PARTNERING IN CONSTRUCTION: A FIELD STUDY TO FURTHER DEVELOP THE FRAMEWORK OF SUPPLY CHAIN INTEGRATION

Jelle Koolwijk[1], C. van Oel, R. Vrijhoef and J.W.F. Wamelink

Department of Real Estate and Housing, Delft University of Technology, Delft, The Netherlands

According to Eriksson (2015) 'there is still a lack of comprehensive conceptual and practical frameworks that enable both a detailed and systemic understanding of integration in project-based supply chains.' He therefore developed a theoretical framework that includes the four dimensions of strength, scope, duration and depth of integration. In this study we used this framework to describe four cases on relatively small scale (1M - 12M Euros) social housing refurbishment projects which are delivered through strategic partnerships. The data was collected through field research. The aim of this study was to further test the four levels of integration on their usefulness and to further elaborate on what could be added to the framework and how to operationalise its dimensions. It's our aim to use this operationalisation for an overarching study. In general, we think this framework provides a useful instrument in describing the level of integration in project based supply chains. We conclude that it is comprehensive in regard of critical elements that influence the performance of the partnership. Additionally, we found elements that can be added to the framework.

Keywords: strategic partnering, supply chain integration, collaboration.

INTRODUCTION

The physical nature of construction products; the loose and often adversarial relations between supply chain actors; the organisational structure in terms of the separation of design and production, and growing degree of specialisation makes construction industry (CI) an environment that severely restricts team learning which in turn is deemed to lead to its poor performance (Miozzo and Dewick, 2004; Vrijhoef, 2011). To overcome these problems, supply chain partnering (SCP) is often promoted as means of improving performance by establishing close relationships and integrating activities between supply chain actors (Vrijhoef, 2011). While the application of SCP seems like a logical step forward for the CI, this industry is having problems in managing partnerships and obtaining the intended improvements (Briscoe and Dainty, 2005). More recent literature reviews on the relationship between supply chain integration and performance which indicate that the results are mixed and not very convincing (i.e. Fabbe-Costes and Jahre, 2007). According to Eriksson (2015) this is due to a lack of comprehensive conceptual and practical frameworks that enable both a detailed and systematic understanding of integration in project-based supply chains. Therefore, Eriksson developed a theoretical framework which describes the integration in project-based supply chain teams along four dimensions. First, the strength of integration: the extent to which integrative activities are carried out within

[1] j.s.j.koolwijk@tudelft.nl

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a team such as formulation of joint objectives and follow-up meetings. The second dimension is the scope of integration, referring to the number and nature of supply chain partners and their interdependencies. The third dimension concerns the duration of integration. The duration of construction projects facilitates strong integration within one project, particularly if partners collaborate over many project stages and get early involved. Finally, the depth of integration reflects the extent to which integrative activities are performed jointly. For instance, many partnering arrangements only involve the higher managerial levels and do not consider personnel at lower hierarchical levels.

Eriksson used his framework on large scale industrial projects. In this study we applied it on four relatively small scale (1M - 12M Euros) social housing refurbishment projects that were delivered through strategic partnerships. These strategic partnerships were characterised by high levels of integration on all four levels. Therefore these cases appeared suitable to further investigate the four levels of integration on their usefulness, to further elaborate on what could be added to the framework, and how to operationalise its dimensions when they are used in this particular context. We aim to use this operationalisation for an overarching study in which we aim to further investigate the relation between the organizational team setting and psychological processes in collaborative construction teams that are working on housing refurbishment projects and link them to team performance.

This paper is structured as follows. In the next section the research method is explained. Then, the four cases are described using the framework of Eriksson. The following section explores the differences within and between the four cases using the framework of Eriksson as a guide. In this section we have aimed to focus on adding elements that are not present in the framework as yet, or that may deepen our understanding on how to operationalise its dimensions. In the final section, conclusion are drawn and theoretical contributions to the framework are discussed.

