



COLLABORATION IN CONSTRUCTION SUPPLY CHAIN IN DEVELOPING COUNTRIES

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ABSTRACT

Highlights: Supply chain collaboration has been presented in recent decades as a solution to performance issues. However, collaborative supply chains are far from being a reality in the construction industry, especially in emerging countries. Rio de Janeiro, a state of Brazil, was used to investigate CSC (Construction Supply Chain) in an emerging country.

Purpose: This article aims to evaluate the characteristics of CSC (*Construction Supply Chain*) collaboration and identify its critical elements. These elements were also compared in two groups of construction companies: small and medium/large construction companies, in order to verify whether size influences the degree of collaboration.

Design / methodology / approach: This study used a combination of two methods: literature review and application of a survey to construction companies in the state of Rio de Janeiro. Data collection was performed from October 2018 to January 2019. The statistical analysis of the elements was performed using the software “R”, by Mann-Whitney U test.

Findings: The survey revealed that the elements considered the most important for collaboration were: “joint planning and decision making”, “trust”, and “collaborative culture”. On the other hand, the element considered of minor importance for collaboration was “Information Sharing”. Comparison of the two groups of companies made it possible to conclude that there is a gap between the two groups of builders evaluated, and the medium/large builders were more prone to collaboration. Thus, the article suggests on which points effective collaboration in the CSC should be given attention.

Research limitations / implications: This study was limited to researching collaboration in the CSC in construction companies located in the state of Rio de Janeiro.

Originality / value: This article contributes to the literature on collaboration at CSC in Brazil and emerging countries, since there are few studies in this area for emerging countries.

Keywords: Collaboration; Construction Supply Chain; Partnership; Construction Industry



1. INTRODUCTION

The great competitiveness faced by organizations due to the growing integration of markets and the increasing demand from consumers has generated an incessant search for performance improvement, technological development and greater offer of products and services (Vitorino Filho et al., 2016).

In this sense, collaboration has been explored in recent decades as a means of improving companies performance, as well as improving supply chain as a whole (Panahifar et al., 2018). And today, collaboration has been seen as a path to innovation through information sharing and joint knowledge-building between suppliers and customers, enabled by information technology (Jimenez-Jimenez et al., 2019).

Collaboration was originated in the 1990s as a successful strategy for supply chain management (Soosay and Hyland, 2015). According to Simatupang and Sridharan (2002, pp. 19) it can be defined as: two or more independent companies working jointly to plan and execute supply chain operations with greater success than when acting in isolation.

By collaborating, supply chain partners can work as if they were part of a single company, can access and leverage each other's resources and enjoy associated benefits, such as: process efficiency, flexibility, business synergy, quality, and innovation (Cao and Zhang, 2011).

Collaborative management requires the involvement of all agents in planning, and real-time information exchange and information management are fundamental requirements in the process (Vivaldini; Pires, 2012).

Several authors report the success of the application of collaborative practices across companies, including: Marine-West, Procter & Gamble, and Hewlett-Packard, which have achieved cost reductions, improved sales, and improved forecast accuracy through collaboration in SC (*supply chain*) (Ramanathan and Gunasekaran, 2014).

In the construction industry, this subject has been discussed since mid-1990s, when the UK government sponsored two studies: Latham (1994) and Egan (1998) (Meng et al., 2013; Briscoe and Dainty, 2005; Akintoye et al., 2000). These studies highlighted various issues faced in the industry (Dike and Kapogiannis, 2014) and suggested that performance improvement could be achieved through joint work and collaborative agreements (Akintoye and Main, 2007).

Although collaboration is pointed out as a solution to the construction industry challenges, this sector has not been able to fully benefit from the supply chain management strategy, and this problem is more severe in emerging economies (Faris et al., 2019; Costa et al., 2019).

As in several emerging countries, Brazilian construction is characterized by 1) low productive efficiency; 2) unsatisfactory quality and productivity; 3) little interest in modifications; 4) use of low skilled labor and; 5) high staff turnover (Mello, 2007). In addition, the sector is recognized for using outsourcing services as its main strategy (Moratti, 2010), resulting in a complex, highly fragmented and heterogeneous production chain, encompassing several materials and service providers (de Brito Mello and de Amorim, 2009).

