Rules, Power and Trust

Interplay between inter-organizational structures and interpersonal relationships in project-based organizations in the construction industry

Jelle Koolwijk

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Interplay between inter-organizational structures and interpersonal relationships in project-based organizations in the construction industry

Dissertation

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by

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This dissertation has been approved by the promotors.

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Prof. dr. ir. H.J. Visscher	Delft University of Technology, reserve member

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The compelling urge of [hu]man[kind] to explore and to discover, the thrust of curiosity that leads [humans] to try to go where no one has gone before.

Presidential Science Advisory Committee. 1958. Introduction to outer space. Washington D.C., USA: The White House.

Acknowledgements

Completing a PhD thesis might seem like a lonely process, but it can only be completed with the help of many. I would like to thank everyone who helped me in this endeavor.

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Suzan, thanks for your love, trust and patience. You were there for me all the time. You never put me under any pressure, did not ask when I was going to finish, you just listened and supported me whenever I needed it. Without you I could not have completed this PhD project.

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Summary

The construction industry faces many different challenges, one of which is climate change. At the same time, the knowledge that can be used to design and produce buildings is growing at a tremendous rate, and along with it, new technologies and specializations are emerging. As a consequence, more coordination and integration of knowledge between different experts is needed to realize construction projects. To cope with this challenging environment, companies and customers in the construction industry are increasingly looking for more integrated ways of working in order to improve the efficiency and effectiveness of project organizations. These ways of working are often embodied in various forms of integrated and collaborative project delivery methods, such as Design and Build and Strategic partnerships.

What integrated and collaborative forms of project delivery have in common is that they bring together key actors, such as designers and contractors, early in the organization of a project. The purpose of this is to leverage their capabilities and align their processes to increase efficiency. Creating an integrated and efficient supply chain is costly and it takes time to reap the benefits of close collaboration. Therefore, building long-term relationships between actors in a supply chain is seen as an important element for success. Long-term relationships would reduce the need to learn from scratch in each new project and increase the opportunities for continuous improvement. In practice, however, actors face serious issues when trying to implement integrative and collaborative forms of project delivery. These problems are especially apparent when people are confronted with the new structural and relational elements of these new forms of collaboration, such as working on the basis of trust and providing financial insight.

Current research in the field of integrated and collaborative project delivery methods mainly focuses on three perspectives - the macro, meso and micro level. The macro level concerns the context in which the project takes place, such as the political, economic, cultural and legal context. It is an interplay of circumstances in which the project finds itself. The meso level concerns the inter-organizational structures that companies develop with the aim of aligning their activities and developing close relationships to achieve project goals. At the micro level, face-to-face interactions take place between project team members. Usually, research focuses on one of these levels. While these studies have contributed significantly to the understanding

of elements that influence the effectiveness of integrated and collaborative project delivery methods, this narrow focus masks the interdependencies of inter-organizational structures and interpersonal relationships.

This PhD project aims to provide insight into the multi-level interplay between the meso-level inter-organizational structures and micro-level interpersonal relations in building project organizations. In the first two studies, quantitative approaches were used to validate assumptions about how inter-organizational structures are shaped by actors and how interpersonal relationships affect the effectiveness of project teams in the construction industry. These two studies were integrated in a third qualitative case study that explored the interplay between inter-organizational structures and interpersonal relationships in long-term partnerships.

The final study sampled three cases of strategic partnerships that are characterized as long-term, highly integrated and collaborative relationships. Strategic partnerships are thought to have many positive effects in the construction industry, such as learning opportunities and cost reductions. Despite its potential, the concept of strategic partnering has not developed as strongly in the construction industry as in other industries. Previous studies have reported that actors are experiencing difficulties in developing this kind of long-term and close relationships. Therefore, *this PhD project aims to provide insight into the multilevel interplay between the inter-organizational structures and interpersonal relations in strategic partnerships.* Grasping the complexity of this interplay is essential if we want to comprehend what actually goes on in these partnerships and understand why project actors often disengage from them.

Methodology

A multilevel mixed method research design consisting of three studies was applied. In the first study, a quantitative approach was used to validate assumptions about how meso-level inter-organizational structures are shaped by actors in building project organizations. The second quantitative study explored how micro-level interpersonal relationships affect the effectiveness of project teams in the construction industry. These two studies were integrated in a third qualitative case study that explored the interplay between inter-organizational structures and interpersonal relationships in strategic partnerships in the construction industry (FIG. SUM. 1).

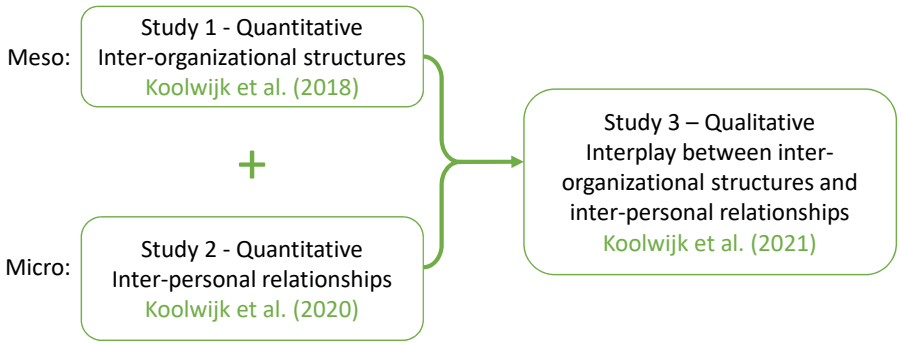

FIG.SUM. 1.1 Multilevel mixed method research design applied in this PhD project

The third study was grafted on Giddens's structuration theory (1984). This theory provided an ontological vision on how to understand the interrelation between individual actions and social structures, in the sense that individuals shape social structures, but at the same time these structures influence the choices individuals make.

Findings and conclusions

The major finding across the three studies is that the way integration in the supply chain develops is highly dependent on the interaction between project actors. Study 2 showed the importance of trusting relationships between project actors for the effectiveness of integrated project delivery methods. Study 1 suggested that trusting and committed relationships between project actors can develop irrespective of the project delivery method used, but that these relationships are more likely to be found in strategic partnerships. The third study provided further explanation for this. The way actors use the inter-organizational rules of a project organization influences the level of trust and no-blame culture that emerges through interaction. The narratives showed that as a project progresses, team members face different challenges, such as financial conflicts. In this kind of scenario, the level of trust is best considered a dynamic state that can influence the rules of actors (FIG. SUM. 2). Specifically, dominant actors seem to be able to change the rules of the system. When a dominant actor uses its power position to change the rules of the social system (for instance, the way financial information is used), it can make other actors feel mistreated by this dominant partner. This can make them lose their commitment to the partnership.

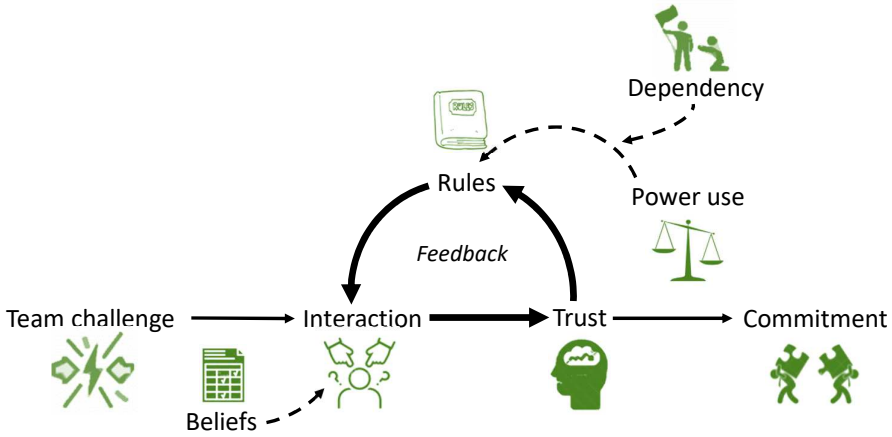

FIG.SUM. 1.2 The interplay between rules, trust, and power in strategic partnerships in the construction industry

Study one contributed to the existing literature on integration and collaboration because it has conceptualized both concepts for the construction sector. A factor analysis on the survey data identified that integration and collaboration consist of 4 components. The first component of collaboration concerns the long-term relationship between parties and the degree of trust between these parties. The second component is financial integration and concerns the extent to which parties share project-related risks and opportunities with each other and whether or not they share (sensitive) financial information. The third component is inclusive decision-making and concerns the degree of involvement of upper and middle management in decision-making within the project, and whether the parties have joint project-transcending objectives. The fourth part is information exchange and reflects the extent to which knowledge is shared between the people in the project team and the extent to which they are stimulated to do so through incentives. The first study also showed that that the degree of integration and collaboration is not so much dependent on the type of contract that parties have. Although in the literature it is often assumed that traditional forms of collaboration lead to poor and relatively short-term relationships, this research shows that both traditional and more integrated project delivery methods can lead to long-term and close relationships in the construction sector over time. The findings of the third study suggest that this kind of relationship can only develop under the condition of mutual trust and power balance between partners.

Study 2 provided further evidence that the way team members collaborate and share knowledge is influenced by a team's no-blame culture. Team members should feel safe to speak their minds, ask questions, learn from their own and others' mistakes, and openly share information if the knowledge that resides within team members is to be unleashed. Knowledge sharing is crucial if we want these team members to solve complex design issues and other unplanned or emergent situations that often occur in complex construction projects. A multilevel analysis showed that the relationship between integral forms of collaboration, such as design & build and partnering, and team effectiveness varies depending on the degree of no-blame culture within the project organization. It was found that the experienced culture can differ greatly between teams. The difference in team effectiveness between the different project teams was explained for 24% by the culture, 37% by the degree of teamwork and 33% by the skills that are present in the team. This means that integrated working arrangements may influence, but not determine the level of no-blame culture in a project organization. Therefore, the team culture and interpersonal trust between actors have to be developed and maintained through interaction. Furthermore, a mediator analysis showed that about 2/3 of the effect of culture on team effectiveness is mediated by the degree of teamwork. Teamwork partially explains the relation between the no-blame culture and team effectiveness. In other words, when the right culture is present, this does not immediately lead to an effective team. Teamwork is also of great importance for a team to become effective.

Practical implications

Based on Giddens' structuration theory (1984), this research adopted a dialectic view of social structure and interactions. Study 3 provided supportive evidence that, consistent with the basic premise of structuration theory, team members shape and use the organizational structures through their interactions, while at the same time these social structures influence how the team members interact. This new insight is an important notion, as it provides guidance to the daily practices of consultants and practitioners in developing and maintaining successful strategic partnerships. It means that developing successful long-term and close collaboration between firms continuously requires careful consideration of how the organizational structures are designed and used and their effect on relationships between actors. In turn, interactions between actors can affect the way in which organizational structures are used. Therefore, one should not assume that integrated contracts and integrative practices that have been shown to work in one partnership will automatically lead to close and long-lasting relationships between actors in another partnership. For example, when a dominant party uses its position to secure its interest, it can damage mutual trust and lead to the long-term relationship being abandoned by one of the partners.

Research implications

The need for interdisciplinary research approaches is growing, as we live in an era of increasingly complex problems. This research shows that interdisciplinary research can lead to new insights and contribute more substantially to solving current day challenges. In this sense, this study can act as a guide to new interdisciplinary research in the future.

The feedback loop shown in FIG. SUM. 2 has already been recognized by Ilgen, Hollenbeck et al. (2005) in their input-mediator-output-input (IMOI) framework for team effectiveness. However, they assumed that feedback loops between emergent states – such as trust – and inputs – such as rules – are less potent because inputs are less malleable. The importance of the current research lies in the fact that these rules in building project organizations are more malleable than Ilgen, Hollenbeck et al. (2005) expected. Indeed, Study 3 provided evidence that the malleability of such rules are under the influence of emergent states of the project team. Actors shape the rules as the team goes through different episodes –such as a conflict. This finding has important implications for future research into studies on collaboration and integration in strategic partnerships.

Samenvatting

De bouwsector wordt geconfronteerd met veel verschillende uitdagingen, zoals klimaatverandering. Tegelijkertijd groeit de kennis die kan worden gebruikt om gebouwen te ontwerpen en te produceren in hoog tempo en daarmee ontstaan ook nieuwe technologieën en specialisaties. Een gevolg hiervan is dat er meer coördinatie en integratie van kennis tussen verschillende experts nodig is om bouwprojecten tot stand te brengen. Om deze uitdagende omgeving het hoofd te bieden, zijn bedrijven en klanten in de bouwsector steeds meer op zoek naar meer geïntegreerde manieren van werken om de efficiëntie en effectiviteit van projectorganisaties te verbeteren en zoeken ze naar manieren om beter gebruik te maken van de kennis die aanwezig is bij de verschillende bedrijven. Deze manieren van werken worden vaak belichaamd door verschillende geïntegreerde en collaboratieve samenwerkingsvormen, zoals strategische partnerships.

Wat geïntegreerde en collaboratieve samenwerkingsvormen gemeen hebben, is dat ze belangrijke deelnemers van de toeleveringsketen, zoals ontwerpers en aannemers, vroeg in de projectorganisatie samenbrengen. Het doel hiervan is om gebruik te maken van hun capaciteiten en hun processen op elkaar af te stemmen om de efficiëntie te verhogen. Het creëren van een geïntegreerde en efficiënte toeleveringsketen is echter kostbaar en het kost tijd voordat men de vruchten van de nauwe samenwerking kan plukken. Daarom wordt het opbouwen van lange termijnrelaties tussen actoren in een toeleveringsketen gezien als een belangrijk element voor succes. Langdurige relaties zouden de noodzaak om te leren in elk nieuw project verminderen en de mogelijkheden voor continue verbeteringen vergroten. Projectactoren ondervinden echter ernstige problemen wanneer ze integratieve en collaboratieve samenwerkingsvormen willen implementeren. Deze problemen komen vooral naar voren wanneer mensen worden geconfronteerd met de nieuwe structurele en relationele elementen van deze nieuwe vormen van samenwerking, zoals het werken op basis van vertrouwen en het geven van financieel inzicht.

