**Managing supply chain relationships in construction industry: compete or collaborate?**

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**Summary:** This research provides a preliminary answer to whether clients in the construction industry should compete or collaborate with their supply chain partners. To address this issue, a coherent research model was designed to analyze supply chain relationships in the construction industry and their performance outcomes. Pre-contractual, contractual, and relationship factors are used as explaining variables. The research is based upon comparing in-depth case studies, taken from complex renovation and maintenance projects of a Dutch Housing Association (DHA). Case studies were stratified among three different types of projects: 1) traditional, competitive projects, 2) building team projects, and 3) supply chain projects. The results indicate that the DHA should foster both collaboration and competition in its working relationships with subcontractors and suppliers. In doing so, the organization should make certain trade-offs, depending on a project’s knowledge intensity, complexity, and the risk attitude of parties involved. Besides these trade-offs, the DHA should be aware of the importance of both relationship and contractual factors.

**Keywords:** competition, collaboration, construction supply chain

**Submission category:** Working paper

**Introduction**

The construction industry is one of the most diverse and unstable sectors in Europe (Dainty, Briscoe, & Millett, 2001). It faces a variety of problems regarding collaboration in their supply chain relationships. The effects of these problems go beyond their respective domains. They cause many failures and misunderstandings during building processes, which results in high failure costs due to rework and time delays (Love, Irani & Edwards, 2004; Roders, Gruis & Straub, 2013).

A main collaborative problem is the fragmentation within the construction industry (Dainty et al., 2001; Hong-Minh, Barker & Naim, 2001; Love et al., 2004). Moreover, the construction industry is short-term focused, because of its project orientation (Briscoe & Dainty, 2005; Gadde & Dubois, 2010; Vrijhoef & Koskela, 2000). In addition, due to the large number of organizations involved in the building process, the supply network is complex, which limits opportunities for process integration (Dainty et al., 2001; Egan, 1998; Hong-Minh et al., 2001). Finally, as Briscoe and Dainty (2005), Hong-Minh et al. (2001) and Roders et al. (2013) indicated, construction projects suffer from poor communication, a lack of commitment and win-lose relationships between contractors and subcontractors. Most of the time (sub-) contractors are selected on the lowest price and not on the best value, which results in negative effects in the construction industry’s stakeholder environment (Briscoe & Dainty, 2005; Egan, 1998; Love et al., 2004; Vrijhoef & Koskela, 2000).

The current situation in the construction industry is alarming and requires a change regarding collaboration in the construction supply chain (Egan, 1998). This research provides the first insights into fostering collaboration *and* competition in the construction supply chain, based on a case study research at a Dutch Housing Association (DHA). Based upon a thorough literature study it provides a coherent research framework to analyze and compare supply chain relationships in different project settings in the construction industry.

**A project approach to the building process in the construction supply chain**

The construction industry is project-oriented (Briscoe & Dainty, 2005; Gadde & Dubois, 2010; Vrijhoef & Koskela, 2000), which results in unique characteristics for every project. In the construction industry, four types of construction projects can be distinguished (Maas & van Eekelen, 2004). The first type is *‘new building projects*’, in which completely new buildings and/or houses are built. The second type is *‘renovation*’, in which houses and buildings receive a facelift, which can be either on the inside or outside. The third type of project is an ‘*expansion’*, which are mainly additions to a house, like a veranda, patio or room extension. The fourth, and last, type of project is ‘*maintenance projects*’, which are either planned or unplanned.

Every project starts with defining the specification for what needs to be accomplished, which is called *‘the demand’* in the construction industry (Ashworth, 2012; van Weele, 2005). Within the construction industry, *two types of demand* can be identified: a technically specified demand and a functional demand (Vrijhoef et al., 2013). The traditional way of specifying a demand in the construction industry is the *technically specified demand*. In this type of demand, the client, e.g. a housing association, both describes the project’s technical requirements and design solution, i.e. how the technical requirements should be met. This way of describing the demand provides certainty to the housing association and its constructors. Another advantage of this type of demand is that housing associations can easily judge the different construction companies and select the best one. However, there are also disadvantages to a technically specified demand, like the high costs the housing associations have to pay for developing and describing the design solution and specifying the technical requirements. Moreover, the knowledge and expertise of construction companies is not used, which can result in flaws in the project design and project plan during the execution of the project (Vrijhoef et al., 2013).