In this way, the study of collaboration in CSC can be a way to improve performance in emerging countries. This paper aims to discover the nature and characteristics of construction supply chain collaboration in emerging countries from the point of view of construction companies in the state of Rio de Janeiro/Brazil. To this end, it was sought to answer the following questions: What are the characteristics of collaboration for the building sector? What are the supply chain collaboration key elements? Do these elements have different degrees of importance within the CSC (construction supply chain)?

The elements within two groups of construction companies were also compared: small and medium/large. This comparison was made to verify whether construction company size influences the degree of collaboration.

To reach the research objective, a critical literature review was carried out, the main elements that could compose a conceptual model of collaboration for the civil construction were identified, and then a survey questionnaire was applied to confirm these elements.

The following section presents literature review; section 3 presents the research method; section 4 presents questionnaires' results analysis. Finally, section 5 presents the conclusions about the research performed.

2. BIBLIOGRAPHIC REVIEW

The success of supply chain collaboration in other industry sectors, such as manufacturing, has been an inspiration to the construction industry (Meng, 2013). However, practices in the manufacturing industry cannot be applied directly to the construction industry due to their peculiar characteristics (Akintoye et al., 2000). Thus, it is necessary to study which elements compose it.

This section presents a literature review on the main elements related to collaboration. To do so, the most relevant articles on the subject were searched through Google Scholar, from 2000 to 2018.



From this review it can be concluded that for a successful collaboration, joint planning and decision making was the most cited element by authors. Information sharing, resource sharing, trust, process alignment, common goals, collaborative culture, and joint problem solving were also frequent. These elements are listed in Table 1, which lists the key critical elements verified through the Review performed and the corresponding authors.

The first collaborative initiatives came in the form of joint planning (Barratt, 2004) from the use of tools, such as ECR (Efficient Consumer Response), VMI (Vendor Management Inventory), and CPFR (Collaborative Planning Forecasting Replenishment) that use information exchange to align operations, as well as each partner capabilities, enabling operational decision making (Oliveira, 2016; Panahifar et al., 2018).

The key critical elements are defined next:

Information sharing plays a vital role in SCC (*Supply Chain Collaboration*) and has a positive effect not only on performance, but is also a good tool for reducing uncertainty (Al-Doori, 2019; Hudnurkar et al., 2014). It encompasses monitoring, processing and data dissemination, directly impacting better process visibility and enabling more agile demand planning (Simatupang et al., 2004).

Information exchanged can be about information forecast/demand, available inventory levels, inventory maintenance costs, and others (Kumar and Nath Banerjee, 2012).

In turn, resource sharing is the process of leveraging and investing in resources and assets between SC partners. These resources can be equipment, facilities or technology, and investments can be both financial and non-financial (Cao et al., 2010).

Trust is the principle that governs collaborative relationships (Fawcett et al., 2008). It enables large amounts of information to be exchanged between trading partners (Panahifar et al., 2018), contributing to decreasing the occurrences of execution problems and increased chances of success (Fawcett et al., 2012).

Process alignment is the commitment of supply chain stakeholders to improve processes in order to enhance overall performance (Angerhofer and Angelides, 2006). This alignment involves overcoming many functional boundaries, where the involvement of top management is extremely important (Barratt and Green, 2001).

The concept of common goals among those involved in the supply chain means that each partner can achieve their individual goals by working toward supply chain goals (Cao et al., 2010). According to Simatupang and Sridharan (2002), a common goal should be focused on results for end customers.