Huidig onderzoek op het gebied van geïntegreerde en collaboratieve samenwerkingsvormen richt zich voornamelijk op drie perspectieven – het macro-, meso- en microniveau. Het macroniveau gaat over de context waarin het project zich afspeelt, zoals de politieke, economische, culturele en juridische context. Het is een samenspel van omstandigheden waarin het project zich bevindt. Het mesoniveau

betreft de interorganisatorische structuren die bedrijven ontwikkelen met als doel hun activiteiten op elkaar af te stemmen en nauwe relaties te ontwikkelen om projectdoelen te bereiken. Op microniveau vinden face-to-face interacties plaats tussen projectteamleden. Doorgaans zijn onderzoeken naar samenwerkingsvormen gericht op één niveau. Hoewel deze studies aanzienlijk hebben bijgedragen aan het begrip van elementen die van invloed zijn op de effectiviteit van geïntegreerde en collaboratieve samenwerkingsvormen, maskeert deze beperkte focus de wederzijdse onderlinge afhankelijkheden van interorganisatorische structuren en interpersoonlijke relaties.

Dit promotieonderzoek heeft tot doel inzicht te verschaffen in de interactie tussen de interorganisatorische structuren op mesoniveau en interpersoonlijke relaties op microniveau in samenwerkingsvormen in de bouw. In de eerste twee onderzoeken werden kwantitatieve benaderingen gebruikt om aannames te valideren over hoe interorganisatorische structuren worden gevormd door actoren en hoe interpersoonlijke relaties de effectiviteit van projectteams in de bouwsector beïnvloeden. Deze twee studies werden geïntegreerd in een derde kwalitatieve case study die de wisselwerking tussen inter-organisatorische structuren en interpersoonlijke relaties in strategische partnerschappen onderzocht.

In de laatste studie zijn drie casussen van strategische partnerschappen onderzocht. Strategische partnerschappen worden gekenmerkt als langdurige, sterk geïntegreerde en nauwe samenwerkingsrelaties tussen bedrijven en de daarbij betrokken project actoren. Ondanks zijn potentieel heeft het concept van strategische partnerschappen zich in de bouwsector niet zo sterk ontwikkeld als in andere sectoren. Eerder onderzoek laat zien dat actoren in de bouw moeilijkheden ondervinden bij het ontwikkelen van dit soort langdurige relaties. Dit promotieonderzoek heeft daarom als doel inzicht te verwerven in de interactie tussen de interorganisatorische structuren en interpersoonlijke relaties in strategische partnerschappen. Het begrijpen van de complexiteit van dit samenspel is essentieel als we willen begrijpen wat er werkelijk gebeurt in deze partnerschappen en waarom projectactoren zich er vaak uit terugtrekken.

Methode

In dit onderzoek is een multi-level mixed method research design toegepast, bestaande uit drie studies. In de eerste twee onderzoeken werden kwantitatieve benaderingen gebruikt om aannames te valideren over hoe interorganisatorische structuren op mesoniveau worden gevormd door actoren en hoe interpersoonlijke relaties op microniveau de effectiviteit van projectteams in de bouwsector

beïnvloeden. Deze twee studies zijn vervolgens geïntegreerd in een derde kwalitatieve casestudy. In deze studie is de wisselwerking tussen interorganisatiestructuren en interpersoonlijke relaties in strategische partnerschappen in de bouwsector onderzocht (FIG. SAM. 1).

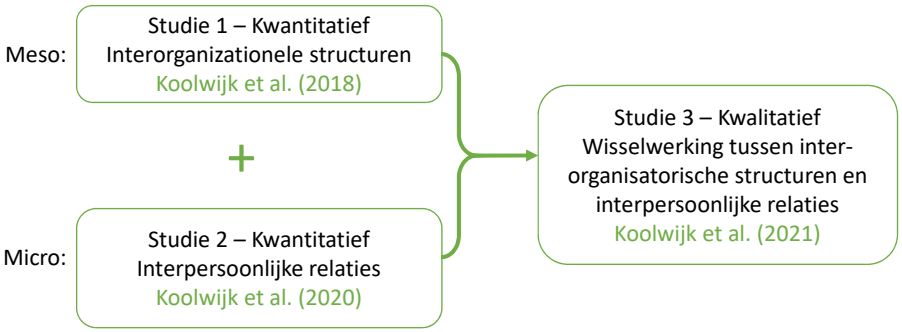

FIG.SAM. 1.1 Multi-level mixed method research design toegepast in dit promotieonderzoek

De derde studie is geënt op de Structuratie theorie van Giddens (1984). Deze theorie geeft een visie op hoe de onderlinge relatie tussen individuele acties en structuren te begrijpen, in de zin dat individuen deze structuren vormen, maar tegelijkertijd beïnvloeden deze structuren de keuzes die individuen maken.

Bevindingen

De belangrijkste bevinding is dat de manier waarop integratie en samenwerking zich ontwikkelt in een strategische partnerschap sterk afhankelijk is van de interactie tussen projectactoren. Studie twee toonde het belang aan van vertrouwensrelaties tussen projectactoren voor de effectiviteit van geïntegreerde samenwerkingsvormen. Studie één suggereerde dat vertrouwensrelaties en toegewijde relaties tussen projectactoren zich kunnen ontwikkelen, ongeacht de gebruikte samenwerkingsvorm, maar dat deze relaties eerder te vinden zijn in strategische partnerschappen. Het derde onderzoek gaf hiervoor een nadere verklaring. De manier waarop actoren de interorganisatorische regels van een projectorganisatie gebruiken, is van invloed op het niveau van vertrouwen en een cultuur van openheid die ontstaat door interactie. De verhalen lieten zien dat teamleden naarmate een project vordert, voor verschillende uitdagingen komen te staan, zoals financiële conflicten. In een dergelijk scenario kan het vertrouwensniveau het best worden beschouwd als een dynamische toestand die de regels van actoren kan beïnvloeden (FIG. SAM. 2).

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Vooral dominante actoren lijken de regels van het systeem te kunnen veranderen. Wanneer een dominante actor zijn machtspositie gebruikt om de regels van het sociale systeem te veranderen, bijvoorbeeld de manier waarop financiële informatie wordt gebruikt, kan dit andere actoren het gevoel geven dat ze door deze dominante partner onjuist worden behandeld. Hierdoor kunnen ze hun betrokkenheid bij het partnerschap verliezen.

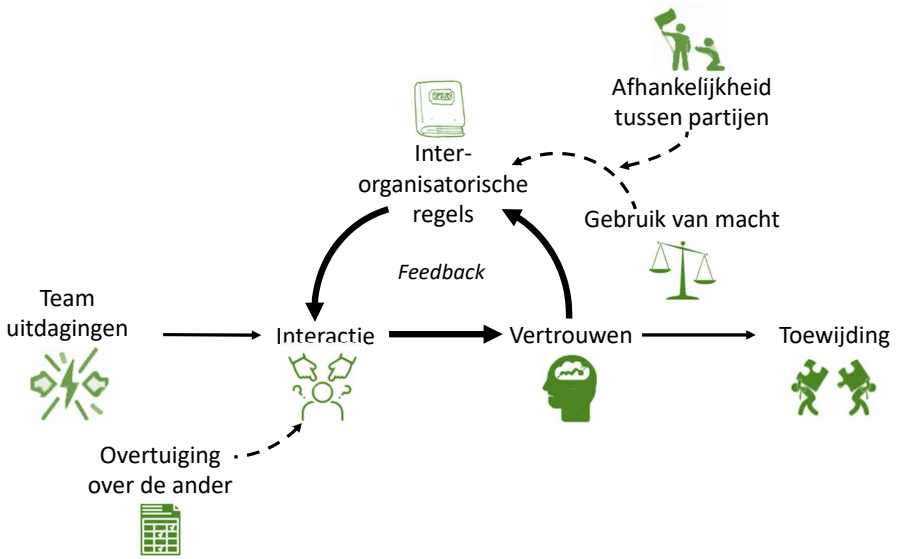

FIG.SAM. 1.2 De wisselwerking tussen regels, vertrouwen en macht in strategische partnershappen in de bouwindustrie

Studie één droeg bij aan de bestaande literatuur over integratie en samenwerking omdat het beide concepten voor de bouwsector heeft geconceptualiseerd. Een factoranalyse op de onderzoeksgegevens wees uit dat integratie en samenwerking uit 4 componenten bestaat. Het eerste onderdeel van samenwerking betreft de langdurige relatie tussen partijen en de mate van vertrouwen tussen deze partijen. Het tweede onderdeel is financiële integratie en betreft de mate waarin partijen project gerelateerde risico's en kansen met elkaar delen en al dan niet (gevoelige) financiële informatie delen. Het derde onderdeel is inclusieve besluitvorming en betreft de mate van betrokkenheid van het hoger en middenmanagement bij de besluitvorming binnen het project en of de partijen gezamenlijke project overstijgende doelstellingen hebben. De vierde component is informatie-uitwisseling en weerspiegelt de mate waarin kennis wordt gedeeld tussen de mensen in het projectteam en de mate waarin ze daartoe worden gestimuleerd door middel

van incentives. Uit het eerste onderzoek bleek ook dat de mate van integratie en samenwerking niet zozeer afhankelijk is van het type contract dat partijen hebben. Hoewel in de literatuur vaak wordt aangenomen dat traditionele vormen van samenwerking leiden tot slechte en relatief korte termijnrelaties, laat dit onderzoek zien dat zowel traditionele als meer geïntegreerde samenwerkingsvormen kunnen leiden tot langdurige en hechte relaties in de bouwsector. . De bevindingen van de derde studie suggereren dat deze relatie zich alleen kan ontwikkelen onder de voorwaarde van wederzijds vertrouwen en machtsevenwicht tussen partners.

Studie twee leverde verder bewijs dat de manier waarop teamleden samenwerken en kennis delen, wordt beïnvloed door de no-blame cultuur van een team. Teamleden moeten zich veilig voelen om hun mening te uiten, vragen te stellen, te leren van hun eigen fouten en die van anderen, en openlijk informatie te delen als we de kennis die in teamleden aanwezig is willen benutten. Het delen van kennis is cruciaal als we willen dat deze teamleden complexe ontwerpvraagstukken en andere ongeplande of onverwachte situaties oplossen die vaak voorkomen bij complexe bouwprojecten. Uit een multi-level analyse bleek dat de relatie tussen integrale vormen van samenwerking, zoals Design & Build en Partnering, en teameffectiviteit varieert afhankelijk van de mate van no-blame cultuur binnen de projectorganisatie. Gebleken is dat de ervaren cultuur sterk kan verschillen tussen teams. Het verschil in teameffectiviteit tussen de verschillende projectteams werd voor 24% verklaard door de cultuur, 37% door de mate van teamwork en 33% door de vaardigheden die in het team aanwezig zijn. Dit betekent dat integrale werkafspraken het niveau van de no-blame cultuur in een projectorganisatie mogelijk kunnen beïnvloeden, maar niet bepalen. Daarom moeten de teamcultuur en het interpersoonlijke vertrouwen tussen actoren worden ontwikkeld en onderhouden door tijdens de interactie tussen personen. Verder toonde een mediatoranalyse aan dat ongeveer 2/3 van het effect van cultuur op teameffectiviteit wordt gemedieerd door de mate van teamwork. Dit betekent dat teamwerk de relatie tussen de no-blame cultuur en teameffectiviteit gedeeltelijk verklaart. Met andere woorden, wanneer de juiste cultuur aanwezig is, leidt dit niet direct tot een effectief team. Teamwork is ook van groot belang om een team effectief te laten worden.

Praktische implicaties

Gebaseerd op Giddens' structuratietheorie (1984), nam dit onderzoek een dialectische kijk op sociale structuur en interacties aan. Studie drie leverde ondersteunend bewijs dat, in overeenstemming met het uitgangspunt van de structuratie theorie, teamleden de organisatiestructuren vormgeven en gebruiken, door hun interacties, terwijl deze sociale structuren tegelijkertijd de interactie tussen

de teamleden beïnvloeden. Dit nieuwe inzicht is een belangrijk begrip omdat het een leidraad biedt voor de dagelijkse praktijk van consultants en praktijkmensen bij het ontwikkelen en onderhouden van succesvolle strategische partnerschappen. Het betekent dat om succesvolle langdurige en nauwe samenwerking tussen bedrijven tot stand te brengen, voortdurend een zorgvuldige afweging vereist van hoe de organisatiestructuren worden ontworpen en gebruikt en hun effect op de relaties tussen actoren. Interacties tussen actoren kunnen op hun beurt invloed hebben op de manier waarop organisatiestructuren worden gebruikt. Men mag er daarom niet van uitgaan dat geïntegreerde contracten en integratieve praktijken waarvan is aangetoond dat ze in het ene partnerschap werken, automatisch zullen leiden tot hechte en langdurige relaties tussen actoren in een ander partnerschap. Wanneer bijvoorbeeld een dominante partij zijn positie gebruikt om – voor zijn gevoel -- zijn belang veilig te stellen, kan dit het onderling vertrouwen schaden en ertoe leiden dat de langdurige relatie wordt ontbonden door een van de partners.

Onderzoeksimplicaties

De behoefte aan interdisciplinaire onderzoek groeit, aangezien we in een tijdperk leven met steeds complexere problemen. Dit onderzoek laat zien dat interdisciplinair onderzoek kan leiden tot nieuwe inzichten en een grotere bijdrage kan leveren aan het oplossen van hedendaagse uitdagingen. In die zin kan dit onderzoek als leidraad dienen voor nieuw interdisciplinair onderzoek in de toekomst.

