

# **SUBCONTRACTING AND COOPERATION NETWORK IN BUILDING CONSTRUCTION: A LITERATURE REVIEW**

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## **ABSTRACT**

Owing to recent structural transformations in the construction sector in many countries like Brazil, production is much more subcontracted nowadays than in the past. Consequently, supply chain management became more important, including the management of subcontractors.

Cooperation networks appear to be an advantageous way of supply chain organization, which is beneficial to subcontractors and building firms. Cooperation networks are consequences of strategic alliances between some agents of the supply chain. Such firms, organized together, cooperate, reaching better results than they would obtain individually.

With the main focus on subcontractors and building constructors, this paper, based on a literature review, seeks to deal with the decision of make or buy (subcontracting) and to analyze its importance in the formation and development of cooperation networks in building construction. Brazilian current management practices that happen in constructor firm-subcontractor relationship are described, as well as a parallel with the case of Great Britain. About stimulating cooperation networks in the sector, some actions are also quoted.

It can be said that supply chain integration in a cooperation network through strategic partnering is a key success factor for increasing competitive advantages in the sector.

## **KEYWORDS**

Supply chain management, subcontractor, cooperation network, lean construction, building construction.

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## INTRODUCTION

Lean production consists of a complex cocktail of ideas, including continuous improvement, lean organization structures, teamwork, elimination of waste, efficient use of resources and cooperative supply chain management. These aspects have been challenged by authors like Koskela (1992) and Howell and Ballard (1994), and discussed by others, like Green (1999) and Garnett *et al.* (1998).

Koskela (1992) was a pioneer in applying lean production ideas to construction. He proposed the need to understand construction production as a combination of conversion and flow processes and not as a mere number of disjointed conversion processes.

Lean construction philosophy deals with the production process and aims at the adoption of methodologies that allow for the attainment of favorable results in terms of generation of aggregate value to product, without implying cost increase or quality loss. It relies on five principles of the Lean Thinking philosophy: value, value stream, flow, pull and perfection (Womack and Jones 1996). As consequences of the implementation of this philosophy, the following can be mentioned: systematic waste reduction, operational costs reduction and attainment of commitment and teamwork qualification (Contador 1998). The central themes of lean construction have been eliminating waste and improving workflow in construction (London and Kenley 2001).

According to Amato Neto (1999), some changes in the modern capitalist world, such as the emergence of new technologies, imposed changes in the organizational structure of enterprises. In this context, the advent of the lean production paradigm has produced new kinds of inter-firms relationships. One form of inter-firm relationship is cooperation network among companies operating within the same production chain, which can create synergy of positive impacts, the so-called 'collective efficiency'<sup>3</sup>.

Even if the lean production concepts are more related to the firms themselves, in the 'micro' level, they can be extended to the '*mezzo*' or medium one, concerning relationship between firms, in an industry. This relationship deals with market aspects, but also with general ones, like technology, organization, manpower, design, etc.

In this way, the purpose of this paper is to stimulate discussions about the decision of make or buy (subcontracting) and about the constitution of cooperation networks in construction industry and also to highlight the importance of partnering for building industry improvements. The study is based on the analysis of a large number of publications about correlated subjects.

Focusing mainly on subcontractors and building constructors, this paper seeks to discuss two types of partnering (project and strategic) and to analyze its importance in formation and development of cooperation networks in building construction.

## LITERATURE REVIEW

### VERTICAL INTEGRATION

Vertical integration involves a variety of decisions concerning whether corporations, through their business units, should provide certain goods or services in-house or purchase

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<sup>3</sup> Hubert Schimitz defines collective efficiency as the competitive advantage derived from local external economies and joint action. See more details in Schimitz, H. (1995). "Collective Efficiency: Growth Path for Small-Scale Industry". *The Journal of Development Studies*, 31 (4), 529-566.

them, instead (Harrigan 1985). The strategy of vertical integration consists in defining if a company will make or buy its basic inputs and jobs.

Porter (1980) defines vertical integration as the production processes combination, distribution, sales and/or other distinct production processes within the borders of the same company.