Culture is a very influential factor in collaboration across organizations (Faris et al., 2019), because it reflects the way companies/individuals think, work, interact, and behave (Kumar and Nath Banerjee, 2012). According to Fulford and

Table 1. Critical elements for successful supply chain collaboration

Critical Elements for Collaboration	Authors
Joint planning and decision making	Simatupang and Sridharan (2002), Barratt (2004), Min et al. (2005), Soosay et al. (2008), Cao et al. (2010), Kumar and Nath Banerjee (2012), Meng (2013), Sridharan and Simatupang (2013), Ramana-thamn and Gunasekaran (2014), Oliveira (2016)
Information sharing	Simatupang and Sridharan (2002), Min et al. (2005), Fawcett, Magnan and McCarter (2008), Soosay et al. (2008), Cao et al. (2010), Sridharan and Simatupang (2013), Oliveira (2016), Panahifar et al. (2018)
Resource sharing	Barratt (2004), Min et al. (2005), Soosay et al. (2008), Cao et al. (2010), Kumar and Nath Banerjee (2012), Oliveira (2016)
Reliance	Akintoye et al. (2000), Fawcett et al. (2008), Meng (2013), Fulford and Standing (2014); Panahifar et al. (2018)
Process alignment	Barratt (2004), Angerhofer and Angelides (2006), Soosay et al. (2008), Sridharan and Simatupang (2013)
Common goals	Akintoye et al. (2000), Simatupang and Sridharan (2002), Cao et al. (2010), Meng (2013)
Collaborative culture	Barratt (2004), Kumar and Nath Banerjee (2012), Fulford and Standing (2014), Oliveira (2016)
Joint problem solving	Min et al. (2005), Kumar and Nath Banerjee (2012), Meng (2013), Oliveira (2016)

Source: The authors



Standing (2014), a collaborative culture should be based on teamwork and group effort over individual effort and rewards.

The last item was joint problem solving. According to Kumar and Nath Banerjee (2012), problems such as conflict and disagreements are natural when companies work together; thus, mechanisms need to be created to resolve them. These mechanisms can result in mutually developed process improvement ideas (Min *et al.*, 2005).

The following section explains the research methodology.

3. RESEARCH METHODOLOGY

To achieve this paper objective, a combination of two methods was performed: a literature review and application of a survey. A research methodology scheme is presented in figure 1. The literature review establishes a basis for the study because (1) it provides an understanding of the collaboration scenario in the CSC, (2) defines the main elements of collaboration, and (3) identifies the necessity of the current research.

The review results were used to develop the survey questionnaire. This questionnaire was divided into two stages: the first refers to qualitative open and closed questions, to understand characteristics of existing collaboration and acceptance of collaboration as a strategy for improving CSC performance. The second stage refers to closed questions that aimed at understanding the elements that make up the collaboration.

In the second stage, eight questions were elaborated to classify interviewee's perception of the importance of each element of the collaboration. For such purpose, the five-point *Likert* scale was used (1 = Strongly Disagree, 2 = Partially Disagree, 3 = Indifferent, 4 = Partially Agree, and 5 = Strongly Agree).

A pre-test was conducted with four qualified professionals: two academics and two professionals of the segment. The purpose of this pre-test was to validate the questionnaire and check points where improvements were needed. At this stage, the questionnaire was personally administered

by researchers, and from this pre-test, some necessary adjustments were made to the questionnaire.

After the pre-test, the questionnaire was *emailed* and managed through the *Google Forms* tool for the target group. The research target group is made up of 34 construction companies that are part of the Rio de Janeiro Real Estate Business Managers Association (ADEMI/RJ – *Associação de Dirigentes de Empresas do Mercado Imobiliário do Rio de Janeiro*). This population was selected in view of the central role of construction companies in the supply chain dealing with customers, suppliers and subcontractors.

In order to ensure data collected reliability, the questionnaire was applied only to people responsible for contracting suppliers within the construction companies. The respondent's profile is shown in table 1.

Data collection was performed at a single time interval from October 2018 to January 2019. 32 questionnaires were answered. However, only 22 respondents (68.75%) said they had experience with collaboration, which shows how recent the topic is in this sector. For this research, only questionnaires of companies that claimed to have experience with collaboration were used. The respondents' profiles are presented in table 2.