De feedback lus getoond in (FIG. SUM. 2) is al eerder beschreven door Ilgen, Hollenbeck et al. (2005) in hun input-mediator-output-input (IMOI) raamwerk voor teameffectiviteit. Ze gingen er echter van uit dat feedback lussen tussen emergente toestanden, zoals vertrouwen, en inputs, zoals regels, weinig voor zouden komen omdat inputs minder aan verandering onderhevig zijn. Het belang van het huidige onderzoek is dat deze regels in bouwprojectorganisaties meer aan verandering onderhevig zijn dan Ilgen, Hollenbeck et al. (2005) hadden verwacht. Onderzoek drie leverde inderdaad bewijs dat de maakbaarheid van dergelijke regels wordt beïnvloed door de emergente toestand van het projectteam. Actoren veranderen de regels terwijl het team verschillende situaties doormaakt, zoals een conflict. Deze bevinding heeft belangrijke implicaties voor toekomstig onderzoek naar studies over samenwerking en integratie in strategische partnerschappen.

1 Introduction

The construction industry is being confronted with many different challenges, among which climate change. At the same time, the knowledge that can be used to design and deliver buildings is growing at tremendous pace and, concurrently, new technologies emerge. Technologies, such as Building Information Modelling, fundamentally change the way buildings are designed and produced (Owen et al. 2015, Papadonikolaki 2020). The growth of knowledge and new technologies necessitates greater specialization (Robbins and Judge 2013). As a result, more coordination and integration of knowledge amongst different experts is needed to deliver construction projects (Edmondson 2012). To cope with this challenging environment, firms in the construction industry are increasingly searching for more integrated and collaborative ways of working to improve the efficiency and effectiveness of project organizations (Van den Berg 1990, Van den Berg et al. 1996, Cushman and Loulakis 2001, Walker and Hampson 2002). These ways of working are often embodied by various integrated and collaborative project delivery methods, such as Partnering, and Design Build.

What these integrated and collaborative project delivery methods have in common is that they intend to bring together key actors of the supply chain early in the project organization (Baiden and Price 2011, Eriksson 2015). Each actor brings a different type of expertise to the project team– such as electrical engineering, sustainable design and architecture – enabling the timely integration of their information into the design (Ancona and Caldwell 1992, Edmondson and Nembhard 2009). Team members have to collaborate closely and coordinate their actions across disciplinary and organizational boundaries to accomplish shared project goals (Fong and Lung 2007). Together, project team members have to manage complex problems, solve difficult design issues, and deal with last-minute design changes (Savelsbergh et al. 2015, Hamzeh et al. 2018). Before a team can take effective actions, its members need to reach a common understanding of the issue at hand and how it can be solved (Barron 2000). To develop a joint understanding, team members must openly discuss their ideas, challenge others' assumptions, share information, and integrate their diverse knowledge and viewpoints (Allen et al. 2005, Edmondson and Lei 2014, Manata et al. 2018).

While it is recognized that societal challenges require some level of integration and collaboration between firms in the construction supply chain, project actors are experiencing serious issues when they want to implement integrative and collaborative project delivery methods. These problems emerge particularly when project actors are confronted with the new structural and relational elements of integrated and collaborative project delivery methods, which contradict earlier experiences often gained in more traditionally procured projects (Venselaar et al. 2015, Bygballe and Swärd 2019). In news items about construction projects, similar struggles can be recognized. Recently, the Dutch Highway Agency (*Rijkswaterstaat*) made the news, due to the fact that large delays, enormous cost overruns and disputes are such a regular feature of its projects (Van den Berg and Riemersma 2021). The Highway Agency tries to solve these problems by changing the way they procure their projects, such as a two-stage tender process for major construction works. They seem to have the idea that project success can be engineered by making structural changes to the project organization, ignoring the actual organizational complexity and unplanned events that often occur in construction projects (Flyvbjerg 2017). These are events that require close collaboration of various actors in the supply chain to be understood and managed.

Current research in the field of integrated and collaborative project organizations mainly focusses on three perspectives – the macro-, meso-, and micro-level (Li et al. 2019). The macro-level is about the context in which the project takes place, such as the political, economic, cultural, and legal context. It is a set of circumstances in which the project is situated (Griffin 2007). The meso-level concerns the inter-organizational structures that firms develop in order to align their activities and to develop close relations to reach project goals (Leuschner et al. 2013, Eriksson 2015). The micro-level is where face-to-face interactions take place between project team members. It is the level where interpersonal relationships emerge that influence the effectiveness of the project team (Mathieu et al. 2008, Edmondson and Lei 2014). Research often treats each level in isolation (Dawe 1970, Mathieu et al. 2008, Li et al. 2019). Edmondson (2009), for instance, focuses on the relation between the team's interpersonal relationships and its effectiveness. Mesa et al. (2016) argue that the interaction between actors is mainly determined by their inter-organizational context. By imposing particular inter-organizational rules it is assumed that actors will start to behave in the required way. In practice, however, none of the three levels have clear boundaries (Robbins and Judge 2013). Individuals shape and negotiate the inter-organizational structures as the project progresses (Bresnen 2009). In turn, these structures enable and constrain individuals in their actions (Giddens 1984). Grasping the complexity of this multi-level interplay is essential if we want to comprehend what goes on in project-based organizations and understand the actual problems practitioners face in such complex environments

(Hitt et al. 2007, Cao and Lumineau 2015). There is only limited knowledge about how actors shape the structures of building project organizations, and how these interrelate with the team's interpersonal relationships over time (Bresnen et al. 2005, Bygballe and Swärd 2019). Therefore, this PhD project aims to *provide insight into the multi-level interplay between the meso-level inter-organizational structures and micro-level interpersonal relations in project-based organizations in the construction industry.*

In this PhD project, which comprises of three studies, a multilevel mixed method research design was applied (Schoonenboom and Johnson 2017) (FIG. 1.1).

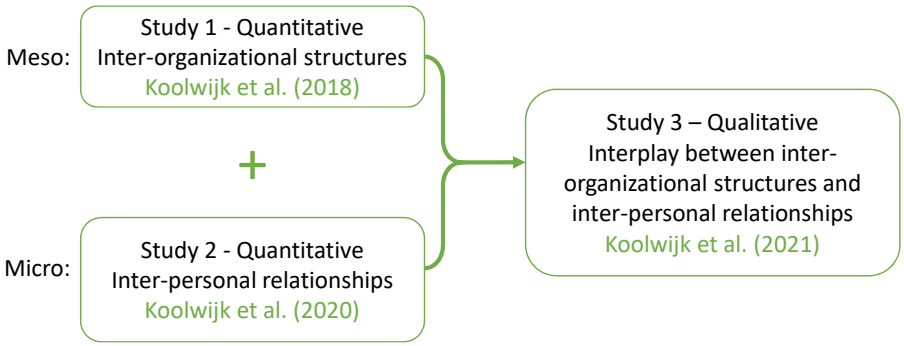

FIG. 1.1 Multilevel mixed method research design applied in this PhD project

In the first two studies, quantitative approaches were used to validate assumptions about how inter-organizational structures are shaped by actors and how interpersonal relationships affect the effectiveness of project teams in the construction industry. These two studies were integrated in a third qualitative case study that explored the interplay between inter-organizational structures and interpersonal relationships in long-term partnerships.

The final study sampled cases of strategic partnerships, because these are characterised as long-term, integrated and collaborative relationships (Bygballe et al. 2010). Creating an integrated and efficient project organization is costly and takes time to become beneficial (Bygballe et al. 2010, Meng 2012). Therefore, building long-term relationships between actors in a supply chain is seen as a key element for success (Bygballe et al. 2010). Long-term relationships would reduce the need to learn in every new project (Dubois and Gadde 2000), enhance the possibilities for continuous improvements (Bresnen and Marshall 2002), and

increase the incentives for close collaboration (Kaufmann and Carter 2006, Balliet et al. 2011). Despite its potential, the concept of strategic partnering has not developed as strongly in the construction industry as in other industries (Bygballe et al. 2010, Sundquist et al. 2018). Case studies report that actors are experiencing difficulties in developing this kind of long-term relationships (Venselaar et al. 2015, Bygballe and Swärd 2019). By examining the multi-level interplay, we deepened our insight into why some strategic partnerships are maintained, whereas others were abandoned.

In the remainder of this introduction, the background to the three studies and research questions is briefly presented. This is followed by the mixed-method research approach. The introduction concludes with an overview of the three studies. These studies have been published in three different articles, and correspond with chapters 3, 4 and 5 in the thesis. In each chapter, a more extensive background and description of the research approach is provided. This dissertation ends with the conclusions and discussion, and considerations for research and project management.

1.1 Theoretical background

This research aims to provide insight into the multi-level interplay between the meso-level inter-organizational structures and micro-level interpersonal relations in building project organizations (FIG. 1.2). The meso level is defined as the level of supply chain integration and collaboration between firms in building project organizations. The micro level is where face-to-face interactions take place between project team members. This is the level where interpersonal relationships emerge that influence the effectiveness of the project team (Mathieu et al. 2008, Edmondson and Lei 2014). The structuration theory of Giddens (1984) provided a view for understanding the interrelations between inter-organizational structures and interpersonal relationships. The basic premise of structuration theory is that individuals shape and use the organizational structures through their interactions but, at the same time, these structures influence how people interact. Giddens (1984) calls this the duality of structure.

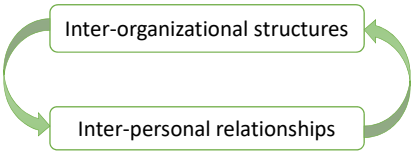

FIG. 1.2 The interplay between the meso-level inter-organizational structures and micro-level interpersonal relationships in building project organizations.

In the following paragraphs, the concepts used to define the two levels and the reason for the research questions in each of the three studies are further elaborated.

1.1.1 Inter-organizational structures

To understand how actors shape inter-organizational structures between firms, this study uses the concept of supply chain integration and collaboration. In the construction industry, supply chain integration and collaboration is seen as a way to increase efficiency and quality of production processes and to make better use of complementary capacities across firms (Bresnen and Marshall 2000, Akintoye and Main 2007, Bygballe et al. 2010). There is little consensus on the definition of integration nor of collaboration (Fabbe-Costes and Jahre 2008, Meng 2012, Leuschner et al. 2013). The concept of supply chain integration and collaboration therefore needed clarification before further research could be done.

In this first study, integration between firms includes inclusive decision-making, financial integration and information sharing (Koolwijk et al. 2018). Inclusive decision-making concerns the level of involvement of top and middle management in the project and joint decision-making by the client and suppliers (Koolwijk et al. 2018). Key partners need to be involved in decision-making and allowed to voice their concerns and opinions (Eriksson 2015). Unless there is inclusive decision-making, sub-optimisation of the chain may occur (Arshinder et al. 2011). Information sharing concerns the sharing of information among the members of the supply chain and the use of information technology to exchange and manage information (Koolwijk et al. 2018). Information sharing is an important facilitator of an effective and efficient supply chain because it provides enhanced coordination between partners and opportunities for innovation within the joint team (Edmondson and Nembhard 2009). Information exchange is paramount to the development of trust and collaboration between partners (Kadefors 2004). This lowers the total costs of the supply chain, which is a major motivating factor in the formation of partnerships (Sambasivan et al. 2013). Financial integration involves the sharing of risks, costs and rewards along the chain, and sharing of sensitive financial

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information to evaluate the financial performance of the single entities in the supply chain (Koolwijk et al. 2018). Sharing risks and rewards should make partners look beyond the goals of their own organisation to the performance of the whole chain. Risks and rewards need to be shared across the partners on a fair basis (Narayanan and Raman 2004). If incentives are not aligned, firms may revert to optimising their production (Rose and Manley 2010). The sharing of financial risks and rewards by partners legitimises close collaboration and the sharing of information (Rose and Manley 2010), because the partners will 'sink or swim together' (Walker and Lloyd-Walker 2015). Collaboration is defined as the soft aspect of supply chain management (Kache and Seuring 2014). Through the development of trust, commitment and long-term orientation, close collaboration significantly influences the firm or project performance (Chen et al. 2004, Hult et al. 2004, Dyer and Hatch 2006, Leuschner et al. 2013).

Integration and collaboration are interrelated. Integrative practices constitute the opportunities to develop collaboration; that is, it develops mutual trusting relationship between firms. For partners to get to know each other and build a trusting relationship, the duration of this relationship is important (Zheng et al. 2008, Eriksson 2015). Trust between team members needs to grow with experience (Dwyer et al. 1987). For instance, Maurer (2010) found that project team members who know each other from prior collaborative projects and get involved early in the project have greater opportunities to interact and get to know each other, which lay the ground for mutual trust.