The general question of vertical integration is the extent to which a firm is directly responsible for producing all of the inputs required for its products (Eccles 1981). Thus, if the company decides to acquire some inputs from other firms, the main question turns into the efficient management of these relationships.

Among the benefits of vertical integration are: reduction of transaction costs<sup>4</sup>, guaranteed supply of features, improved internal coordination, broader technological capacity and biggest difficulty of entering the market (Buzzell 1983).

The disadvantages of vertical integration are: need of high investments, flexibility reduction to demand, variation of market and specialization loss, because the organization is concentrated on some production processes, still according to the same author.

The adequate development of the integration strategies, according to Krippaehne (1992), requires the following actions by the firms:

- to prevent the internal development of capacities that can be satisfied by external firms;
- to develop good relations with the group of subcontractors and suppliers they work with;
- to appeal to other pre-qualified firms to monitor the conditions of market price and technology;
- to reduce its amount of work performed with proper features, disintegrating in some way, mainly in the case of those with low profit margin;
- to be aware that, whichever the strategy adopted, it must be constantly revised.

Harrigan (1983) describes four generic strategies of vertical integration, each with different degrees of transferences and different internal investments and each implying bargaining power with adjacent industries. These strategies are described as follows:

- *Full integrated strategies*: the fully integrated firms internally buy or sell all of their requirements for a particular material or service internally. They have the highest degree of internal integration (Harrigan 1983).
- *Taper-integrated strategies*: taper-integrated firms rely on outsiders for a portion of their requirements. Taper integration means that the firm purchases or sells the remainder through specialized supplier, distributor, or competitors that are not so integrated (Harrigan 1983).

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<sup>4</sup> Transaction costs are the costs of running the economic system, or simply the costs of carrying out any exchange, whether between firms in a marketplace or a transfer of resources between stages in a vertically integrated firm. They are the economic equivalent of friction in physical systems. See more details in Williamson, O.E. (1985). *The Economic Institutions of Capitalism - Firms, Markets, Relational Contracting*. New York, The Free Press. See also Hobbes, J.E. (1996). "A Transactional Cost Approach to Supply Chain Management". *Supply Chain Management*, 1 (2), 16-27.

- *Quasi-integration*: quasi-integrated firms need not own 100 percent of the adjacent business units in question, but they may consume or distribute all, some, or none of the outputs or inputs of the adjacent, quasi-integrated unit (Harrigan 1983).
- *Nonintegrated strategies*: firms simply buy raw materials or assemblies as needed.

## SUBCONTRACTING

Subcontracting has been presented as an organizational alternative for some economic activities (Beardsworth 1988). Firms are decentralizing their jobs more and more, allowing subcontracting to become a basic part of the work organization.

Veltz (2000) points out that the firm does not need to have the control of all the value string, being able to externalize non-strategical activities, aiming to reduce costs.

Pagnani (1989) defines subcontracting as a legal-economic relationship between two agents, in which the characteristic criteria are substitution and subordination. The substitution criterion means that the subcontractor executes the operation with technical and financial risks, instead of the job assignor; the subordination criterion means the subcontractor must follow the direction given by the contractor.

Some main aspects involved in job subcontracting, for the case of buildings construction, are analyzed in Table 1.