Table 2. Sample Profile

Characteristics	%	Quantity
Respondent's Position	68.18% Procurement Analyst / Manager	15
	22.72% Engineer / Construction Manager	5
	9.10% Director or Higher Position	2
Experience	22.72% Between 5 and 10 Years	5
	59.09% Between 10 and 20 Years	13
	18.19% Over 20 Years	4
Level of Education	4.54% High School	1
	36.36% Higher Education	8
	59.10% Post-graduation	13

Source: The authors

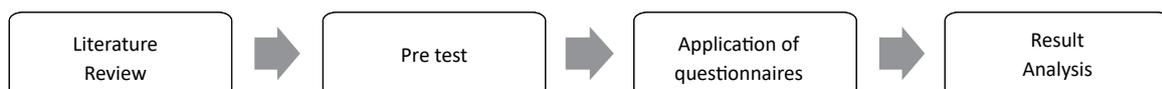


Figure 1. Research Methodology Sequence

Source: The authors



For the analysis, respondents were divided into two groups (small and medium/large construction companies) based on the number of employees to determine if their answers varied according to the size of the construction company. Table 3 shows the grouping of answers.

Table 3. Size of the respondent construction companies

Group	Qty of Employees	Frequency	%
Small Construction Company	Up to 99 employees	5	23%
Medium / Large Construction Company	More than 99 employees	17	77%
Total		22	100%

Source: The authors

The statistical analysis of the results was performed with aid of *Project R for Statistical Computing(R)* Software, using the *Mann-Whitney U test*, based on the median values. The Mann-Whitney U test is a non-parametric test used to compare two independent samples that have different sizes based on ranking the data.

The choice of this test was made because, in this case, the t-Test could not be applied due to the fact that the work was carried out with categorical variables, which do not have normal distribution and with very small samples ($n < 20$). The next topic presents the results of this research.

4. RESULTS

As explained in the research methodology, in the first step, qualitative questions were asked in order to understand the collaboration characteristics in the building sector. These questions are in table 4 and the analysis of the answers is presented in tables 5-8.

Table 4. Qualitative Questions

No.	Question
1	Can your experience with collaboration be considered positive?
2	Has your experience with collaboration been of short or long term?
3	Was there a contract that formalized the collaboration/partnership?
4	In your opinion, which activities should be collaborative? All of them or some (structures, masonry, cladding, waterproofing...)?

Source: The authors

Table 5. Perception of experiences with CSC collaboration

Experience	Frequency	%
Positive	22	100%
Negative	0	0%
Total	22	100%

Source: The authors

Table 6. Type of Collaboration

Collaboration Type	Frequency	%
Short term	2	9%
Long Term	20	91%
Total	22	100%

Source: The authors

Table 7. Type of hiring

Hiring	Frequency	%
With Contract	16	73%
No contract	6	27%
Total	22	100%

Source: The authors

Table 8. Which activities should be collaborative?

Services	Frequency	%
All of them	14	64%
In the critic ones	5	23%
Others	3	14%
Total	22	100%

Source: The authors

As it may be observed in table 5, 100% of respondents agree that their experience with collaboration was positive. As for the type of collaboration, 20 construction companies (91%) answered that they had experience with long term collaborations (the collaboration regarded as long-term is that between builder and supplier in more than one work) and only two construction companies (9%) had experience with short-term collaborations (one work only), table 6.

In Table 7, it is observed that 16 builders (73%) claim to have used contracts to formalize collaborations with suppliers, and other six (27%) did not use any contract.

When asked which activities should be collaborative, 14 respondents (64%) said it should occur in all activities, five construction companies (23%) responded that collaboration should only occur in critical activities, and three (13%) responded that other specific activities should be collaborative, table 8.