When a *functional demand* isapplied, the housing association describes the problem that needs to be resolved and formulates functional requirements for the project. Next, construction companies need to present their ideas about potential solutions for the client’s problem, which are presented in an interactive session with the client. As construction firms are selected based upon their experience and expertise, they should know the best ways to solve the client’s problem. Using such functional demand specifications allows for optimal and thus advantageous use of the construction companies’ knowledge and qualities. On the other hand, the invested time and costs for preparing solutions that are tailored to the client’s problem and the required time to engage with the client are much higher for the construction company (Vrijhoef et al., 2013).

After the demand is specified, suitable suppliers are selected, which is called *‘the tender procedure’* in the construction industry. Finally, the best supplier is selected and an appropriate contract model is selected, depending on the supply chain organization model and type of demand. (Ashworth, 2012; van Weele, 2005)

**Collaboration in construction projects**

Each new construction project requires a decision regarding the organization of its supply chain. In practice, three types of supply chain models can be distinguished: the traditional collaboration model, the building team collaboration model, and the supply chain management model. These three types of supply chain organizational models are outlined in Figure 1, which illustrates the structure of these models and how the projects are scheduled over time.



Figure 1: Supply Chain Organizational Models

*Traditional collaboration*

The *traditional collaboration model* is a commonly used organization model within the construction industry (Vrijhoef et al., 2013). In this model, the housing association is responsible for the entire building process, except the execution phase (Liebregts & van Bergen, 2011). In turn, the construction company is responsible for the execution of the construction project. This illustrates a clear separation between the roles of the housing association and the contractor. This separation is disadvantageous in terms of knowledge transfer within the building process. Actually, minimal knowledge transfer between the housing association and contractor exists, as the latter is only responsible for the execution of the project. Evidently, it is possible that conflicts arise during the building process (Liebregts & van Bergen, 2011).

*Building team collaboration*

Compared with the traditional way of organizing the building process, the responsibilities in a *building team collaboration* are blurred. Within this model, the construction company is not only responsible for the execution of the project, but is also involved in the project preparations regarding both the design and specification phases. Therefore, the constructor can serve as an advisor, as well as an architect. One disadvantage of the building team organization is the demarcation of the roles between constructor and client. As a result, individual team roles among representatives from both client and constructor may not be clear, which may lead to confusion, frustration, and alienation. As a result, individual team members may feel less responsible for their respective jobs. Another consequence of this blurred line between responsibilities between client and constructor, is that the assignment of risks and their consequences is not clear. These problems can result in conflicts, which can delay the process (Liebregts & van Bergen, 2011).

*Supply chain management*

Since the 1990’s, the construction industry has an increased interest in *supply chain management* (Segerstedt & Olofsson, 2010). Different concepts of supply chain management can be distinguished in the construction industry, like partnering, supply chain collaboration, and supply chain integration (Akintoye McIntosh & Fitzgerald, 2000; Gadde & Dubois, 2010; Hong-Minh et al., 2001; Kim, Kumar & Kumar, 2010; Soosay, Hyland & Ferrer, 2008). The reviewed literature points out that the preceding concepts almost mean the same. Therefore, this paper uses the following definition of supply chain management or partnering: *“Partnering is a long-term commitment by two or more organizations for the purpose of achieving specific business objectives by maximising the effectiveness of each participant’s resources. Partnering requires changing traditional client-constructor relationships to a shared culture without organizational boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other’s individual expectations and values. Expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services.”* (Construction Industry Institute (CII), 1991).

**Sharing knowledge in construction projects**

These different supply chain organizational models allow for different ways of sharing knowledge with each other. The more complex the project, the more knowledge sharing will be required among supply chain partners. Sharing knowledge results in improved supply chain performance levels (Cheng & Fu, 2013). Furthermore, sharing knowledge provides a competitive advantage to the supply chain compared with other supply chains. However, the whole supply chain should be involved into the knowledge sharing process in order to create results. Cheng and Fu (2013) argued that closer relationships among partners result in more knowledge sharing, which in turn results in better project outcomes.