METHOD

We aimed to investigate the four dimensions of integration and their interaction how they actually occurred in a project. Therefore, we have taken a participative observation approach in which the researcher (1st author) became part of the project team. The participative observer collected data by participating in the daily life of those who were studied for a considerable period of time (Bryman, 2008). This involves 'direct and sustained contact with human agents, within the context of their daily lives, watching what happens, listening to what is said, asking questions, and producing a richly written account that respects the irreducibility of human experience, that acknowledges the role of theory as well as the researcher's own role, and views humans as part of the object and subject' (Pink *et al*. 2013). There are various ways of characterising participant observation (Kawulich, 2005). In our cases the researcher took the role of team coach who works for a consultancy firm. Together with one of the directors of this firm, he coached the strategic partnership. The director coached the management team and the researcher coached the project team. Through his role the researcher became a full and active member of the project team. Because the observer is so closely involved, it 'permits the investigator to experience and observe the group's norms, values, conflicts and pressures, which (over a long period) cannot be hidden from someone playing an in-group role' (Hargreaves and Hargreaves, 2006, p. 139). To guide us in our study, we used prior research on supply chain integration by Vrijhoef (2011) and Vrijhoef *et al*. (2014). We used the concepts

from these studies as sensitizing concepts to provide a starting point for this study. In this paper we eventually used the framework recently published by Eriksson (2015) to present our findings because this framework mainly focusses on the integration in project-based supply chain teams. This focus fits the overall aim of the overarching study.

Case selection

To increase our understanding and uncover areas for further research, multiple cases were analysed to explore differences and conformities within and between the four cases (table 1). For this research we selected 'extreme' cases in regard of the level of supply chain integration. We were able to participate in four strategic and highly integrated partnerships. The partnerships are setup by four different Dutch housing associations which gives these projects a similar cultural context. This has enabled to focus mainly on the differences and conformities how the partnerships were implemented. When we look deeper into the project characteristics, we see that these characteristics vary considerably in terms of monetary size and complexity. These differences gave the chance to see how project characteristics affect the dimensions of integration.

Table 1 Project description

	Project A	Project B	Project C	Project D
Size of HA / location in NL	8.500 houses North/East	10.500 houses South	32.700 houses North/West	27.500 houses South/West
Type of houses	row houses	row houses	apartments	row houses
Year or constr.	1920's	1965	1940's	1940's
Project size	26	100	189	79
Year project	2012	2012	2013/2014	2014/2015
Description of the work	Insulation of facades, new roofs, restoration of window frames and window shutters, specialist re-pointing and brick restoration, new chimneys and new glazing.	Abatement of asbestos, renovation of chimneys, roofing, new insulating glass with ventilation grilles, insulation of floors, painting of windows and doors. Tenants could choose for new bathrooms, kitchens and/or toilets.	Insulation of facades, new aluminium window frames, new roof finishing, PV-cells, restoration of concrete balconies, new mechanical ventilation and central heating. Tenants could choose for a new kitchen and/or bathroom. Layout of the apartment could be changed.	Chimneys, roofing, new window frames with ventilation grilles, insulating glass, new doors, new mechanical ventilation and central heating, impregnation and insulation of facades. Tenants could choose for new bathrooms, kitchens and toilets. Layout of the houses could be changed.
Specific technical issues	Monumental	N/A	Regarded as monumental	N/A
Procurement method	Strategic partnering	Strategic partnering	Strategic partnering	Strategic partnering

Data collection and analysis

The researcher was an active member of the project team. Every team meeting the researcher was present. As a member of the team, the researcher received the project team e-mails and had access to the documents on the projects' websites. Therefore, the researcher was able to follow the project and the project team on a daily basis. The researcher spent a considerate amount of time with the team members to gain their

trust. This position gave the researcher the opportunity to get their reflection on observations and to gain insight in their real ideas, thoughts and intentions. Together with the other coach, the researcher gave workshops, did evaluations and executed specific interventions to help the project team to develop mutual goals, team spirit and a joint process. It also gave us a deeper understanding about how people interpreted situations and behaviours of others.