There is a strong focus on integration and collaboration at the project level in construction-related research (Lahdenperä 2012, Meng 2012, Izam Ibrahim et al. 2013). In these studies, integrated project delivery methods, such as project alliancing, are primarily believed to foster integration practices between diverse organizations involved in delivering construction projects (Lahdenperä 2012, Izam Ibrahim et al. 2013). Project delivery methods of this kind are relatively new, the most commonly used method being the traditional design-bid-build approach (D'Agostino and Bridgers 2010, RIBA 2012). The latter is characterized by a phased approach in which design and production are separated. By definition, the traditional approach does not entail integrative activities. However, ignoring the level of integration and collaboration in traditionally procured projects may deny the fact that in the construction industry many firms may have developed long-term relationships with their major clients (Egemen and Mohamed 2006, Carter et al. 2009). Notwithstanding, according to Dewulf and Kadefors (2012), traditional construction contracts often lead to distrust and conflicts in project teams. Alternatively, integrative activities may give rise to conflicts in project teams that eventually result in poor collaboration (Edmondson and Nembhard 2009). Thus,

there is a need for research that explores the level of integration and collaboration in project-based supply chains in construction. *The first study does so by addressing the question of whether integrative and collaborative practices can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods can also foster integration and collaboration.*

1.1.2 Interpersonal relationships

Team members' interpersonal relationships are believed to be a critical success factor for integrated and collaborative project delivery methods in the construction industry (Yeung et al. 2007, Lahdenperä 2012). An environment in which people feel safe to speak their minds, ask one another questions, learn from their own and others' mistakes, and openly share information is crucial to unleashing the knowledge that resides within team members (Edmondson and Lei 2014, Lloyd-walker et al. 2014). In the context of construction project organizations, such an environment is often characterized as an environment with a no-blame culture (Baiden et al. 2006, Lloyd-walker et al. 2014). Lloyd-walker et al. (2014, p. 233) define a no-blame culture as "one in which individuals do not fear repercussion from risk taking or problem identification, where employees feel free to contribute to discussions and raise issues."

A no-blame culture is promoted as an important condition for teamwork that in turn will lead to higher project team effectiveness (Lloyd-walker et al. 2014). Teamwork implies that trust and open communication emerges during collaboration (Hoegl and Gemuenden 2001, Edmondson and Lei 2014). When actors work together for the first time, they need to take a 'leap of faith', because they are rather unknowing of each other. They are willing to accept the risks of working together because they hold positive assumptions about the other partner. They perceive the other partner as someone who does not take advantage of them (McKnight and Chervany 2001), and who has the "ability, dependability, or competence to perform a task" (Pinto et al. 2009, p.640). During their collaboration, each partner will learn about the true trustworthiness of the others (Kostis and Näsholm 2018). Trust is reinforced by positive experiences and increased knowledge of the other, and declines when expectations are not met (Lewicki et al. 2006). Drawing upon the theoretical basis identified above, the level of team effectiveness is indirectly, via teamwork, positively influenced by the no-blame culture. To date, studies investigating this mediational pathway for project teams in the construction industry are lacking. *Therefore, the first main question of this second study is whether teamwork mediates the relationship between no-blame culture and team effectiveness.*

Integrated and collaborative project delivery methods, such as project alliancing, often set policies and procedures that are thought to support a no-blame culture (Lloyd-walker et al. 2014). However, project team members often encounter situations in which the adoption of collaborative arrangements has an opposite effect (Rose and Manley 2010, Chan et al. 2012). Moreover, other 'less collaborative' integrated project delivery methods, such as Design Build, may also benefit from a no-blame culture. Therefore, irrespective of the integrated project delivery method used, integrated project teams may require an environment of a no-blame culture to become effective. *Thus, the second main question of this second study is whether the relation between project delivery method and team effectiveness varies across levels of no-blame culture.*

1.1.3 The interplay between inter-organizational structures and interpersonal relationships

In the construction industry, strategic partnerships are thought to have many positive effects, such as providing learning opportunities and enabling cost reductions (Cheng et al. 2004, Ingirige and Sexton 2006). Despite its potential, the concept of strategic partnering has not developed as strongly in the construction industry as in other industries (Bygballe et al. 2010, Sundquist et al. 2018). Case studies report that team members struggle with the partnership's social system, because it contradicts earlier experiences often gained in more traditionally procured projects (Venselaar et al. 2015, Bygballe and Swärd 2019).

Social systems consist of multiple dimensions that are constituted by social structures and individual actions that produce, reproduce and change these structures (Giddens 1984). Social structures consist of rules and resources that help actors to give meaning to what they are doing and enable them to acquire power within the social system (Reimann and Ketchen Jr 2017). Partnering is based on different rules and power relations than is the case in traditional procurement, which can cause individuals who are new to this social system to feel disembedded (Hartmann and Bresnen 2011, Giddens 2013). Whereas traditional procurement is based on short-term and arm's-length relationships, the aim of strategic partnering is to utilize the capacities of different firms by fostering long-term and close collaboration between individuals and integrating processes between firms (Koolwijk et al. 2018). For close collaboration to emerge, it is important that individuals have trust in both the rules of the social system and the individuals who constitute this system (Mathieu et al. 2008, Kähkönen 2014). Furthermore, the power relations between the partners must be balanced (Kähkönen 2014). A dominant partner that

uses its power to influence the social system might be regarded as unfair by its partners, causing harm to the relationship (Pulles et al. 2014).

There is only limited knowledge about how and why the social structures of strategic partnerships are shaped by actors and how these interrelate with a team's interpersonal relationships over time (Bresnen et al. 2005, Bygballe and Swärd 2019). Grasping the complexity of this interplay is essential if we want to comprehend what actually goes on in these partnerships and understand why actors often disengage from them. *This third study, therefore, aims to gain insight into the multi-level interplay between the meso-level inter-organizational structures and micro-level interpersonal relations in project-based organizations in the construction industry.* Specifically, we sought to understand when dynamics in trust legitimize dominant actors to change the financial rules in strategic partnerships. In turn, we wanted to explore the effects of these changes on the interaction between parties in the supply chain and eventually their commitment to the partnership.

1.2 Methodology

1.2.1 Rationale

This research aims to gain insight into the multi-level interplay between the meso-level inter-organizational structures and micro-level interpersonal relations in project-based organizations in the construction industry. An environment that is constructed in the mind of actors in interaction with other actors who together form a temporal project team. This environment is not solely mental but also relies on the material elements, such as contracts, which anchor the necessary information that supports this environment (Gherardi and Strati 2012). Therefore, this research views the social world consisting both of static 'things' and as dynamics, unfolding in relations (Emirbayer 1997). To capture this 'first person view' of both static elements and social dynamics, a practice based approach was used. A practice based approach makes it possible to see both the ordering of the social world in which 'being' and 'becoming' are not separated (Gherardi and Strati 2012).

This PhD project used a mixture of qualitative and quantitative approaches. Quantitative methods were used to develop a general understanding of particular phenomena, such as the level of integration and collaboration in various project delivery methods. The temporal, ongoing and complex processes among actors in a project-based organization are better captured using case studies (Loscher et al. 2019).

1.2.2 Research design

In this PhD project, a multilevel mixed research design was applied (Creswell 2015, Schoonenboom and Johnson 2017). Two independent quantitative studies preceded the third qualitative study in which knowledge from the first two studies was integrated. The first two quantitative studies were performed simultaneously. The first quantitative study aimed to develop the main components of supply chain integration and to validate the hypothesis that actors shape building project organizations in different ways. The second quantitative study aimed to identify associations among the main interpersonal variables, and to examine how these variables affect the effectiveness of project teams within different project organizations in the construction industry. These two studies were then integrated in a third qualitative case study that aimed to give insight into the multi-level interplay between the meso-level inter-organizational structures and micro-level interpersonal relations in strategic partnerships in the construction industry. The analysis of the third study was, therefore, dependent on the outcomes of the first two studies. In the third study, an initial conceptual framework was developed using the concepts from the first two studies (Bowen 2006, Charmaz 2006, Schoonenboom and Johnson 2017). Throughout this third study, other variables were discovered and a theory emerged from the data. This provided the basis for the in-depth description of the theory on the interplay between inter-organizational and interpersonal variables in strategic partnerships in the construction industry.

1.2.3 Data collection and analysis

Because there is little consensus on the definition of integration nor of collaboration (Fabbe-Costes and Jahre 2008, Meng 2012, Leuschner et al. 2013), the first study on inter-organizational structures aimed to define these constructs. Additionally, this study compared the level of integration and collaboration of various building project organizations that are arrived at via different routes. To reach this aim, a questionnaire was developed, based on a theoretical framework. The scales were then discussed with 14 practitioners and piloted on six projects. Finally, 46 project managers who work on projects that use various project delivery methods were accessed through a collaborative innovation network of 18 housing associations. Explanatory factor analysis was used to identify the components that explained collaboration and integration in project design teams (Field 2009). Analysis of variance of factor scores was used to identify whether project delivery methods were significantly different in terms of the dimensions of integration and collaboration (Field 2009).

The second study on interpersonal relations aimed to examine how a no-blame culture affects the effectiveness of project-based design teams within different project delivery methods in the construction industry. The first main question was whether teamwork mediates the relationship between no-blame culture and team effectiveness. The second main question aimed to investigate whether the relationship between project delivery methods and team effectiveness is dependent on the existence of a strong no-blame culture. A questionnaire was developed using existing scales that were developed in other industries. The concepts were discussed with practitioners and the scales were shaped to match the jargon in the construction industry. Because all variables represented team level variables, team members in various project organizations were asked to participate in a survey. A total of 92 team members of 34 project-based design teams, varying widely in background and experience, type and size of projects, and project delivery methods, were recruited via a variety of routes, such as an online contact database containing the addresses of 1099 architectural firms. A multi-level statistical analysis was done to investigate whether the relation between integrated project delivery methods (De Leeuw and Meijer 2008, Field 2009), such as Design-build and Strategic Partnering, and team effectiveness varies across levels of no-blame culture. A mediated regression analysis was used to see whether the effect of no-blame culture on team effectiveness is mediated by teamwork (Hayes 2017, Kenny 2017).

The third study explored the interplay between inter-organizational structures and interposal relationships grounded in data collected in strategic partnerships in the construction industry. To uncover these dynamics, three case studies were performed. Because this study investigated the interplay between inter-organizational and interpersonal variables, 14 actors that were active on various levels and for different partners of a building project organization were interviewed. Being an engaged scholar in the cases, the PhD researcher could add his viewpoint and review his personal journals to help in understanding the complexity of each of them (Bäckstrand and Halldórsson 2019). However, the interviews were used as the primary source to develop narratives to keep them close to how the individual actors experienced each situation.To achieve theoretical sensitivity, a conceptual framework was developed using the concepts from the previous two studies (Bowen 2006, Charmaz 2006). Data collection, data analysis and the development of the conceptual framework occurred concurrently (Bowen 2006). Thematic analysis was done in close collaboration with two co-authors to ensure trustworthiness of the research findings. Because the lead and second author have different backgrounds, they had to cross boundaries, which resulted in them creating synergies and avoiding disciplinary narrowness.

1.2.4 Timeline

This part-time PhD started in June 2015, as a follow-up to contract research projects that took place between 2011 and 2015. Three conference papers were presented in 2014 and 2015 and a final journal article (study 1) was published in January 2018. The latter received an editor's choice award. In 2015, the researcher presented two conference papers that served as scoping studies for this PhD. The data for the second study was collected in 2016 and 2017. A conference paper based on this data was presented in 2019 and a journal article (study 2) was published in 2020. The conference paper received a best paper award for the theme collaboration. Between 2011 and 2016, the researcher was engaged in several strategic partnerships. Three strategic partnerships became part of study three. A journal article (study 3) about these three cases was published in 2021. Near the end of this PhD project, a conference paper about the general conclusions of this research was presented at the SEEDS conference and a research poster was presented at the RISE awards. The conference paper received a best paper award for the theme industrial strategy. The poster won the RISE award in the category contracting and construction management. The timeline is shown in figure 1.3. For more details about the conference and journal papers, see table 1.1 in paragraph 1.3.

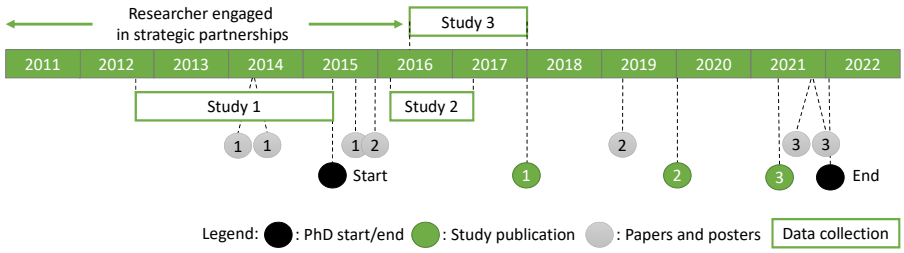

FIG. 1.3 Timeline of this PhD project

1.2.5 Ethical approval and data availability statement

This study was formally approved by the Human Research Ethics Committee of Delft University of Technology (HREC). Following the ethical guidelines of the HREC, informed consent was obtained from each participant before they started the survey or interview, anonymity was ensured, and participants were informed that they could withdraw at any time. The data were treated confidentially and stored in a secure data server that is accessible only by the researchers.

Some or all data used during the study are confidential in nature and may only be provided with restrictions. Data concerning personal information of the respondents and the projects on which they have worked may not be made public due to restrictions imposed by the Human Research Ethics Committee of Delft University of Technology. These data contain information that could compromise the privacy of the research participants.

1.3 Structure of this dissertation

Table 1.1 gives an overview of the introduction, three studies, and conclusions that are part of this PhD project.

In chapter 2, 3 and 4, the three studies that comprise this dissertation are presented. Chapter 5 gives the overall conclusion and implications for managers and research.