The type of relationship also determines the type of *knowledge sharing*. Im and Rai (2008) distinguish two types of knowledge sharing in long-term, inter-organizational relationships. The first type, exploitative knowledge sharing, includes *“the exchange of knowledge between firms in a long-term relationship to seek short-run rewards, focusing on the survival of the components of the system and pursuing risk-averse behaviours”* (Im & Rai, 2008). The second type is referred to as exploratory knowledge sharing and entails “*the exchange of knowledge between firms in a long term relationship to seek long-run rewards, focusing on the survival of the system as a whole, and pursuing risk-taking behaviours”* (Im & Rai, 2008). Clearly, exploitative knowledge sharing has to deal with cost efficiency, improvements of processes, and implementation of changes in the short-run, while exploratory knowledge sharing contributes to the innovation of products, services, and processes to coordinate in the long run.

In general, knowledge exchange in inter-organizational relationships results in better performance outcomes, i.e. improved coordination of the supply chain, as well as improvements in both product quality and implementation processes (Cheng & Fu, 2013). Hong-Minh et al. (2001) argued that supply chain management in general results in a change in attitude, enhanced process orientations, and improved communications across the whole chain. Furthermore, Vrijhoef and Koskela (2000) argued that implementing supply chain management serves two main objectives: reducing both costs and project lead time. Egan (1998) mentioned similar main goals and claims that effective supply chain collaboration would reduce 20-50% of the estimated costs and 50-80% of the required time within the building process. These ideas have been confirmed by other authors such as Akintoye et al. (2000) and Roders et al. (2013).

**Research framework**

In relation to the previous outlined literature on the construction industry, this research proposes a research framework in which project outcomes are explained by pre-contractual factors, contractual factors, and relationship factors. These factors affect knowledge sharing and exchange among both the client and its supply chain partners (cf. Figure 2). These factors have been translated into constructs and items taken from previous studies, allowing for a validated research questionnaire and a survey (van Vught, 2014).

Figure 2: Research Framework

The research framework assumes that pre-contractual factors positively influence contractual and relationship factors (relations ‘P1’ and ‘P2’, cf. table 1). Pre-contractual factors include the level of competition as deployed during the tender procedure (Ashworth, 2012) and the type of demand (Vrijhoef et al., 2013). Contractual factors include the type of contract (Tate et al., 2010), and level of specification (Wuyts, 2007). Relational factors include trust, leadership, commitment, and coordination (Kim et al., 2010).

Contractual and relationship factors are related to knowledge sharing (relations ‘P3’, ‘P4’ and ‘P5’ cf. table 1). Here, we differentiate between ‘exploitative knowledge sharing’, focusing on short-term savings and improvements, and ‘explorative knowledge sharing’, focusing on savings and innovations in the long-run (Im & Rai, 2008). This research assumes that the contractual and relationship factors, as well as the relation between these two, positively influence knowledge sharing in construction projects. Furthermore, we assume a positive relation between knowledge sharing and project performance (relation ‘P6’ cf. table 1), based on the research of Cheng and Fu (2013). Finally, our framework assumes that risk attitude moderates the relationship between knowledge sharing and project performance (relation ‘P7’ cf. table 1) (Godfrey, 1996; Mills, 2001) and that project performance is positively translated into end customer satisfaction (relation ‘P8’ cf. table 1).

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| **Relations**  |
| *P1* | Pre-contractual factors have a positive influence on contractual factors |
| *P2* | Pre-contractual factors have a positive influence on relationship factors |
| *P3* | Positive contractual factors result in more knowledge sharing |
| *P4* | Positive relationship factors result in more knowledge sharing |
| *P5* | The interaction effect between contractual and relationship factors results in more knowledge sharing |
| *P6* | More knowledge sharing results in a better project performance |
| *P7* | Risk attitude has a positive, moderating effect on the process of knowledge sharing, which results in a better project performance |
| *P8* | Better project performance results in higher customer satisfaction |

Table 1: Relations in research Framework

**Case study research at DHA**

The case study research was conducted at nine large construction projects at DHA, which were subject to the three different supply chain organizational models: 1) traditional collaboration, 2) building team collaboration, and 3) supply chain management, allowing for sufficient differentiation. All these projects were renovation projects, which were running during our research or had been executed in the last five years. The projects were randomly selected after inquiring several project managers at the DHA. Data collection was performed using the DHA’s project documentation, including project reports, meeting reports, and contract information. In addition, questionnaires and interviews with project stakeholders, both from DHA and contractors, allowed for an in-depth review of the different projects. These nine projects were analysed using our proposed research framework (cf. figure 2).