*Table 1: Aspects of subcontracting in building construction*

<b>Aspects</b>	<b>Comments</b>
<i>Flexibility</i>	Subcontracting appears as an answer to market uncertainties.
<i>Quality</i>	Subcontracting, on the one hand, can improve product quality because it uses specialized manpower and, on the other hand, can get worse, because it leads to problems of control and coordination.
<i>Costs</i>	Fixed costs become smaller, while transaction costs increase. Fixed costs are lesser because subcontracting eliminates equipment maintenance and underutilized manpower. Transaction costs can become bigger, because each new contract negotiation can involve some proposals by subcontractors.
<i>Productivity</i>	Subcontracting tends to further tie the laborer to the firm subcontractor. Thus, the effects of replication, continuity and learning lead to higher productivity by the manpower. Easy access to specialized equipment and constant training also lead to higher productivity.
<i>Controls</i>	Controlling the quality of work is difficult with subcontracting, because the high amount of independent organizations in the site makes the control of work progress difficult.
<i>Planning</i>	The intensive subcontracting of manpower makes the planning process difficult. Moreover, conflicting interests can intervene negatively with the programming of activities.
<i>Technology</i>	Market instability leads the contracting firms not to establish stable agreements with the subcontractors, thus not allowing technology transfer.
<i>Training</i>	The contractors tend to pass the responsibility of training to the subcontractors, but generally they are not apt to accomplish it, due to financial features and the lack of time for training.
<i>Safety at work</i>	The final responsibility for the safety at work falls on the contracting company, as well as the implementation of a safety program, the commitment and supervision of the subcontractors. The disinterest of the contractor in investing in programs of safety for floating and unknown workers and the lack of familiarity of the workers with the working atmosphere aggravates this problem.
<i>Consumption of materials</i>	Subcontracting can magnify materials waste; subcontractors tend to finish the job as fast as possible, without controlling the use of materials.

Adapted from Shimizu and Cardoso (2002).

According to Bennett and Ferry (1990), building firms are organized into a consistent operating core based on their individual capabilities. Construction companies are becoming

construction managers or contractor managers, transferring construction work to specialists.

Subcontractors are specialist agents in the execution of a specific job, supplying manpower, besides materials, equipment, tools or designs. They respond only for the executed part of the workmanship, acting as agents of the production system of the contractor company.

According to Tommelein and Ballard (1997), specialty contractors are construction 'job shops', performing construction work that requires skilled labor from one or at most a few specific trades and for which they have acquired special-purpose tools and equipment as well as process know-how.

In the United States, in many projects, particularly building projects, it is common for 80-90% of the work to be performed by subcontractors (Hinze and Tracey 1994). Villagarcia and Cardoso (1999) state that during the last years subcontracting has increased in Sao Paulo (Brazil), and it is known that, to date, subcontracting achieves similar levels to the ones mentioned by Hinze and Tracey.

Subcontractors classification focuses on the kind of activities they perform. Table 2 shows three types of classification of subcontractors in building construction, organized by Brazilian authors.

Table 2: Classification of subcontractors in building construction.

Author	Classification	Examples activities
Farah (1993)	<i>subcontractors of basic activity</i>	formwork, mortar, concrete, masonry, rendering and ceramic coatings
	<i>subcontractors of stages and specialized jobs</i>	jobs done by workers with specific qualifications
Villacreses (1994)	<i>subcontractors of basic activity</i>	formwork, mortar, concrete, masonry, rendering and ceramic coatings
	<i>subcontractors of special techniques</i>	electric fittings, plumbing, air conditioning
	<i>subcontractors of special work and/or materials</i>	external waterproofing, painting, floor, glasses, external rendering, foundations
Pereira (2001)	<i>subcontractors supplying manpower</i>	masonry, painting
	<i>subcontractors supplying manpower and materials</i>	electric fittings, plumbing, joinery
	<i>subcontractors supplying manpower, materials and designs</i>	waterproofing, gypsum wallboard
	<i>subcontractors supplying manpower, materials, designs and maintenance</i>	air conditioning, sprinkler-system, special fittings

Adapted from Farah (1993), Villacreses (1994) and Pereira (2001).

Note that in Pereira's classification there is an enlargement of the subcontractors role from the first to the last type. This classification seems to be more appropriate for the purpose of this paper.

## PARTNERING

Partnering has been seen as a tool for improving the performance of the construction process and emphasizes the way it helps to create synergy and maximize the effectiveness of each participant's resources (Barlow *et al.* 1997).

The Construction Industry Institute defines partnering as *a long-term commitment between two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant's resources. This requires*

*changing traditional relationships to a shared culture without regard to organizational boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other's individual expectations and values* (Barlow *et al.* 1997).