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TABLE 1.1 Overview of three studies and conference paper that are part of this PhD project

Chapter	Publications, presentations and awards
2	– Koolwijk, J. S. J., van Oel, C. J., Wamelink, J. W. F., & Vrijhoef, R. (2018). Collaboration and integration in project-based supply chains in the construction industry. *Journal of Management in Engineering*, *34*(3). DOI: 10.1061/(ASCE)ME.1943-5479.0000592. *Received an Editor's choice award* **Preceding conference papers and presentations** – Koolwijk, JSJ., van Oel, CJ., Vrijhoef, R., & Wamelink, JWF. (2015). Partnering in construction: A field study to further develop the framework of supply chain integration. In AB. Raiden, & E. Aboagye-Nimo (Eds.), Proceedings of the 31st annual ARCOM conference (pp. 1209-1218). Reading, UK: ARCOM, Association of Researchers in Construction Management. – Koolwijk, JSJ., Vrijhoef, R., van Oel, CJ., van der Kuij, RS., & Wamelink, JWF. (2014). Organizational effectiveness of building project organisations and greenfields to develop. In D. Amaratunga, R. Haigh, L. Ruddock, K. Kermiminiyage, C. Kulatunga, & C. Pathirage (Eds.), Proceedings of the 2014 CIB W55/65/89/92/96/102/117 & TG72/81/83 International Conference on Construction in a Changing World (pp. 1-12). s.l.: s.n. – Vrijhoef, R., Koolwijk, JSJ., van der Kuij, RS., van Oel, CJ., & Wamelink, JWF. (2014). Developing a monitor for the characterisation of supply chain collaboration and the measurement of its effectiveness in the Dutch social housing sector. In D. Amaratunga, R. Haigh, L. Ruddock, K. Kermiminiyage, C. Kulatunga, & C. Pathirage (Eds.), Proceedings of the 2014 CIB W55/65/89/92/96/102/117 & TG72/81/83 International Conference on Construction in a Changing World.
3	– Koolwijk, J. S. J., van Oel, C. J., & Gaviria Moreno, J. C. (2020). No-Blame Culture and the Effectiveness of Project-Based Design Teams in the Construction Industry: The Mediating Role of Teamwork. *Journal of Management in Engineering*, *36*(4). DOI: 10.1061/(ASCE)ME.1943-5479.0000796 **Preceding conference papers and presentations** – Koolwijk, J., & van Oel, C. (2019). The mediating role of teamwork between a no-blame culture and team effectiveness in project-based design teams in the construction industry. Paper presented at the Project Management Congress: "ADAPT or DIE", Research meets Practice: towards Project Management 3.0.", Delft, Netherlands. *Received best paper award for the theme Collaboration* – Koolwijk, JSJ., van Oel, CJ., & Wamelink, JWF. (2015). Supply chain partnership in construction a field study on project team level factors. In MA. Farshchi, & C. Egbu (Eds.), Proceedings of the joint CIB international symposium - Going north for sustainability: Leveraging knowledge and innovation for sustainable construction and development (pp. 81-91). London: IBEA Publications Ltd.
4	– Koolwijk, J., van Oel, C., & Bel, M. (2021). The interplay between financial rules, trust and power in strategic partnerships in the construction industry. *Engineering, Construction and Architectural Management, Vol. ahead-of-print (ahead-of-print).* DOI: 10.1108/ECAM-09-2020-0713
1 & 5	– Koolwijk, J.S.J. & Van Oel, C.J. (2021). Interplay between Rules, Trust and Power in strategic partnerships in the construction industry. *International SEEDS conference 2021: Sustainable Ecological Engineering Design for Society*, 1-3 September 2021 Leeds Beckett University, Leeds, United Kingdom. *Received best paper award for the theme Industrial Strategy* **Research poster:** – Koolwijk, J.S.J. & Van Oel, C.J. (2021). Interplay between Rules, Trust and Power in strategic partnerships in the construction industry. Research poster for the *RISE AWARDS 2021*, 3 September 2021, Leeds Beckett University, Leeds, United Kingdom. *The award was presented by the Leeds Sustainability Institute, Technological University Dublin, Suffolk Sustainability Institute, and the University of the West of England. Received the RISE award in the category Contracting and Construction Management.*

2 Collaboration and Integration in Project-based Supply Chains in the Construction Industry

Koolwijk, J. S. J., van Oel, C. J., Wamelink, J. W. F., & Vrijhoef, R. (2018). Collaboration and integration in project-based supply chains in the construction industry. *Journal of Management in Engineering*, *34*(3). DOI: 10.1061/(ASCE)ME.1943-5479.0000592

Received an Editor's choice award

ABSTRACT This study investigates whether integrative and collaborative practices in the construction industry can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods also foster integration in project-based design teams. Project managers assessed team collaboration and the integration of teams in 46 construction industry projects in the Netherlands. Explanatory factor analysis (EFA) was used to identify the components that explained collaboration and integration in project design teams. Using analysis of variance of factor scores, the main finding of the study was that, in the construction industry, collaboration is an independent component in integrative and collaborative practices, which can be reliably assessed in research. Furthermore, this study provides suggestive evidence that both traditional and integrated project delivery methods might lead to collaboration over time. The third finding is that different

project delivery methods were not significantly different in terms of the dimensions of integration and collaboration, except for inclusive decision making between Building Team and Strategic Partnering. The findings suggest that relying on the type of project delivery method is not sufficient for managers to communicate about the level of supply chain integration and collaboration.

KEYWORDS Supply chain integration; collaboration; construction industry; project-based supply chains; project delivery method

2.1 Introduction

Supply chain integration and collaboration aims to improve performance by establishing close relationships and the alignment of activities between upstream and downstream actors in the supply chain (Carter et al. 2009, Barrett 2004). In construction, both integration and collaboration are seen as a way to increase efficiency and quality of production processes (Bresnen and Marshall 2000, McDermott and Khalfan 2006, Akintoye and Main 2007, Bygballe et al. 2010).

There is little consensus on the definition of both integration and collaboration (Burgess et al. 2006, Fabbe-Costes and Jahre 2008, Meng 2012, Leuschner et al. 2013). Collaboration is here defined as being a soft aspect of supply chain management (Kache and Seuring 2014). This people-focussed concept deals with social relationships, such as trust and commitment (Burgess et al. 2006). Integration here refers to practices that are performed on a project level. These practices concern tangible activities or technologies, such as, the shared use of a Building Information Model or using a shared office that allows face-to-face communication (van der Vaart and van Donk 2008, Eriksson 2015).

There is a strong focus on integration and collaboration at the project level in construction related research (Lahdenperä 2012, Meng 2012, Izam Ibrahim et al. 2013). In these studies, integrated project delivery methods, such as project alliancing, are primarily believed to foster integration practices between diverse organizations involved in delivering construction projects (Lahdenperä 2012, Izam Ibrahim et al. 2013). Such project delivery methods are relatively new, with the most commonly used method is the traditional design-bid-build approach (D'Agostino and Bridgers 2010, RIBA 2012). The latter is characterized by a phased approach in which design and production are separated. By definition, the traditional approach does not entail integrative activities. However, ignoring the level of integration and

collaboration in traditionally procured projects, may deny that in the construction industry many firms may have developed long-term relationships with their major clients (Egemen and Mohamed 2006, Carter et al. 2009). Notwithstanding, according to Dewulf and Kadefors (2012), traditional construction contracts often lead to distrust and conflicts in project teams. Alternatively, integrative activities may give rise to conflicts in project teams that eventually result in poor collaboration (Edmondson and Nembhard 2009).

Thus, there is a need for research that explores the level of integration and collaboration in project-based supply chains in construction. This study does so by addressing the question of whether integrative and collaborative practices can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods can also foster integration and collaboration.

To this end, a multi-dimensional questionnaire was developed based on a theoretical framework of supply chain integration and collaboration. It was validated using construction projects that relied on different project delivery methods, believed by many researchers to foster different levels of integration and collaboration. Below, we will first discuss the results of the exploratory factor analyses used to validate the questionnaire, before comparing outcomes between traditional and collaborative project delivery methods.

2.2 Theoretical framework

There is a lack of a clear definition and understanding of the concept of supply chain integration and collaboration (Burgess et al. 2006, Kache and Seuring 2014). To develop a theoretical framework, we examined extensive literature reviews performed by Eriksson (2015), Kache and Seuring (2014), Leuschner et al. (2013), Vaart and Van Donk (2008), Fabbe-Costes and Jahre (2008) and (Frohlich and Westbrook 2001), comparing their underlying variables (FIG. 2.1).

After reviewing the concepts and underlying variables from each article, a theoretical framework consisting of seven concepts was developed for this study: (1) scope of integration, (2) integration of activities, (3) duration of integration, (4) financial integration, (5) information sharing, (6) inclusive decision-making and (7) collaboration. Below, the seven concepts are further defined, followed by the four project delivery methods used in this study.

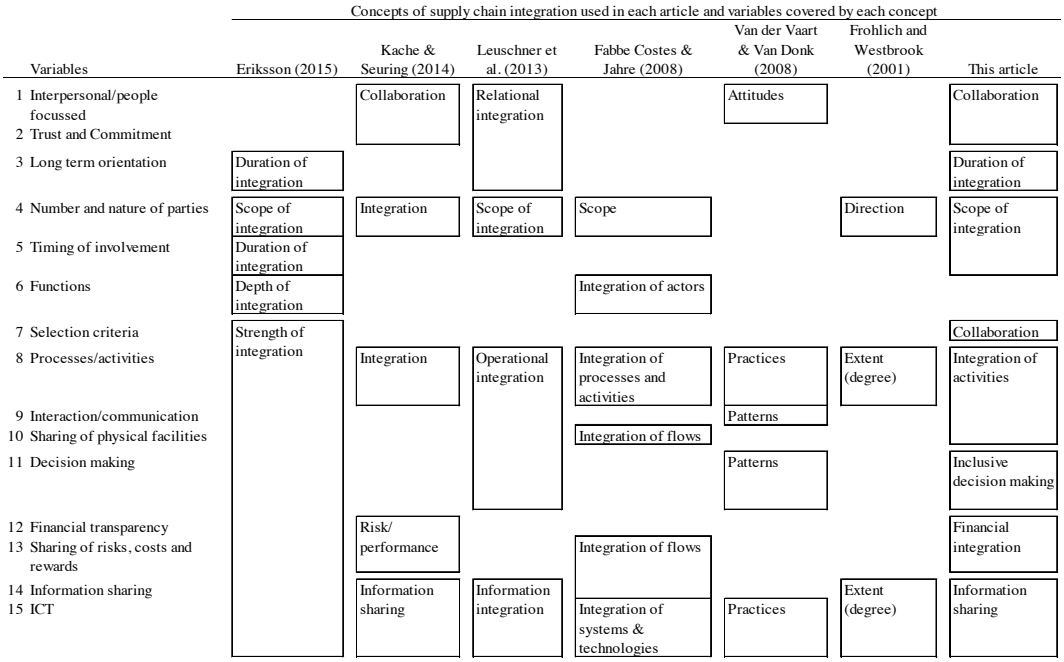

FIG. 2.1 Comparison of studies on supply chain integration based on their concepts and underlying variables

2.2.1 Scope of integration

The scope of integration concerns the "nature and number of organizations or participants included in the integrated supply chain" and the timing of their involvement in the project (Fabbe-Costes and Jahre 2008, Eriksson 2015) (FIG. 2.1). This could include customers (downstream), internal (across) functions, suppliers (upstream), competitors and non-competitors (Frohlich and Westbrook 2001, Barratt 2004). The importance of timing has been pinpointed in many studies, suggesting that key contractors and suppliers should be involved early in the project in order to contribute their knowledge, experience and skill to the design (Eriksson 2015).

TOC

2.2.2 Integration of activities

The integration of activities concerns project-related activities that are undertaken together, and the physical facilities that are shared by the organizations or participants that are part of an integrated supply chain. This concept is referred to by Fabbe Costes and Jahre (2008) as integration of processes and activities and by Van der Vaart and Van Donk as practices (2008) (FIG. 2.1). Eriksson (2015) referred to activities that were performed to build a project team, for example, "team building activities," and the facilities used by the project team, such as "co-location of project team members." Integration of activities should not be confused with tools and techniques for process improvement, such as Six Sigma or Total Quality Management, which are often used to support the integrative effort.

2.2.3 Duration of integration

Duration of integration is adopted from Eriksson (2015) and involves the length of the relationship over a series of projects (FIG. 2.1). Eriksson (2015) calls to explicitly investigate this dimension of supply chain integration in construction. He argues that most studies have focused on manufacturing industries, "in which there is an implicit assumption of long-term relationships". In construction related literature, it is often thought that the discontinuous nature of construction projects makes it difficult or almost impossible to build long term relationships (Briscoe and Dainty 2005, Bygballe et al. 2010). However, some studies have shown that long-term relationships in construction do exist and play a critical role in improving performance (Saad et al. 2002, Meng 2012, Koolwijk et al. 2015, Pellicer et al. 2016). For instance, long-term integration enhances the possibilities for continuous improvements (Bresnen and Marshall 2002).

2.2.4 Financial integration

Financial integration involves the sharing of risks, costs and rewards along the chain, and sharing of sensitive financial information to evaluate the financial performance of the single entities in the supply chain. This concept is referred to by Kache and Seuring (2014) as risk / performance. Fabbe-Costes and Jahre (2008) included this concept as a part of the integration of flows (FIG. 2.1).

Sometimes one firm in the chain has to work less effectively than it could do, to raise the overall efficiency of the whole supply chain (Kache and Seuring 2014). If incentives are not aligned, a firm may optimize its own production instead of the production of the chain. To make supply chain partners look beyond the realm of their company and to improve the performance of the whole chain, incentives therefore need to be aligned – that is, the risks, costs and rewards should be shared across the network on a fair basis (Das and Teng 2001, Mentzer et al. 2001, Narayanan and Raman 2004). The sharing of sensitive financial information, in this respect, is key to being able to define what the sharing of risks and rewards on a fair basis would require (Gunasekaran and Ngai 2007).

2.2.5 Information sharing

Information sharing deals with the sharing of information among the members of the supply chain and the use of information technology to exchange and manage information. Leuschner et al. (2013) referred to this concept as information integration (FIG. 2.1).