*Traditional collaboration*

Traditionally, most renovation projects at DHA are executed through traditional collaboration, since it represents one of the oldest ways of working together in the construction industry. The three selected projects were tendered among three construction firms each. For one of the projects, the tender took place in two rounds. The first round was aimed at pre-selecting the contractors based on pre-qualification criteria. The second round involved a selection of the best offer. The remaining two projects were selected based on tender selection criteria, in which price was one of the criteria. Other criteria referred to the overall project planning and the detailed project works plan. All projects were tendered based on a technical demand.

Concerning the three projects’ outcomes, all projects exceeded their budget and the project managers had to put a lot of effort in realizing the project’s planning. All projects resulted in a lot of quality complaints, i.e. correction points after completion of the renovation work. None of the project managers wanted to reveal the actual number of quality complaints, as some of these were subject to discussion with the contractors concerned. Furthermore, in one of the projects the contractor went bankrupt. This risk was not foreseen by the DHA.

Information regarding the projects was shared on a daily basis between DHA and its contractors. However, information concerning the project’s budget or DHA’s overall financial performance were not disclosed. Our analysis indicated that knowledge sharing seems predominantly limited to exploitative knowledge, while explorative knowledge sharing is limited.

In all three cases there was an effective and good relationship between client and contractors. However, the constructors expressed more positive views about the relationship with DHA than vice versa. Our analysis indicated that trust plays an important role within the relationship. However, our analysis indicated that the DHA seems less committed to the projects than the constructors are.

The contracts of the projects were standard contracts. Hence, the contract’s level of specification, i.e. the level of detail was minimal. The contract generally included articles about managing contract variations, conflict resolution, and damages and liabilities when exceeding the project’s due date. In general, the concerned contracts were complicated and hard to understand for the project managers. In fact, during interviews they indicated that they do not understand the contract and do not know how it is related to the project. They feel that the Purchasing Department drafts the contract, as they had the required knowledge.

In conclusion, the traditional collaboration projects of DHA show some critical points for collaboration. Concerning the relationship factors, ’trust’ is an important variable for a good collaboration. Moreover, project outcomes were not as expected. All projects exceeded their budgets and the project manages involved had to put a lot of effort into meeting the project’s planning. In addition, as the project resulted in a lot of quality complaints, this resulted in unforeseen corrections and rework. Risk management was not particularly addressed in these projects. Therefore, it can be concluded that the three traditional collaboration projects were not effective in collaboration and knowledge exchange.

*Building team collaboration*

Working in so called building teams is a rather new phenomenon to DHA. It represents a new way of working and therefore all parties consider it as more complex. The three projects considered in this part of our research were tendered through selective competition, followed by face-to-face negotiation. All tenders were judged using the following criteria; price, plan of action, and planning of the project. The level of competition was high in the projects, as the contractors submitted similar prices. One of the tenders was based upon a technically specified demand, while the others were based upon a functional demand. In the latter cases, the constructors were involved in an early phase of the tender process. At that stage, contractors actually suggested ideas that improved project design and execution.

Project outcomes in terms of costs and quality seemed reasonable for all three projects. The number of quality complaints, i.e. correction points, seemed still quite high (around 5 per house). In all three projects, the costs exceeded the budget. Risk was considered high for all projects. However, in general, the constructor felt more responsible for the design and technical risks in the projects, compared to traditional collaboration projects. Both parties clearly felt responsible for the planning, timing and execution of the projects.

Information about the project planning and inhabitants of the houses was shared on a daily or weekly basis between DHA and the contractors in the construction projects. In contrast, the project’s budget, quality, and performances were discussed on a monthly basis. Therefore, extensive exploitative knowledge sharing was present in all of these projects. In addition, in one of the projects, the constructor and DHA improved the business processes in the project for the long run, which can be seen as explorative knowledge sharing. Therefore, explorative knowledge sharing seems present, though limited.