Table 9. Medians and U Test for Collaboration Elements

Element	Total (n = 22)		Small Size (n1 = 5)	Medium/Large Size (n2 = 17)	Mann-Whitney U	
	Average	Median	Median	Median	U	p-value
Information sharing	3.63	4	4	4	29.5	0.3088
Resource sharing	3.90	4	4	4	45.0	0.869
Joint planning and decision-making	4.81	5	5	5	47.0	0.5993
Reliance	4.72	5	5	5	49.5	0.5096
Process alignment	4.27	4	4	4	48.5	0.6327
Common Goals	4.54	5	4	5	66.5	0.03
Collaborative Culture	4.63	5	4	5	56.5	0.1943
Joint Problem Solving	4.27	4	4	4	42.5	1

Source: The authors

Table 9 assesses degree of agreement (or importance) that builders gave to key elements that make up collaboration, and compares whether perception is the same across two groups of respondents: small and medium/large.

To verify the relative importance of each element, the mean of the answers was used. For the comparison between the two groups, the analysis was made based on the value of the medians, considering the null hypothesis, in which the median values of each element are statistically equal for the two groups, and the alternative hypothesis, in which the median values are different. For this, the Mann-Whitney U test was used, with a significance level of 95%.

In addition, the internal consistency of the questionnaire was verified using Cronbach's alpha, which in this case was 0.91, which indicates a high degree of scale reliability and internal consistency.

From the comparison of the averages of each element it can be observed, in table 8, that the element "Joint planning and decision making" was pointed as the most important. This finding converges with theory because this element is the basis of the concept of collaboration, since the first collaborative initiatives had the form of planning, forecasting and replenishment, as explained earlier. The elements "trust" and "collaborative culture" also presented high average values and were in second and third places, respectively.

One fact that caught the eye was that the "strategic information sharing" element came last. Schultz and Unruh (1996) concluded that the construction industry is unwilling to trust or share information with members of the supply chain. One possible reason for this lack of desire may be due to the perception of its economic value (Simatupang and Sri-

dharan, 2002), and fearing the loss of competitiveness (de Oliveira Siqueira et al., 2015).

Regarding the comparison of responses of the two groups (small and medium/large companies) from the *Mann Whitney* U test, for most of the elements the companies' opinion can be considered the same. The only exception found was in the "common goals" element, since the p-value was <0.05.

The higher median value found in the "common goals" item for the medium/large construction group indicates that this group is more likely to collaborate than small construction companies. This difference may be due to small builders' excessive focus on competitive advantages, which encourages individual behavior in order to maximize their own benefits (Cao and Zhang, 2011).

5. CONCLUSIONS

This article intends to start a discussion on collaboration in the Brazilian civil construction supply chain, providing information about the construction companies' point of view on this subject. Thus, it was sought to characterize the type of collaboration existing over time, the existence of a contract, the key elements that compose it and the comparison between two groups: small and medium/large construction companies.

For such purpose, a literature research was performed, enabling better understanding of the concept. From this, eight critical factors were identified: Joint Planning and Decision Making, Information Sharing, Resource Sharing, Trust, Process Alignment, Common Goals, Collaborative Culture, and Joint Problem Solving. After a bibliographic review, the



application of a questionnaire to construction companies in the state of Rio de Janeiro was performed.

The survey revealed that respondents think that collaboration is seen as a positive strategy for CSC. In Rio de Janeiro, collaboration is characterized by long-term and formalization of contracts and it is considered more important in the critical activities of the project.

According to the assessment of the degree of importance, the three main elements for collaboration, according to the construction companies, are: "Joint planning and decision making", "Trust", and "Collaborative Culture". On the other hand, the "Information Sharing" element has less relevance, especially within medium/large companies, and the main cause may be builders' fear of being exposed.

According to Panahifar et al. (2018), information sharing is characterized by: readiness, accuracy and security of information, and readiness and accuracy are directly linked to the level of trust between parties. Thus, it is understood that, in order to have information sharing, it is necessary to build a support base grounded on trust between supplier and builder.

Another important finding was that medium/large builders are more likely to collaborate than small builders, especially when talking about common goals. This is probably due to the excessive focus on individual gains by small construction companies. Thus, there is a need of disseminating the idea of collaboration among small construction companies.

The present study was limited to the evaluation of construction companies in the building industry in the state of Rio de Janeiro/Brazil. Thus, the replication of this study in construction companies of other countries is suggested, in order to provide greater evidence and empirical generalization of the results obtained.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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