CASE DESCRIPTION

This section describes the four cases by partnering using the 4 dimensions of integration proposed by Eriksson (2015).

Table 2 The four dimensions of integration in project A-D

Dimensions	Project A	Project B	Project C	Project D
Strength	Partners selection: Based on past experiences. The SC's were selected by the client and GC together. Payment/Performance: GC and SC's had similar payment schemes open book accounting for direct and indirect costs. Pain/Gainshare contract on the riskfund and profit. Payout is connected to project goals. Integrative activities: startup workshop, joint objectives, joint IT tools, facilitator, weekly project team meetings, monthly management team meetings, concurrent engineering, lean methods.	Partners selection: Partners GC, SC-E, SC-HVAC, SC-P, SC-A/D were selected based on past experiences on conventional project. The SC's were selected by the client and GC together. The SC-R was selected based on experiences of a neighbour-housing corporation. Payment/Performance: Same as project A. Integrative activities: Same as project A	Partners selection: GC was selected based on past experiences on conventional projects. SC-E, SC-HVAC, SC-P are (daily) maintenance partners of the HA. Payment/Performance: Same as project A. Integrative activities: Same as project A + use of BIM 3D tool. The joint IT tools to share information was abandoned by the project team. The use of a BIM tool, which was mandated by the client, led to a lot of frustrations within the project team.	Partners selection: GC, SC-P/G/W were selected based on past experiences on conventional projects. SC-HVAC was involved through the GC (the preferred SC-HVAC of the housing corporation did not have time). Payment/Performance: Same as project A. Integrative activities: Same as project A + use of IT Take in tool to record current state of the buildings.
Scope	project team: C-PM, C-BS, C-PrM, T-R_client, T-R_tenant GC, SC-P/G/W, SC-M, Mun-M partially involved: ECO, Cost, D-O	project team: C-PM, C-BS, C-PrM, GC, SC-E, SC-HVAC, SC-P, SC-R, SC-A/D partially involved: ECO, Cost, D-O	project team: C-PM, C-BS, C-PrM, A, BIM, E-BS, E-S, GC, SC-E, SC-HVAC, SC-P, SC-A/D partially involved: ECO, Cost, T-R_b	project team: C-PM, C-PrM, T-R_tenant and b, GC, SC-E, SC-HVAC, SC-P, SC-P/G/W partially involved: SC-A/D, Cost, A, D-O, E-BS

Depth	High hierarchical levels in management team. Project managers and work planners of GC and SC's are part of project team together with repr. of the client and tenants. Foremen/blue collar workers: were involved in design.	Structure is the same as project A.	Structure is the same as project A. The SC-A/D was added later. This partner was critical due to the high risk of asbestos. Foremen were invited too late to the design table. This led to last minute changes.	Structure is the same as project A.
Duration	Involvement: Whole project team was involved from the feasibility stage until final delivery. Long term: The strategic partnership was continued with all partners on a similar project. After this 2nd project, the strategic partnership was asked to do another 3rd project.	Involvement: The project brief was made by the C-PM, C-PrM and E-BS. The project team was established soon after. Together with the project team, design scenarios were investigated and matched with the budget. Long term: The strategic partnership was continued with	Involvement: Only A, GC, E-BS and E-S were involved in feasibility study that took more than 2 years due to unclear goals that came from the board of the housing corporation. The project team was established soon after the project brief and budget was established. Long term: Due to a change of	Involvement: The project started as a conventional project. Only E-BS and A were involved in feasibility and concept design. Strategic partnership was setup after concept design. The concept design was largely abandoned due to budget constraints. Long term: The HA ended this strategic partnership Main reasons are: (1) awareness of
Project results	Costs comparison feasibility-realised: The project budget was 1,2M. Capital costs in the end were 1,0M euros (-16%). Cost comparison with traditional: Capital costs were 6,9% lower. Project time: 5 months to make the design and to prepare construction. Construction took 4 months. A traditional project would normally take about 18 months in total. Quality: The aim was to reach label B. This label was reached. Tenant satisfaction: was regarded as very high in comparison to average. Defects: Unknown.	Costs comparison feasibility-realised: budget 2.5M euro's. The project was delivered for this amount. Cost comparison with traditional: Capital costs were 26.7% lower. Time: 4 months to make the design and to prepare construction. Construction 6 months. A traditional project would normally take about 18 months. Quality: aimed energy label was level C. Lower D label was reached Tenant satisf.: very high in comparison to average. Defects: av.6 per house. This is low.	Costs comparison feasibility-realised: Budget 12.1 M euro's. The project has been delivered for 10.5M euros (-12%). Cost comparison with traditional: Unfortunately no comparison was made. Time: 6 months to make the design and to prepare constr. Construction took 10 months. Planned time to prepare. was 12 months and the planned time for construction was 18 months. Quality: After feasibility the aimed Energy label was level B. Higher overall label A was reached. Tenant satisf.: was low for the first 40 houses. Defects: unknown.	Costs comparison feasibility-realised: Full budget was used. Cost comparison with traditional: Unfortunately no comparison was made. Project time: It took the project team 3 months to make the design and to prepare construction including all needed permits. Construction took 5 months. A traditional project would normally take about 12 to 14 months. Quality: n.a.(raising energy label was not a priority) Tenant satisfaction: above average. Defects: 2,6 defects per house. This is very low.