The relationship between the organizations involved was mentioned as important in this type of collaboration. The director of one construction company referred during his interview to the length of the relationship between DHA and his company. However, due to new people in both organizations, they needed to invest in building trust in their relationships again.

For the building team collaboration projects, the contract looked like a traditional collaboration agreement, which is highly standardized and limited in details. The contracts had no outcome-based elements in it, like a common performance goal. One of the contracts seemed more tailor made and during the interview the contractor told us that the contract was set up together with DHA. This discussion resulted in a positive attitude among the involved parties.

In conclusion, the building team collaboration projects seem to demonstrate the advantages of early involvement of the constructor. Early involvement results in better preparation of the project, which can result in better project outcomes. However, knowledge sharing within the building team collaboration projects seems still moderate and there seems room for improvement here. Furthermore, closer collaboration between the DHA and the contractor seems to enhance customer satisfaction.

*Supply chain management*

Since 2010, the DHA has executed three supply chain management projects together with one construction company. The selection of the constructor was based on a close relationship between the directors of both companies, which wanted to experiment with supply chain management within their collaboration. Therefore, none of the projects were tendered and no external competition applied. All projects were based on a functional demand, which resulted in early involvement of the constructor and, indeed, a closer collaboration.

The performance outcomes of the three supply chain projects clearly increased over time. One of the goals of the three projects was to reduce the costs of the construction projects. In the first and second project, the overhead costs decreased with 16%. In the third project, the parties also tried to reduce the costs for materials and wages. However, the contractor contracted its suppliers in a traditional way. As a result, materials and subcontractor prices were negotiated in an opportunistic manner which did not result in significant price reductions.

In supply chain management projects, the outcomes increased over the three projects in terms of time and cost. These projects resulted in time and cost savings. Another remarkable outcome was that customer satisfaction was significantly lower compared to the other type of projects. In addition, our analysis indicated that risks decreased over the three supply chain projects. Furthermore, the constructor felt more responsible for the projects’ risks and took more ownership of these risks.

In the three projects, information was either shared on a weekly or monthly basis. This was done at a level comparable to traditional collaboration projects. However, the project managers of the constructor and DHA indicated that they improved their ways of working over the three projects. They really wanted to help each other within the project, which seems illustrative for explorative knowledge sharing.

The relationship between DHA and the constructor was quite good in the supply chain management projects. Over time, the client-contractor relationship was reported to grow stronger during the three projects. In the last project, the level of trust was considered to be optimal, the foundation of which was created during the previous projects. The project managers concerned stated that people within these supply chain management projects were open and honest. Moreover, they told that their staff actually shared knowledge and came up with creative ideas to improve the project.

The contracts regarding the three supply chain management projects were quite similar to traditional collaboration agreements. The contracts were not outcome-based and had a low level of specification. For example, common performance goals were not found in the contracts.

In conclusion, the supply chain management projects seem to demonstrate more positive project outcomes for a long-term collaboration in terms of time and cost savings. Furthermore, the relationship between the two organizations improves over time, resulting in more efficient knowledge sharing. In addition, the risk appearance in supply chain management projects is quite small and the constructor takes more responsibility for risks. In the end, it is remarkable to see that the customers are less satisfied with the closer collaboration between the DHA and the contractor.

**Cross-case comparison**

A comparison of these three types of supply chain organization models indicates small differences between the nine cases. In our research, it seemed that more knowledge sharing did not directly result in improved project performance (relation ‘P6’ cf. table 1). In addition, the risk appearance was higher in traditional collaboration projects compared with supply chain management projects. Contractors in traditional collaboration projects took less ownership for these risks compared with supply chain management projects. Therefore, collaborations in the supply chain management projects can decrease the risk appearance in construction projects (relation ‘P7’ cf. table 1).