Information sharing is an important facilitator of an effective and efficient supply chain as it provides enhanced coordination between partners and gives a better understanding of the needs of the client (Sahin and Robinson 2005, Li and Lin 2006, Leuschner et al. 2013, Kache and Seuring 2014). Information technology (IT) enables firms to rapidly exchange and manage information. IT can make information more accurate and available in a timely way, which can lead to higher performance (Stank et al. 1999). In construction, IT is also seen as important enablers of supply chain integration (Eriksson 2015, Papadonikolaki et al. 2019).

2.2.6 Inclusive decision-making

Inclusive decision-making concerns the level of involvement of top and middle management in the project and joint decision making by the client and suppliers. Inclusive, or involvement in, decision-making is considered by Van der Vaart and Van Donk (2008) to be part of interaction patterns between the focal firm and its suppliers and/or customers (FIG. 2.1).

For supply chain integration to be long-lasting, it requires inclusive decision-making. Key partners need to be involved in decision-making and allowed to voice their

concerns and opinions (Eriksson 2015). Proposals for the integration of activities should be consented to by all partners. Unless there is inclusive decision-making, sub-optimization of the chain may occur (Arshinder et al. 2011).

2.2.7 Collaboration

Collaboration concerns the interpersonal processes and reflects the level of trust and commitment between people, and sense of belonging to a team in the supply chain (Kache and Seuring 2014). Leuschner et al. (2013) considered trust and commitment to be part of relational integration.

Because construction is a project-based industry, collaboration should be considered at the project team level, as inter- and intra-organizational collaboration will change per project and over time (Briscoe and Dainty, 2005). Changes in team composition across projects and over time will affect team learning, because extra-role behaviours, such as speaking up and showing commitment, will be only present if team members trust each other and feel safe (Edmondson and Lei 2014, Savelsbergh et al. 2015). Therefore, collaboration enhances team learning and holds a strong relationship with team performance.

2.2.8 Interdependence between integration and collaboration

Integration is here considered an activity-focused concept. When companies decide to integrate their activities, they accept becoming vulnerable to the actions of other firms. They are willing to do so, as they expect the other firm to be capable of performing a particular action that is important to them, without taking advantage of them (Mayer et al. 1995). Moreover, integration requires the firms involved to invest resources, while the benefits of integration do not always come so easy (Leuschner et al. 2013). Before partners are willing to share sensitive financial information, an environment in which all partners are “allowed to make money” is required, as well as trust that the other partners will not misuse the information that is shared (Eriksson 2015). Integration, thus, requires a long-term vision and commitment of the firms involved (Handfield and Nichols 2002, Kwon and Suh 2004, Kwon and Suh 2005, Eriksson 2015).

Collaboration as a people-focussed concept deals with social relationships, such as trust and commitment (Burgess et al. 2006). From the literature review it appears that collaboration is to be distinguished from integration, but both concepts

are interrelated. Integrative practices constitute the opportunities to develop collaboration, i.e. developing mutual trusting relationship between firms. For partners to get to know each other and build a trusting relationship, the duration of this relationship is important (Zheng et al. 2008, Eriksson 2015). Trust between team members needs to grow with experience (Dwyer et al. 1987). For instance, Maurer (2010) found that project team members who know each other from prior collaborative projects and get involved early in the project have greater opportunities to interact and get to know each other, which lay the ground for mutual trust.

2.2.9 Project delivery methods and the level of integration and collaboration

The four delivery methods examined in this article are: Design-Bid-Build (DBB), Design-Build (DB), Building Team (BT) and Strategic Partnering (SP). Although the underlying characteristics of different project delivery methods may overlap and the boundaries between them can be ambiguous (Mollaoglu-Korkmaz et al. 2013, Franz and Leicht 2016, Pellicer et al. 2016), a description of the essence of each project delivery method will be given separately below.

DBB is a project delivery method in which the owner enters into a contract with an architectural/engineering (A/E) firm that provides design services based on the requirements stipulated by the owner. The A/E deliverables include full plans and specifications for the construction of a project. These documents are subsequently used by the owner as the basis of a separate contract with a constructor. In this approach, the contractor and sub-contractors are not involved in the design phase.

In DB, the owner signs a contract with one entity, a design-builder, often based on functional specifications and a basic design (Molenaar et al. 1999). This approach requires integration and collaboration within the design-build entity (Pellicer et al. 2016).

BT is a Dutch approach in which the owner, contractor, A/E and often key sub-contractors work together to develop the basic design into a final design (Chao-Duivis et al. 2013). The owner selects the partners and signs separate contracts with the A/E, contractors and sub-contractors for the design phase. In addition, a collaboration agreement is signed by all building team members, which states the mutual obligations, such as how to collaborate, task division and decision-making (Chao-Duivis et al. 2013). BT offers greater scope of integration by including key sub-contractors in the early design phase.

SP is a delivery method in which the owner enters into a long-term collaborative multi-party agreement with the main contractor, multiple key sub-contractors and an A/E firm. The partners work together from the early design phase. When the final plan accords with all the pre-set targets, the works are awarded to the partnership. What makes this a “strategic” partnership is that the partners are awarded a follow-up project when they deliver according to pre-set Key Performance Indicators. Other characteristics of SP include decision-making by a board of directors representing all key partners, open book accounting, risk and reward sharing, open communication and joint team-building activities.

To conclude, the preceding literature review demonstrates that collaboration and integration are inter-related concepts, and that supply-chain integration may improve project performance, not only due to the integration of activities but also because of the emerging processes that arise in collaboration. Duration of integration, inclusive decision-making, information sharing and financial integration are considered as practices indicating the extent of integration.

2.3 Method

To address the question of whether integrative and collaborative practices can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods can also foster integration and collaboration, a multi-dimensional questionnaire was developed based on the theoretical framework of supply chain integration and collaboration and applied to projects in the construction industry using different project delivery methods.

2.3.1 Sample

The respondents were project managers, either from a housing association (n = 27) or working for the contractor (n = 19). Respondents were accessed through a collaborative innovation network (CIN) of 18 housing associations considering the adoption of or already engaging in strategic partnering with contractors. In this CIN, housing associations share their knowledge and experiences about strategic partnerships. Their geographical location in the Netherlands is shown in figure 2.2.

Participating organizations were encouraged to contribute projects that were procured through different routes. In all, 46 of the 89 questionnaires were completed, yielding a response rate of 52%.

FIG. 2.2 Geographical locations in the Netherlands of social housing associations that participated in this study

2.3.2 Data collection

Data collection took place over an extended period between September 2012 and May 2015 using an online survey. The aim of the survey was to investigate the level of collaboration and integration in projects procured through different routes. Both the design and construction phases of the survey were assessed (Vrijhoef et al. 2014).

Here, we only report data concerning team collaboration and supply chain integration during the design phase. The construction phase was here discarded as it was argued that only the design phase of traditional DBB project and collaborative project delivery methods are comparable for the purpose of the study. In the construction phase different parties are involved in the traditional DBB projects than there are in the design phase.

2.3.3 Measures

In the first step, we took the seven concepts from our theoretical framework and aimed to establish a valid and reliable conceptualization. We first analyzed the multiple concepts that were related to each level of integration and collaboration to understand their definition. Then, to operationalize each concept, we took the measures from the Supply Chain Monitor (SCMon) and connected them to each concept. The SCMon was developed in 2012 to measure the level of supply chain integration and collaboration. It was developed by a team from TU Delft in close collaboration with an collaborative innovation network of housing associations (Vrijhoef et al. 2014). This resulted in 31 measures clustered under the seven concepts (see TAB 2.1).

The measures that define the level of supply chain integration and collaboration were included in a pilot survey that also included questions about the respondents' individual and organization backgrounds, project and contract information. The face validity of the questions was then discussed and shaped with 14 practitioners (i.e., project managers from clients as well as contractors) in three focus groups, and finally operationalized in an online survey. This online survey was first piloted on six projects. Comments from practitioners who participated in this pilot survey were collected and alterations to the survey were made. Most of the reshaping and altering of the survey had to do with the clarity of questions to the practitioners (i.e., jargon). The Questionnaire S1 is available online in the ASCE library and in the appendixes.

To evaluate "Scope of integration," two questions were asked about the type of partners that were part of the team and the moment these partners became involved in the project. Both variables were combined into an ordinal variable to assess whether the integration of different fields of expertise knowledge was facilitated or not (Eriksson, 2015). Regarding the "Integration of activities," three questions were asked about team-building activities, team "co-location" and whether design development was a task for the whole team. To measure "Duration of integration", five questions were asked about how the projects fit the company vision; how many projects the project partners worked together before; if partners have the intention to work together in the future. "Financial integration" was evaluated by seven questions on the extent to which financial information was shared among the different partners (up and downstream), the sharing of risks and rewards by partners, and the incentives used to encourage the project team to perform better. "Information sharing" was measured by two questions which ask about the use of a digital portal to share files and the actual accessibility of project information to all project team members. To measure "Inclusive decision-

making," seven questions were asked focusing on the level of involvement of top and middle management (representing both the client and the suppliers in the project), the level of joint decision-making and joint goal-setting. Finally, for the measurement of "Collaboration", five questions were used addressing the amount of effort (commitment) partners showed; the sense of belonging among project team members; and the level of participation by project team members in discussions.

TABLE 2.1 Questions used to conceptualize the concepts under study

No.	Concepts and Questions	Items	Scale
Scope of integration		2	
1	What kind of parties are part of the project team?		C
2	When did the parties get involved?		O
	1 and 2 combined: How many parties where part of the project team in the design phase?		O
Integration of activities		3	
3	Did project team members participate in team building activities?		O
4	Does the project team work and meet in the same location?		O
5	To which level did the client prescribe the design?		O
Duration of integration		6	
6	Does the way this project is organized fit with the company vision of the client or partners involved?		O
7	To what extent is this project part of a joint long term strategy to work together?		O
8	How many projects did the project partners work together before this project?		O
9	Do the project partners have the intention or agreement to work together on the next project?		O
10	To what extent is the project team composed out of members that have worked together before?		O

>>>

TABLE 2.1 Questions used to conceptualize the concepts under study

No.	Concepts and Questions	Items	Scale
Financial integration		7	
11	To what extent do suppliers have insight in the project and maintenance budget of the client?		O
12	To what extent does the client have insight in the breakdown of the contract sum (hourly rates, material prices, general costs, …) of the suppliers?		O
13	To what extent do all suppliers have insight in each other's cost breakdown structure?		O
14	To what extent do all suppliers have insight in each other's purchase/cost price?		O
15	What kind of arrangement is used to settle pains and gains?		O
16	When a risk/reward fund is used, what happens with the deficit and surplus at the end of the project?		O
17	What kind of incentives are used to stimulate the project team to perform better?		O
Information sharing		2	
18	Are project files shared and edited on a shared digital portal?		O
19	Can all project information be accessed by all project team members?		O
Inclusive decision making		7	
20	What is the level of involvement of clients' top management in the project?		O
21	What is the level of involvement of clients' middle management in the project?		O
22	What is the level of involvement of partners' top management in the project?		O
23	What is the level of involvement of partners' middle management in the project?		O
24	Are decisions made by the client (one-sided) or by client and suppliers together?		O
25	Are project goals formulated by the client (one-sided) or by client and suppliers together?		O
26	Did the client and project partners formulate joint objectives that go further than a single project?		O
Collaboration		5	
27	Based on which criteria were most partners selected?		O
28	Do you expect that this project team will be kept together on the next project?		O
29	How would you describe the amount of effort team members (commitment) put into the project?		O
30	To what extent do team members feel responsible to speak up and give feedback to each other?		O
31	Is there a sense amongst team members that they are doing this together?		O

2.3.4 Data analyses

SPSS (version 23) was used for the statistical analyses. Explanatory factor analysis was used with varimax and Kaiser normalization rotation to identify the latent structure of the questionnaire. A minimum factor weight of .40 was used for inclusion of questions into a factor, and scree plots and eigenvalues were used to identify distinct variables or dimensions (Field 2009). A value of 0.5 for the Kaiser–Meyer–Olkin (KMO) criterion was used as a threshold for sampling adequacy (Field, 2009). Subsequently, Cronbach's alpha was computed to assess the reliability of the factors identified. The Anderson-Rubin method was used to obtain uncorrelated factor scores (DiStefano et al. 2009) and sum scores were calculated to compare outcomes across different project delivery methods (Field 2009, Starkweather 2012).

Finally, to explore whether project delivery methods could be distinguished by a combination of summed factor scores, multivariate analysis of variance (MANOVA) was performed, examining four different project delivery methods and the level of variance of each factor score for supply chain integration. Here, bootstrapping (2,000 samples) was used to obtain more reliable estimates, because we had a relatively small sample (N = 46) (Field, 2009).

2.4 Results

2.4.1 Descriptive characteristics

Table 2.2 provides the descriptive statistics of the variables. Table 2.3 provides the descriptive statistics of the sum scores per factor. Table 2.4 summarizes the descriptive characteristics of the participants. The majority of the respondents were middle-aged (between 31 and 50) males. Of the participants, 21.7% had secondary vocational training, 56.5% a Bachelor's degree and 21.7% a Master's degree.