EMPIRICAL FINDINGS

In this section we explore the differences within and between the four cases using the framework of Eriksson as a guide. In our description we've tried to focus on elements that are not present in the framework or that might deepen our understanding on how to operationalise its dimensions.

Strength of integration

In all four cases the general contractor (GC) was selected by the client (see table 2). The selection of specialty contractors (SCs) is done by the client, the GC or they select SCs together. In the cases were the GC and the SCs are selected by the client directly, based on earlier experiences, we see that there is a basis of trust which has a positive effect on learning behaviour in the project team. Team members are more open to each other, questioning the client's goals, having productive discussions and helping each other in their search how to work together as a team. In case D where a specialty contractor HVAC (SC-HVAC) is selected unilateral by the contractor, we see that this partner shows less learning behaviour than the partners in the other cases. This might have to do with the more conventional relation that is set by the way this partner was selected.

In terms of project goals, we see that a client needs time to make sense of what he wants achieve on one side, and what can be delivered by the partners for the available budget on the other side. Using a design method that gives options to the client, like a set based design method in combination with target costing, can help the client in making sense of what he's aiming for in the project. In regard of joint objectives, we see that it is important not only to talk about the project goals, but also about how the partners want to work together in achieving these goals. Most partners hardly know each other and have never worked before in a project team setting from a very early phase. They simply need to learn how to work together in this setting.

In terms of contracting, we implemented similar contractual conditions in all four projects. We've seen that applying open book accounting (activity based costing) poses some problems. It takes most partners almost a whole project to really understand how the open book approach should be applied within the own organisation, between the partners and on the project. The same learning period is needed for pain/gain share mechanism in combination with the risk fund. Most construction partners in our cases are relatively small companies that are used to working with fixed price contracts. They hardly have experience with these type of arrangements. Therefore, the incentives are not really felt because the teams are busy understanding how the mechanism works and how to get it implemented. Incentives can also take a non-financial form. In our cases a non-financial incentive was set on the duration of the partnership. When the project would reach its goals, it was the client's intention to give the partnership a follow up project We found this incentive to have a higher impact, because it is understood almost directly by the partners in the current economic conditions.

Next to contracting related mechanisms, all four projects used integrative activities and technologies. In general these activities are seen as effective, except for the use of joint IT tools. In project C we've seen the use of BIM was more of a hindrance than a help to making an integrated design. Most of the programs the partners were using did not communicate very well with the BIM program. Also, the BIM was seen as redundant. As put by one of the partners: *"the as-built-model is standing outside. We should be looking at building instead of an incomplete model"*.