To date, partnering is understood as a set of collaborative processes, which emphasizes the importance of common goals. The base of partnering is a high level of interorganisational trust and the presence of mutually beneficial goals. Partnering means a management process that helps the strategic planning to improve the efficiency of the enterprises, and forms a team with common objectives (Barlow *et al.* 1997).

Participants of a project can improve performance in terms of cost, time, quality, buildability, fitness-to-purpose and a whole of range of other criteria, if they adopt more collaborative ways of working (Bresnen and Marshall 2000). According to the same authors, partnering aims to reduce the adversarialism which is said to be typical in the industry and which has confounded previous attempts to encourage better integration and cooperation between contractual partners.

Barlow *et al.* (1997) mention six successful factor of partnering: building trust, teambuilding, the need for top level commitment, the importance of individuals, the strategic movement of key personnel, and the need of open and flexible communications. The same authors quote as common benefits in a partnering relation: reduced costs, shortened delivery time, improvement in construction quality, better working atmosphere, and organizational learning.

Partnering classification focus on the duration of cooperation between partners. Two main types of partnering are found in literature: project partnering and strategic partnering or long-term partnering.

Project partnering is a cooperative relationship between organizations for the duration of a specific project (Barlow *et al.* 1997). At the end of the project, the relationship is terminated and another partnering may commence on the next project (Kumaraswamy and Matthews 2000). Welling and Kamann (2001) state that if these firms do not meet again in another project, the learning effect reached on the particular project will be eliminated.

Strategic partnering is a relationship with a high level of cooperation between partners (Barlow *et al.* 1997), which takes place when two or more firms use partnering on a long-term basis to undertake more than one construction project, or some continuing activity (Kumaraswamy and Matthews 2000). In this kind of partnering, the learning achieved in a specific project is more likely to be used in future projects.

In the context of a strategic partnering, it becomes a management philosophy that is expected to work continuously for each and every project and there are more expectations from team members than for a project partnering (Cheng and Li 2001).

## **COOPERATION NETWORK**

The term network refers to a set of nodes and relationships that are connected. Grandori and Soda (1995), focusing on organizational theory, see networks as nexuses of integration mechanisms encompassing all the range of organizational inter-firms coordination and cooperation. The proposition is that networks compete with networks, rather than simply firms with firms. It follows that networks encompass both upstream and downstream firms (Lamming *et al.* 2000).

In consummate cooperation, both parties work together to a mutual end, responding flexibly, sharing skills and information (Welling and Kamann 2001).

Networks differ in terms of degree of complexity, concentration of power balance, environmental diversity and stage of network development (Harland *et al.* 2001). Grandori

and Soda's (1995) classification centers on power balance and divides networks in: (1) symmetric, parity-based or equity networks and (2) asymmetric, centralized or non-equity networks. Williamson (1985) classifies networks according to their behavior: (1) opportunistic networks and (2) non-opportunistic networks. These classifications are important because they will influence the way a firm can manage its cooperation network, as discussed below.

## **COOPERATION NETWORKS FORMATION AND DEVELOPMENT**

### **BUSINESS RELATIONSHIPS IN CONSTRUCTION INDUSTRY**

The construction industry is dependent on subcontractors and on suppliers of building materials. However, it is characterized by opportunistic behavior and the lack of vertical cooperation (Welling and Kamann 2001). This happens because of the industry traditional approach of the organizational structure of the construction process, which results in a subordinate position for subcontractors within the hierarchy of relationships forming the traditional design-management-construction process. Consequently, main contractor-subcontractor relationships are often found to be strained and adversarial (Dainty *et al.* 2001).

The French project organization seems to be a particular case. Winch and Campagnac (1995) call it 'co-contracting', where *the principal contractor is directly responsible for the structural works, which it carried out mainly with its own directly employed workforce and where the finishing trades contractors are placed in direct contact with the client and the principal contractor is paid a fee for their management.*

Construction industry, compared with others, lags behind in terms of cooperation. However, some care must be taken when comparing construction with other industries (Welling and Kamann 2001):

- The governance of transactions in construction supply chain differs from mass assembly and process technologies.
- Construction is not one supply chain, but a series of distinct chains, with unique properties that are complex and difficult to coordinate.
- Construction projects require a unique combination of labor and material inputs, performed and coordinated on site, lacking controlled factory environments.
- Organization and management of a construction project almost invariably involves interlinkages among a number of organizations. These organizations generally differ in size, culture, skill level, specialty, automated information systems and methods of production control.