TABLE 2.2 Descriptive statistics of ordinal variables

N					
Variable	Valid	Missing	Median	Range	Min-Max
1&2	38	9	6	24	1-25
3	23	24	0	4	0-4
4	44	3	2	3	1-4
5	32	15	3	3	1-4
6	43	4	3	3	1-4
7	43	4	2	3	1-4
8	43	4	2	3	1-4
9	43	4	2	3	1-4
10	33	14	2	3	1-4
11	44	3	2	3	1-4
12	44	3	3	3	1-4
13	44	3	1	3	1-4
14	44	3	1	3	1-4
15	44	3	2	3	1-4
16	23	24	1	8	1-9
17	44	3	1	3	1-4
18	44	3	1	3	1-4
19	44	3	2	3	1-4
20	43	4	1	3	1-4
21	43	4	3	3	1-4
22	43	4	2	3	1-4
23	43	4	3	3	1-4
24	43	4	2	2	1-3
25	44	3	3	3	1-4
26	43	4	1	3	1-4
27	46	1	2	1	1-2
28	38	9	2	3	1-4
29	43	4	3	3	1-4
30	43	4	3	3	1-4
31	43	4	3	3	1-4

95% CI

TABLE 2.3 Descriptive statistics of sum scores per factor

N										
Factor	Valid	Missing	Mean	Median	SD	Range	Minimum	Maximum	Skewness	Kurtosis
Collaboration	47	0	0.00	0.00	0.97	3.75	-1.81	1.94	0.05	-0.66
Financial integration	47	0	0.00	-0.35	0.97	4.08	-1.24	2.84	1.31	1.23
Inclusive decision making	47	0	0.00	0.08	0.97	3.57	-1.68	1.89	-0.09	-0.70
Information sharing	47	0	0.00	-0.15	0.97	4.48	-1.40	3.08	1.31	1.48

TABLE 2.4 Profile of respondents

	Frequency	%
Age		
20-30	5	10.9%
31-40	10	21.7%
41-50	21	45.7%
51-60	10	21.7%
Gender		
Male	41	89.1%
Female	5	10.1%
Education		
Secondary vocational training	10	21.7%
Bachelor degree	26	56.5%
Master degree	10	21.7%
Employment		
Non government (client)	27	58.7%
Private (contractor)	19	41.3%

Table 2.5 describes the characteristics of the projects. There were 7 Design-Bid-Build (DBB), 8 Design & Build (DB), 10 Building Team (BT), and 21 Strategic Partnering (SP) projects. Most projects concerned housing (89.1%), of which 41.3% were new developments, and 58.7% maintenance or renovation works. The number of project partners in the design phase ranged from 1 to 25 (excl. client) (mean = 7.3). The gross floor area (GFA) varied from 45 to 50,000 m^2 (mean = 7,401 m^2). Most projects were not considered complex (59.7%). Low complexity was characterized by the use of proven technology, simple systems, standard designs, previously used configuration or geometry, proven construction methods. Projects using unproven technology, complicated systems, non-standard designs, new configuration or geometry, new construction methods were considered as highly complex projects.

TABLE 2.5 Characteristics of the projects

Characteristics	n	%	median	mean	sd	Lower	Upper
Project delivery method (N=46)							
Design-Bid-Build	7	15.2%					
Design-Build	8	17.4%					
Building Team	10	21.7%					
Strategic Partnering	21	45.7%					
Function of the buildings (N=46)							
Housing	41	89.1%					
Utility	5	10.9%					
Type of construction works (N=46)							
New building	19	41.3%					
Maint./renovation	27	58.7%					
Technical complexity							
Not complex	27	58.7%					
Complex	19	41.3%					
Partners involved in design phase (N=38)							
			6.0	7.3	5.4	5.5	9.06
Gross floor area of the projects (N=36)							
			5062.5	7401.1	9005.6	5354.0	10448.1

There were no significant correlations ($p < 0.05$) found between the technical complexity, the type of construction works, project delivery method and project size, respectively.

2.4.2 Exploratory factor analysis (EFA) of collaboration/integration in project-based supply chain teams

The 31 questions from table 2.1 were analyzed using explanatory factor analyses (EFA). EFA identified 4 latent factors that together explained 65.3% of the variance. Table 2.6 shows the final factor structure, consisting of four factors, all with eigenvalues of one or higher. From the 31 variables, 12 questions were dropped because of collinearity, low-loading or cross loading (Osborne et al. 2008, Field 2009). The Kaiser–Meyer–Olkin (KMO; 0.63) measure verified the sampling adequacy of the analysis, and all KMO values for individual items were above the threshold of 0.5 (Field, 2009).

TABLE 2.6 Factor loadings, explained variance and Cronbach alpha's for each of the four identified components (relational integration, financial integration, inclusive decision making and information sharing)

No.	Description	Identified components and factor loadings[a]			
		Collaboration	Financial integration	Inclusive decision making	Information sharing
1	What kind of parties are part of the project team?				
2	When did the parties get involved?				
1 and 2 combined	*How many parties where part of the project team in the design phase?*				
3	Did project team members participate in team building activities?				
4	Does the project team work and meet in the same location?				
5	To which level did the client prescribe the design?				
6	Does the way this project is organized fit with the company vision of the client or partners involved?	0.67			
7	To what extent is this project part of a joint long term strategy to work together?	0.64			
8	How many projects did the project partners work together before this project?	0.69			
9	Do the project partners have the intention or agreement to work together on the next project?				
10	To what extent is the project team composed out of members that have worked together before?				
11	To what extent do suppliers have insight in the project and maintenance budget of the client?				
12	To what extent does the client have insight in the breakdown of the contract sum (hourly rates, material prices, general costs, …) of the suppliers?				
13	To what extent do all suppliers have insight in each other's cost breakdown structure?		0.82		
14	To what extent do all suppliers have insight in each other's purchase/ cost price?		0.85		
15	What kind of arrangement is used to settle pains and gains?		0.72		
16	When a risk/reward fund is used, what happens with the deficit and surplus at the end of the project?		0.67		
17	What kind of incentives are used to stimulate the project team to perform better?				0.70
18	Are project files shared and edited on a shared digital portal?				0.92
19	Can all project information be accessed by all project team members?				0.73
20	What is the level of involvement of clients' top management in the project?			0.69	

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TABLE 2.6 Factor loadings, explained variance and Cronbach alpha's for each of the four identified components (relational integration, financial integration, inclusive decision making and information sharing)

No.	Description	Identified components and factor loadings[a]			
		Collaboration	Financial integration	Inclusive decision making	Information sharing
21	What is the level of involvement of clients' middle management in the project?				
22	What is the level of involvement of partners' top management in the project?			0.81	
23	What is the level of involvement of partners' middle management in the project?			0.71	
24	Are decisions made by the client (one-sided) or by client and suppliers together?				
25	Are project goals formulated by the client (one-sided) or by client and suppliers together?				
26	Did the client and project partners formulate joint objectives that go further than a single project?			0.68	
27	Based on which criteria were most partners selected?				
28	Do you expect that this project team will be kept together on the next project?				
29	How would you describe the amount of effort team members (commitment) put into the project?	0.75			
30	To what extent do team members feel responsible to speak up and give feedback to each other?				
31	Is there a sense amongst team members that they are doing this together?	0.80			
Explained variance after extraction and varimax rotation		18.00%	17.22%	16.03%	14.05%
Cronbach Alpha of each factor		0.76	0.80	0.77	0.71

[a] *< .40 is surpressed*

Table 2.6 shows the factor loadings after rotation. The four factors can be considered as reliable scales, with Cronbach's alpha reliability coefficients between 0.70 and 0.80 (DeVellis 2016). Item rest correlations were all between 0.45 and 0.79.

Component 1 can be characterized as *collaboration* as it deals with person-focused elements , i.e. long-term orientation, having previous working relations and cohesion between partners, and by the joint effort team members put into the project. Component 2 seem to reflect *financial integration.* The questions that make up this factor address the extent to which team members share project-related risks and opportunities with each other and whether or not they share financial information. The third component was labelled *inclusive decision-making* and concerns the level of involvement of top and middle management within the project, as well as whether joint objectives go beyond one project. The fourth component was interpreted as *information sharing* and reflects the level of information sharing within a project team: how team members are stimulated to share their knowledge by means of incentives and the use of supporting technology among firms in a project. The four components of integration in project-based supply chains in construction are shown in figure 2.3.

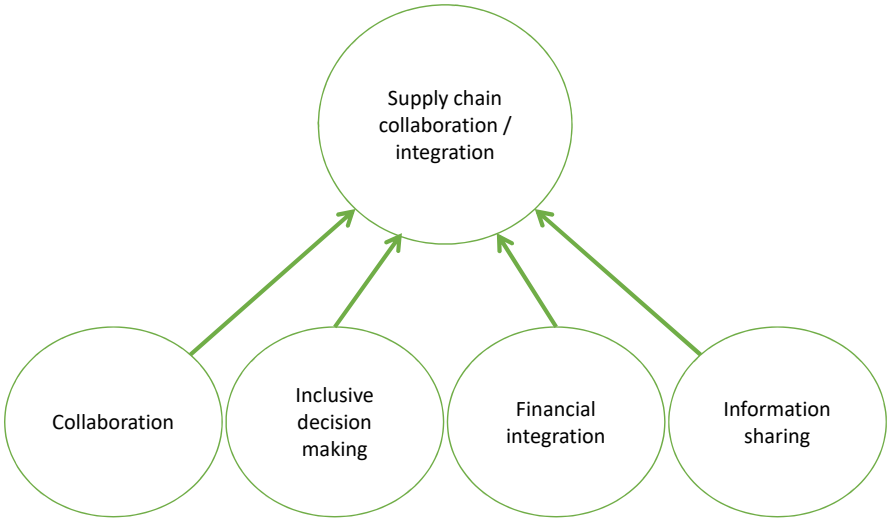

FIG. 2.3 The four components of collaboration/integration in project based supply chains in the construction industry

Remarkably, several questions about integrative activities, such as team-building activities and working and meeting at the same location, did not combine into a distinct dimension. These questions were dropped due to cross-loading or low-loading.

TOC

2.4.3 Collaboration/integration across different project delivery methods

To investigate whether integrative and collaborative practices can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods might also foster integration, sum scores of the uncorrelated factor scores were used to compare outcomes across different project delivery methods. The multivariate test showed that there was a statistically significant difference in level of integration according to the project delivery method used (F (4, 12) = 2.21, p < .05; Wilk's Λ = .016). The level of integration was significantly dependent on the type of project delivery method. Only inclusive decision-making (p = .02; TABLE 2.7) differed between project delivery methods.

TABLE 2.7 Influence of project delivery method on relational, and financial integration, coordinated decisionmaking, and information sharing

			95% CI for mean						
Factor	Project delivery method	n	Mean	sd	Lower	Upper	df	F	Sig.
Collaboration	Design-Bid-Build	7	-.67	.36	-1.00	-.34	3.00	.97	.42
	Design-Build	8	.43	1.07	-.46	1.32			
	Building Team	10	-.40	.49	-.75	-.05			
	Strategic Partnering	21	.25	1.11	-.26	.75			
	Total	46	.00	.98	-.29	.29			
Financial integration	Design-Bid-Build	7	-.20	.96	-1.08	.69	3.00	2.47	.08
	Design-Build	8	-.25	1.13	-1.19	.69			
	Building Team	10	-.26	1.18	-1.11	.59			
	Strategic Partnering	21	.28	.80	-.08	.65			
	Total	46	.00	.98	-.29	.29			
Inclusive decision making	Design-Bid-Build	7	-.27	1.01	-1.20	.67	3.00	3.61	**.02**
	Design-Build	8	-.24	.97	-1.06	.57			
	Building Team	10	-.33	.97	-1.02	.36			
	Strategic Partnering	21	.34	.93	-.09	.76			
	Total	46	.00	.98	-.29	.29			
Information sharing	Design-Bid-Build	7	.11	1.12	-.93	1.14	3.00	1.22	.31
	Design-Build	8	-.49	.60	-.99	.02			
	Building Team	10	-.23	.63	-.68	.22			
	Strategic Partnering	21	.26	1.13	-.26	.77			
	Total	46	.00	.98	-.29	.29			

Post-hoc, pairwise comparisons showed the level of inclusive decision-making to be different only between Building Team and Strategic Partnering ($p < 0.01$; TABLE 2.8). This means there is a difference in the level of involvement of top management (board level) on both the client and partner sides, as well as a difference in the joint formulation of long-term goals (that go further than one project).

TABLE 2.8 Pairwise comparison between project deliver methods for each component

						95% CI for Difference[b]	
Dependent Variable	(I) Type of project delivery method	(J) Type of project delivery method	Mean dif. (I-J)	Std. Error	Sig.[b]	Lower	Upper
Collaboration	Design-Bid-Build	Design-Build	0.04	0.51	0.93	-0.98	1.07
		Building Team	0.05	0.48	0.93	-0.93	1.02
		Strategic Partnering	-0.46	0.43	0.29	-1.32	0.40
	Design-Build	Design-Bid-Build	-0.04	0.51	0.93	-1.07	0.98
		Building Team	0.00	0.46	1.00	-0.93	0.94
		Strategic Partnering	-0.50	0.41	0.22	-1.32	0.32
	Building Team	Design-Bid-Build	-0.05	0.48	0.93	-1.02	0.93
		Design-Build	0.00	0.46	1.00	-0.94	0.93
		Strategic Partnering	-0.51	0.38	0.19	-1.26	0.25
	Strategic Partnering	Design-Bid-Build	0.46	0.43	0.29	-0.40	1.32
		Design-Build	0.50	0.41	0.22	-0.32	1.32
		Building Team	0.51	0.38	0.19	-0.25	1.26
Financial Integration	Design-Bid-Build	Design-Build	-1,042*	0.48	0.04	-2.02	-0.07
		Building Team	-0.26	0.46	0.58	-1.18	0.67
		Strategic Partnering	-,839*	0.41	0.05	-1.66	-0.02
	Design-Build	Design-Bid-Build	1,042*	0.48	0.04	0.07	2.02
		Building Team	0.79	0.44	0.08	-0.11	1.68
		Strategic Partnering	0.20	0.39	0.60	-0.58	0.99
	Building Team	Design-Bid-Build	0.26	0.46	0.58	-0.67	1.18
		Design-Build	-0.79	0.44	0.08	-1.68	0.11
		Strategic Partnering	-0.58	0.36	0.11	-1.31	0.14
	Strategic Partnering	Design-Bid-Build	,839*	0.41	0.05	0.02	1.66
		Design-Build	-0.20	0.39	0.60	-0.99	0.58
		Building Team	0.58	0.36	0.11	-0.14	1.31