Scope of integration

The structure of project teams in our cases is largely different from the team structure in conventional projects. In general, the general contractor and several specialty contractors become part of the project team from a very early design phase in which they participate in making the design. Because the general contractor and specialty

contractors take over part of the design work, we see the role of consultants being diminished. Only for very difficult design problems or tasks that require very specific knowledge, skills or artefacts a consultant is requested to join the project team.

The choice for a particular specialty contractor is mainly determined on the type of (specialists) works that need to be performed and the expert knowledge that is required to make the design or to identify and manage potential risks. An example is the asbestos abatement contractor. This specialty contractor is generally seen as a crucial partner in refurbishments projects with a high risk for asbestos.

A potential partner that is often forgotten in literature, but can be very crucial when it comes to making design related decisions are the authorities. In project A the building inspector for monuments was part of the project team. Although this partner was not part of the multi-partner agreement, he had a critical role in making a design that would be accepted by the commission for monuments of the municipality.

When we look at the level of internal integration (i.e. functions), we see that different departments of the client are represented in the project team. From the project department, the project manager and often a building supervisor take part in the project team. From the asset management department, which is the internal client (owner of the buildings), a property manager takes place in the team. We've seen that having the different departments of the HA in the project team is very important for the speed of the project. It takes time for a project team to understand what the client wants to achieve. Having the possibility to have a direct discussion with this client has a positive effect on this process. When we look at the supply side to the general and specialty contractors, we often see two internal departments (or functions) taking part in the project team. The first has to do with the planning function, the second with the construction function. Depending on the size of a company, these functions are divided between one or more people. Also, when the company gets larger, a project manager is appointed to manage the team of that particular partner.

When we look deeper into our cases we see that integrating too many specialty contractors can lead to problems. In project C there were three installation contractors taking part in the partnership. All three contractors were able to do all the installation works (i.e. mechanical, ventilation, plumbing and electrical). This led to discussions in task division in the project team. Also, during construction more coordination was needed than normally.

There is also a possible relation between the size of the different companies that take part in the partnership and the effectiveness of the project teams. In project C we worked with a relatively large HA. Also the specialty contractors that were involved in this project were large companies when we compare them to the companies that were involved in project A and B. We observed that in project C communication was more hampered due to the longer lines of communication when we compare this to project A and B.

Duration of integration

The project stage in which partners got involved was different per project (see table 2). In project D the client made a concept design with an architect before setting up the strategic partnership. What we've seen in project D, is that the partners ideas get framed by the concept design; the partners take the concept design as a given point that should be further developed into a detailed design. This more or less blocks the creative design process in which different design solutions are itemised, priced and

considered. In project C, we've seen the concept design made by the contractor and the client led to similar effects as in project D. The specialty contractors got into a sort of (traditional) *"you tell us what to do"*-mode instead of *"we think you should do this and that"*-mode. In project A and B the partners got involved directly after the client made a rough feasibility study. We see that involving specialty contractors in this early phase provides the opportunity for timely integration of their knowledge into design. It also helps in the early identification and solving of design problems. Involving these partners early, also makes concurrent engineering and prototyping possible; the partners can use one or more vacant houses to test their ideas. Altogether, we see this helps to build a common understanding of what needs to get done before construction commences.

Both the partnerships that delivered project A and B still exist today. We see these teams are working much more effective than in the first project. Team members know their role and are more aware of each other's capabilities. Also, the partners trust each other and each other's artefacts more. When we look at the organisational level, we see that overhead-staff in the project has been reduced. In the past, every partner had a project manager present in the project team. Now only the project managers of the contractor and the client are managing the team.