Eccles (1981) points out that all of these organizations have to cooperate in some way in order to combine their resources. At a certain time, a number of these organizations will be simultaneously involved in the project and, given the dependence path of activities, the work of one firm cannot proceed until the work of several others has been completed.

### **PARTNERING IMPORTANCE FOR COOPERATION NETWORKS**

Studies of customer-supplier collaboration have shown that major benefits may be achieved when firms adapt to one another (Dubbois and Gadde 2000).

Corbett *et al.* (1999) state that failing to collaborate results in the distortion of information, which can lead to costly inefficiencies. Through a more open, frequent and accurate exchange of information, typical of a strategic partnering, companies can eliminate many of these problems and ensure ongoing improvement.

Howell (1999) points out that partnering provides the opportunity for collaborative redesign of the planning system to support close coordination and reliable workflow. Nevertheless, this author also says that partnering without a change in project and production management philosophy typically fails, because the mere act of partnering does not change the way the work is done.

The development of trust between organizations is seen as a function of the length of the relationship between them, and the mechanisms that led to this alignment (repetition, routine, understanding) are largely viewed as informal (Bresnen and Marshall 2000).

Although the advantages of project partnering are not regarded as equal to strategic partnering, the fact that it is considered possible to cause change over the timescale of a single project is indicative of the view that partnering can be engineered and does not have to evolve 'naturally' (Bresnen and Marshall 2000).

Thus, in the short term, contractors may be willing to absorb any extra costs in order to develop or maintain a relationship. However, such an approach may be unsustainable in the long run (Bresnen and Marshall 2000).

In rival networks, firms may behave opportunistically, gaining at the expense of other firms. These networks play a zero-sum game, i.e. a situation where for one party to gain, another must lose (Jones 1990). Jones still points out that most networks are rivals, basing decisions primarily on price.

## **CURRENT PRACTICE**

### **Brazil**

In this item, based on Shimizu and Cardoso (2002), the Brazilian current management practices that happen in constructor firm-subcontractor relationship are characterized.

As some Brazilian authors like Serra (2001) have already signaled, subcontractors are generally subordinated to the wills of the constructors, in which the imposition of the decisions of the latter prevails most of the time. In general, subcontractors can only choose between 'accepting the agreement job' according to criteria defined by the constructor or 'to refuse the job'. About the selection of subcontractors, the market focuses only on price.

About the relation between constructors and subcontractors, one is dissatisfied with the other: on the one hand, constructors state that the low organizational level of subcontractors makes the relation difficult; on the other hand, subcontractors assure that constructors usually take advantage of high competition to impose low prices. As Pereira (2001) has shown, this conflict can go beyond the contract phase, and is kept all along the project. This is particularly true in the case of subcontractors belonging to the two first levels of Pereira's classification, presented in Table 2, but less evident in the case of subcontractors supplying manpower, materials, designs and maintenance.

Excluding relationships concerning this last type of subcontractors, the lack of partnering relations between Brazilian contractors and subcontractors is noted. Nevertheless, this characteristic can rapidly change, as subcontractors tend to enlarge their role in the construction process, also supplying materials, design and maintenance.



### **A parallel: Great Britain**

Brazilian reality is similar to that of other countries. Dainty *et al.* (2001) conducted a research with 20 subcontractors in Great Britain and concluded that companies interviewed generally held negative views of partnering and believed that some main contractors did not understand the principles of partnering and strategic alliances, or that their motivations for adopting such practices were not for reasons of engendering mutual trust.

The same authors add that directors of subcontractors viewed partnering, such as open-book accounting, merely as mechanisms for main contractors to drive down their profits. They also state that the barriers identified were seen as being symptomatic of a lack of understanding and empathy with subcontractors' needs by main contractors, particularly with regard to cost and payment issues.