Regarding the relationship, the cross-case comparison showed a somewhat stronger relationship towards knowledge sharing within supply chain management projects than traditional, competitive projects (relation ‘P4’ cf. table 1). Especially trust was emphasized as a key variable for knowledge sharing. Furthermore, the research indicated that a relationship between organizations primarily depends on the quality of the relationships at an individual level. Therefore, as collaboration becomes more complex and requires more knowledge transfer, relationship factors play a more important role between the partners involved. In addition, the contractual factors are less important regarding knowledge sharing compared to relationship factors (relation ‘P3’ cf. table 1).

However, our research revealed an interaction effect, which positively influences knowledge sharing in all three types of building organization models (relation ‘P5’ cf. table 1). The contract and the nature of the relationship mutually reinforce each other regarding construction project collaboration. For example, an outcome-based contract, commitment, and leadership of project managers resulted in more explorative knowledge sharing. Therefore, in good relationships between organizations, with a well-specified, outcome-based contracts, more knowledge is shared.

In conclusion, our research indicated that relationship factors play a role in knowledge sharing between organizations. Nevertheless, contractual factors did not play a major role within the collaboration of these parties. However, the interaction effect of the relationship and contractual factors is important regarding knowledge sharing between organizations. Furthermore, it is remarkable that enhanced knowledge sharing did not directly result in an improved project performance.

**Conclusion**

In conclusion, DHA could foster both competition and collaboration in their future supply chain relationships. However, they have to make certain trade-offs for their future construction projects. Both the project’s complexity and its knowledge intensity will determine whether to go for more competitive or collaborative relationships. The same holds for the risk attitude among partners.

In case of a knowledge-intensive and complex construction project, DHA should both compete and collaborate with their future subcontractors and suppliers. In knowledge-intensive projects, a DHA should first select suppliers based upon their capabilities and competitiveness and next utilize suppliers’ knowledge, as they are professionals in the construction industry. Knowledge-intensive and complex projects need a customized solution, which is unusual in the field. DHAs should involve (sub-)contractors in an early stage of the building process. It is important to use the (sub-)contractors’ knowledge, as they are professionals in the construction industry. Moreover, early involvement can encourage team spirit within the project team, which is advantageous during project execution. However, it is important that DHAs set common project goals and shape common beliefs towards the project team, as team spirit improves the relationship between the involved organizations.

In a non-knowledge intensive and routine construction project, DHA’s should primarily foster competition among their future suppliers. Such projects require a standardized solution, which is provided by a (sub-)contractor’s routine processes. Non-knowledge intensive projects can be primarily tendered on price, as the projects consist of routine supplier tasks.

Whatever the project characteristics, a DHA is recommended to create and maintain a relationship with their future suppliers, based on mutual trust and respect. Our analysis showed that the relationship between organization is one of the most important collaboration factors in construction projects. Furthermore, our research indicates that an outcome-based contract, combined with a trusting relationship, in general positively influences knowledge sharing and, hence, creates positive project outcomes. Organizations should be aware of the added value of a good contract combined with a good relationship. Involving the selected supplier during the contract specification can contribute to the relationship between DHA and contractor. Therefore, an easy-to-understand, outcome-based, and project-specific contract is required in construction projects.

**Limitations and further research**

One of the major limitations of this research was the case study research’s sample size. In further research, the sample has to be enlarged in order to cross-compare more projects within the research framework. This will ensure more reliable and trustworthy results. Furthermore, the sample was based on the construction projects of only one housing association, which resulted in a rather one-sided analysis of housing associations in this research. Therefore, future research should involve more construction projects with multiple housing associations, to ensure that results are reliable, trustworthy and generalizable.

Another major limitation in this research was the unstable environment of the construction industry and the corresponding lack of mutual trust. For example, one construction company refused to participate in the analysis of the DHA’s construction projects, because of bad performances in the selected project. Other construction companies filled out the questionnaire too positively, as they were afraid to be rejected by DHA for future projects. Further research should therefore first emphasize the impartiality of the research. Second, a trustworthy approach should be used for invitees.

A final limitation in this research is a consequence of the responses of the construction companies. Since the answers of the construction companies were quite positive regarding the questionnaire, it could be that the results are somewhat biased. In further research, the questionnaire items should be checked whether they suggest wishful thinking. Moreover, the research has to convince the constructions companies that they have to fill out the questionnaire truthfully, based on their project experiences. In short, research has to provide a safe and trustworthy research environment for the construction companies.

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