Depth of integration

In all four cases a management team (MT) and a project team (PT) are setup. The MT acts as the board of the strategic partnership. The PT manages the project on a daily basis. The MT comprises department managers of the HA and mainly directors of the supplying partners. In the early design phases, the PT comprises projectmanagers, planners, representatives of the clients' departments and in some cases end-user and building inspectors were also present in the team. When the design becomes more detailed, also site managers and foremen become part of the PT. We've seen that having this MT-PT organisational structure helps the project team. The directors are jointly informed about the project progress and important issues. Problems with regard of resources or issues between individuals can be discussed and decisions about how to deal with these issues are jointly taken. This MT-PT is also helpful in the change process that is going on. Strategic partnerships are uncommon in the Dutch construction industry. It takes time for the partners to learn how to work as one 'virtual' organisation. To aid these partners, coaches get involved on a MT and PT level. When there are problems between individuals in the PT, the coaches get in contact and, if needed, can inform the MT about the situation. Also, when a MT-member is not acting in the spirit of the partnership (i.e. following its own agenda instead), this is often felt in the PT.

An end-user (tenant representative) can take part in the project team or be closely involved. This representative can be someone that works for the HA (i.e. tenant consul) (project A), can come from a tenant (sounding) board (project A, C and D), or can be one of the tenants that lives in the buildings that are being refurbished (project A and D). The role of the end-user in this process has two sides. Where the tenant was part of the project team, we've seen that this helped the team in understanding their position and problems, but it also hampered the team in having open discussions about sensitive issues. In project A and D, this led to situations where other team members did not participate in certain discussions because they did not feel safe to share their sensitive knowledge on particular issues with a tenant sitting on the table. In project A, team members agreed that in the follow up project two different meetings should

be held: one technical meeting in which sensitive issues could also be discussed openly, and one meeting with the tenant in which tenant issues could be discussed and the tenant could be informed about project progress.

The input by the site manager and foremen on the design highly valued in the cases were they had to chance to make one or more prototypes when the design reached the phase of being detailed. Key in this process is (1) timing, i.e. the moment the prototypes are built, and (2) the ability and opportunity to draw lessons and translate them into the design. In case C the lessons learned from building a prototype led to a major change of the installation design which saved a few thousand euro's per apartment (189 apartments). However, the timing was too late. Due to a lack of unoccupied apartments, the prototypes were built just before construction commenced. This late change in the design affected the throughput time of the first 20 apartments.

CONCLUSION

In this study we observed four project teams working in a strategic partnering setting which could be seen as highly integrated on all four levels of integration. The levels of integration were based on the framework of integration in project based supply chains made by Eriksson (2015). This framework includes the four dimensions strength, scope, duration and depth of integration. The aim of this study was to further test the four levels of integration on their usefulness and to further elaborate on what could be added to the framework and how to operationalise its dimensions.

In general, the framework appeared to be very useful in describing the level of integration in project based supply chains. We feel that it is comprehensive with regard to critical elements that influence the performance of the partnership. However, we also found some elements that could be further deepened. When we look at elements that describe the strength of integration we see that team level factors that influence the performance are generally lacking in the framework. In terms of contracting, we would widen the concept of incentives from merely being financial to other forms of incentives. Looking at integrative activities, we have seen that the use of ICT tools in our cases was not always a success. Therefore the framework should not only measure if ICT tools are used by more than one partner, but also if these ICT tools are effective as a means for managing particular information in a multi user environment. Looking at the elements that describe the scope of integration we think that the framework should not only look at the nature and number of companies, but also to the size of these companies and their past experience. Further, although few parties are not considered to be part of the multi-partner agreement, stakeholders (e.g. building inspector) that can influence the project directly or indirectly, should be added to the framework, because they could prove to be critical in certain type of projects. In regard of the elements of duration of integration we expect a strong relationship between the moment a partner is involved and performance delivered. When we look at our cases, this affect will probably be the highest in between the concept phase and later design phases. What is critical in this regard, is the amount of influence a partner can have on the design. When we look at the depth of integration we found that end-user involvement can be a good, but also a negative factor depending on the way the end-user is involved, whether in the project team or more at a distance. We have also seen the positive effects of the involvement of production personnel in the design phase. However, timing and the ability to draw lessons of their involvement are very critical to squeeze every possible benefit out of this.

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