Another conclusion of the Dainty *et al.* research was that subcontractors blamed the lack of trust between the parties on the adversarial nature of their working relationships that had characterized the industry operation for many years. Indeed, the cultural issue of mistrust between the parties was seen as a fundamental barrier to increase understanding of each other's needs and to further integration.

Therefore, rethinking the production system design according to lean construction philosophy can be a good opportunity to change the organizational structure of the players, this being a prerequisite for successful partnering. The question is how multi-organizational structures should be designed to effectively execute lean production systems and bring together contractors and subcontractors.

According to Welling and Kamann (2001), construction firms do not seem to take advantage of opportunities to make use of external resources through new organizational forms, such as cooperation, networking and strategic alliances, which are increasingly emphasized as critical factors in successfully running organizations.

This lack of cooperation is influenced by some surrounding economic conditions, like focus on price, short term vision and great competition, which predispose contractual partners to act, for a very rational economic reason, in more 'traditional', adversarial and even exploitative ways.

Many problems referred directly and indirectly to insufficient coordination, communication, and thus commitment, such as failures to inform about schedule changes, late information of deliveries, and lack of feedback procedures (Vrijhoef *et al.* 2001), mainly related to failures in the production system.

However, it is important to list some good experiences related in literature. One example is Barlow *et al.* (1997), whose research explored the managerial process involved in five client-led partnering arrangements, encompassing over 40 firms.

### **STIMULATING COOPERATION NETWORKS**

The central tenet of the building industry is that the greater provision of integration will solve many of the problems that fragmentation has caused within the sector (Dainty *et al.* 2001). The key barriers to greater integration seem to stem from the historical fragmentation of project delivery system, and the contractual and adversarial nature of construction project relationships.

Some arguments in the literature state that not only the players themselves are in charge of such integration. Dainty *et al.* (2001) have signaled the role of those at the head of the production process, pointing towards two specific needs for better integration: a

greater degree of client leadership in order to drive the integration process and an insistence on transparent and mutually beneficial processes for all parties in the supply chain.

Another important issue is minimizing conflicts arising from these relations. Welling and Kamann (2001) recommend the following actions for the management of these relations in the construction:

- Structuring relationships in such a way that there are frequent and durable interactions among specific individuals.
- Appointing account managers and asking firms that are part of the permanent network to do the same should create recurrent meetings among people and this, in turn, should stimulate cooperative relations.
- Monitoring current behavior and experiences and pooling this information enables project managers to share experiences.

## CONCLUSIONS

This paper has given a brief, and by no means exhaustive, overview of some of the main issues arising from current research on cooperation network.

The need of strategies analysis that makes the construction sector more competitive is noticed. Amongst these strategies, the vertical disintegration (subcontracting) appears as a good alternative, providing flexibility, lean structures, productivity, and costs reduction, amongst other advantages.

The use of partnering appears as a possibility of getting the advantages and reducing the disadvantages of subcontracting, through the maintenance of stable and beneficial relationships. It is clear that the advantages of project partnering are not regarded as equal to strategic partnering, but a project partnering has its benefits. Besides, a project partnering may evolve to a strategic partnering in the future. Even if a relationship between firms does not automatically make it a 'perfect team', there is always the potential. Teams develop as the involved parties experiment with various connections and learn from the developments. This is particularly important in Brazil, where subcontractors tend to expand their role in the construction process.

Although there are some good examples of strategic partnerships that have led to considerable improvements in construction project delivery (see Barlow *et al.* 1997) these have been largely restricted to client-contractor linkages, as opposed to developing strategic alliances throughout all the supply chain.

The truth is that strategic partnering alliances are not frequent in the construction industry and that cooperation network is a concept that is very far from current management practices in this sector.

An effective integration is unlikely to be possible without fundamentally rethinking the current inter-organization relationships and dynamics that exist within the construction industry. A change in this situation will require main contractors to make efforts to address the integration and partnership of smaller companies as well as client organizations. Even if the lean construction concepts are more related to firms, they can be extended to this level, as some authors mentioned in this paper have already done.

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