by the contract.

² A) Ministry of Public Works: Regulations for Public Works Contracts.

B) CODELCO: General Management Foundations on Construction, Engineering and Services Contracts; Contract management Manual.

C) Chilean Construction Chamber: Contract General Foundations for Construction and Assembly Works.

6.6 The general contractor EPC shall apply such functions in its own organization (vertical coordination), however he shall also apply them on the sub-contractors (horizontal coordination), in order to coordinate overlapping activities, agreeing on the essential modifications and providing compensation in due time for terms and prices so as to maintain the equity on the contractual relationship.

6.7 The contract shall clearly indicate the parties' responsibilities (owner-contractor or general contractor-sub contractors in the EPC contract type).

6.8 The owner as well as the contractor (or contractor and subcontractor in the case of EPCs) shall foresight prices and terms "clearances" required to absorb their effects on the adjustment of the project variability itself, in accordance with the limits provided in the contract.

6.9 In theory and in practice, a deficient owner or contractor management enables conflicts appearance, which could have been solved in due time in accordance with the contract conditions.

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