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TABLE 2.8 Pairwise comparison between project deliver methods for each component

					95% CI for Difference[b]		
Dependent Variable	(I) Type of project delivery method	(J) Type of project delivery method	Mean dif. (I-J)	Std. Error	Sig.[b]	Lower	Upper
Inclusive decision making	Design-Bid-Build	Design-Build	-0.13	0.47	0.78	-1.07	0.81
		Building Team	0.31	0.44	0.48	-0.58	1.21
		Strategic Partnering	-0.75	0.39	0.06	-1.54	0.05
	Design-Build	Design-Bid-Build	0.13	0.47	0.78	-0.81	1.07
		Building Team	0.45	0.43	0.30	-0.42	1.31
		Strategic Partnering	-0.61	0.37	0.11	-1.37	0.14
	Building Team	Design-Bid-Build	-0.31	0.44	0.48	-1.21	0.58
		Design-Build	-0.45	0.43	0.30	-1.31	0.42
		Strategic Partnering	-1,060*	0.35	**0.00**	-1.76	-0.36
	Strategic Partnering	Design-Bid-Build	0.75	0.39	0.06	-0.05	1.54
		Design-Build	0.61	0.37	0.11	-0.14	1.37
		Building Team	1,060*	0.35	**0.00**	0.36	1.76
Information sharing	Design-Bid-Build	Design-Build	0.54	0.50	0.29	-0.47	1.55
		Building Team	0.27	0.48	0.58	-0.70	1.23
		Strategic Partnering	-0.17	0.42	0.68	-1.03	0.68
	Design-Build	Design-Bid-Build	-0.54	0.50	0.29	-1.55	0.47
		Building Team	-0.27	0.46	0.55	-1.20	0.65
		Strategic Partnering	-0.72	0.40	0.08	-1.53	0.10
	Building Team	Design-Bid-Build	-0.27	0.48	0.58	-1.23	0.70
		Design-Build	0.27	0.46	0.55	-0.65	1.20
		Strategic Partnering	-0.44	0.37	0.24	-1.19	0.31
	Strategic Partnering	Design-Bid-Build	0.17	0.42	0.68	-0.68	1.03
		Design-Build	0.72	0.40	0.08	-0.10	1.53
		Building Team	0.44	0.37	0.24	-0.31	1.19

Based on estimated marginal means

**The mean difference is significant at the ,05 level.*

[b]*Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).*

2.5 Conclusion and discussion

The aim of this study was to investigate whether integrative and collaborative practices can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods might also foster integration. The main finding of the study was that, in the construction industry, collaboration is an independent component in integrative practices, which can be reliably (Cronbach's alpha = 0.76) assessed in research. Therefore, and contrary to what was suggested by Eriksson (2015) and Van der Vaart and Van Donk (2008), collaboration should not be overlooked when attempting to understand project-based supply chains. This is important, as others showed that collaboration significantly influences firm or project performance through the development of trust, commitment and long-term orientation (Chen et al. 2004, Hult et al. 2004, Dyer and Hatch 2006, Leuschner et al. 2013). This finding is also supported by Pellicer et al. (2016), who found that procuring teams with previous working relationships increased the likelihood of project success.

The second main finding of this study concerns suggestive evidence that both traditional and integrated project delivery methods might lead to collaboration over time. This is an important finding, since the dominant approach in the construction industry is that relationships are determined by legal boundaries (Meng 2012, Jelodar et al. 2015). This might indeed explain why collaboration as a concept was discarded by Erikson (2015) and Van der Vaart and Van Donk (2008), or why the influence of collaboration and integration on design quality (Arge 1995, Prins and Kruijne 2011, Owen et al. 2015) has been only studied by comparing traditionally procured projects with integrative project delivery methods.

The current study suggests that both traditional and integrated project delivery methods can lead and contribute to collaboration in the long-term. It may well be that irrespective of project delivery methods – thus also in traditionally procured construction industry projects – collaboration has developed over time, across a series of traditionally procured projects. This might be the case because in the construction industry many firms may have long-term relationships with their major clients (Egemen and Mohamed 2006, Carter et al. 2009) and therefore may also have developed long-term relationship with other firms that, in turn, hold similar long-term relationships with the same clients. It might also be the case that suppliers, for example, a contractor and several sub-contractors, have developed long-term relationships because they operate together in a particular part of the construction market. In addition, the strong emphasis on type of project

delivery method, while ignoring the actual level of collaboration, might well explain the inconsistent results that were reported by studies investigating whether or not project-based supply chains in the construction industry improved project performance relative to traditionally procured projects (Ibbs et al. 2003, Hale et al. 2009, Raisbeck et al. 2010, Chen et al. 2015, Tran et al. 2016).

The third finding is that different project delivery methods are not significantly different in terms of the dimensions of integration and collaboration (except for inclusive decision making between Building Team and Strategic Partnering). This is apparent in the large variance found in each factor between project delivery methods. However, this finding needs further research because we used convenience sampling and obtained rather low numbers per project delivery method, even though we used bootstrapping to address the problem of low numbers per project delivery method. Based on table 2.7, it could be argued that Strategic Partnering shows higher levels of collaboration, inclusive decision-making and information sharing, while Design-Build shows the highest levels of financial integration.

Finally, the outcomes of this study demonstrate that the dimensions that were identified to conceptualize collaborative and integrative practices in the construction industry can best be compared to those suggested by Kache and Seuring (2014) and Leuschner et al. (2013). Like Kache and Seuring (2014) and Leuschner et al. (2013), this study found that collaboration is an independent and important dimension of integration of activities. Collaboration in the construction industry context seems to represent the level of trust, commitment and long-term orientation between supply chain partners on both strategic and operational levels. This raises the question whether a high level of collaboration on a team level is possible without the commitment and long-term focus of strategic management. Walker and Hampson (2002) showed that the level of cooperation within project teams in long-term partnering increases over time. Bowersox et al. (2003) concluded that top management support is necessary to enable collaborative processes between supply chain partners.

Here, inclusive decision-making and information sharing were identified as independent dimensions, while both were included by Leuschner et al. (2013) in their dimension of operational integration, describing joint activities, work processes and coordinated decision-making among firms in the supply chain. Particularly in the construction industry, a project requires integrative practices of many different technical and non-technical fields. Due to a high degree of vertical specialization in the construction industry, knowledge is typically spread across the whole supply chain (Cacciatori and Jacobides 2005). Because construction is inherently a site-specific, project-based activity (Shirazi et al. 1996, Cox and Thompson 1997), the

interactions between professionals mainly take place within a temporary organization (Baiden et al. 2006). This project organization can be structured in many different ways (Baiden et al. 2006) and with varying degrees of operational integration among firms, and may complicate decision-making and information sharing. The latter component has been identified in many other studies (Kulp et al. 2004, Saeed et al. 2005, Ireland and Webb 2007, van der Vaart and van Donk 2008).

Financial integration constitutes the final dimension of collaboration/integration in construction industry projects, and is independent of inclusive decision-making and information sharing. This factor has been previously described by Saeed et al. (2005) as the extent to which supply chain members jointly invest in projects of mutual interest. Here, however, financial integration concerned the extent to which supply chain members share project-related risks and profits, and to what degree sensitive financial information was shared. Although there seem to be elements of information sharing present, financial integration seems to be an independent dimension of collaboration and integration in project-based supply chains. This may be so because of the temporary nature of many projects in the construction industry. Since most studies of collaboration/integration that were included in the work of Leuschner et al. (2013) were performed in the manufacturing industry or logistics, and involved different types of supply chains, it might well be that the project delivery methods were also different, giving rise to financial integration as an independent factor.

Limitations

An important limitation of this study is that convenience sampling was used. To reduce the possibility of misinterpretation, the sample and project conditions were precisely described. Furthermore, we did not find any differences between project delivery methods that could influence the outcomes of our study. Another limitation that results from the sampling approach is that a large share of the projects were procured by social housing associations. In the Netherlands, these associations are private organizations. Therefore, they do not have to comply with EU procurement laws for fair tendering, which might have a positive influence on the development of long-term relationships between partners.

Future research

One of the acknowledged limitations of this study is that a large share of the projects were procured by social housing associations. These organizations do not have to comply with Public laws for fair tendering. Public laws for fair tendering are often seen as a barrier to developing long-term relationships between public clients and private companies. However, public clients can build long-term relationships by tendering repetitive works under a framework agreement. Furthermore, there are many sub-markets of the construction industry in which only a few construction firms provide their services to public clients, such as the Dutch railway industry. In this sub-market, comprising some EUR 11 billion per annum, only one public client and ten general contractors are active (ProRail 2017). Under these market conditions, long-term relationships can develop through repetitive works, irrespective of the project delivery methods used, or any restrictions imposed by legislation. In the future, we aim to obtain a random sample to determine whether collaboration also plays an important role in other sub-markets of the construction industry; for instance, in sub-markets where public laws for fair tendering apply.

Another topic of further research concerns deepening our understanding of collaboration. Collaboration consists of both firm and team-level variables. This raises the question, for instance, of whether having a long-term orientation or previous working relations on a firm level leads to a greater effort by project team members in the project.

Managerial implications

The findings demonstrate that merely relying on the type of project delivery method for comparison is not sufficient for managers to communicate about the level of supply chain integration and collaboration. Managers should look deeper into the way the project has been organized and the resources used. The four dimensions of supply chain integration and collaboration in this project can be used for that purpose.

Our findings inform managers that collaboration is an independent and important dimension of collaboration/integration. Owners who require construction at a more regular basis, should be more aware of the relation they could develop with their suppliers, irrespective of the project delivery method they use, and use this relation as a leverage in their projects. Owners who build occasionally, unfortunately, are not able to give a long-term perspective to their suppliers. However, these owners could look, in a procurement process, for an integrated supply chain that shows high levels of collaboration to delivery their project.

Supplemental Data

The Questionnaire S1 is available online in the ASCE Library (ascelibrary.org) and in the appendixes. Data analyzed during the study are available from the corresponding author by request.

3 No blame culture and the effectiveness of project-based design teams in the construction industry

the mediating role of teamwork

Koolwijk, J. S. J., van Oel, C. J., & Gaviria Moreno, J. C. (2020). No-Blame Culture and the Effectiveness of Project-Based Design Teams in the Construction Industry: The Mediating Role of Teamwork. *Journal of Management in Engineering*, *36*(4). DOI: 10.1061/(ASCE)ME.1943-5479.0000796
Preceding conference paper received a best paper award for the theme Collaboration at the *Project management congress 'Adapt or Die'*, Project Management Institute 2019, Delft, The Netherlands

ABSTRACT This study investigates how a no-blame culture affects the effectiveness of project based design teams across different project delivery methods in the construction industry. Ninety-two team members of 34 project-based design teams assessed the no-blame culture, level of teamwork, and team effectiveness in teams that were procured through different routes. A multilevel analysis shows that the relation between integrated project delivery methods, such as Design-build and Strategic

partnering, and team effectiveness varies across levels of no-blame culture. A mediated regression analysis found that the effect of no-blame culture on team effectiveness is mediated by teamwork. Managers of project-based design teams in the construction industry should, therefore, invest both time and effort in creating a no-blame culture and the level of teamwork in parallel. This will enhance the level of team effectiveness in integrated project delivery methods.

KEYWORDS no-blame culture, teamwork, team effectiveness, project-based design teams, construction industry

3.1 Introduction

Over the past decades, construction clients have increasingly searched for more collaborative and integrated ways of working in the supply chain to accomplish construction projects (Suprapto et al. 2015, Walker and Lloyd-Walker 2015, Chini et al. 2018, Koolwijk et al. 2018). Integrated working arrangements, such as Design-build and Strategic partnering, intend to bring together key participants of the supply chain, such as designers and constructors, early in the project (Baiden and Price 2011, Eriksson 2015). However, bringing people with various backgrounds together does not ensure they will effectively collaborate and make appropriate decisions based on their joint knowledge (Baiden and Price 2011).

For instance, in construction industry projects, team members from various organizations need to collaborate. That is, experts with different backgrounds – such as electrical engineering, sustainable design and architecture – have to closely collaborate and coordinate their actions across disciplinary and organizational boundaries to accomplish shared goals (Fong and Lung 2007). Together, project team members have to manage complex problems, solve difficult design issues, and deal with last-minute design changes (Savelsbergh et al. 2015, Hamzeh et al. 2018). Before a team can take effective actions, its members need to reach a common understanding of the issue at hand and how it can be solved (Barron 2000). To develop a joint understanding, team members must openly discuss their ideas, challenges others' assumptions, share information, and integrate their diverse knowledge and viewpoints (Allen et al. 2005, Edmondson and Lei 2014, Manata et al. 2018).

The way project team members collaborate and share knowledge is influenced by a team's environment (Uhl-Bien et al. 2007, Edmondson and Lei 2014, Li et al. 2019). An environment in which people feel safe to speak their minds, ask each other questions, learn from their own and other' mistakes, and openly share information is crucial to unleash the knowledge that resides within team members (Edmondson and Lei 2014, Lloyd-walker et al. 2014). In the context of construction project organizations, such an environment is often characterized as an environment with a no-blame culture (e.g., Baiden et al. 2006, Lloyd-walker et al. 2014). A no-blame culture is defined by Lloyd-walker et al. (2014, p. 233) as "one in which individuals do not fear repercussion from risk-taking or problem identification, where employees feel free to contribute to discussions and raise issues".

A no-blame culture is believed to be a critical success factor for integrated working arrangements in the construction industry (Yeung et al. 2009, Lahdenpera 2010). However, there is a lack of studies that investigate how a no-blame culture relates to team effectiveness in integrated working arrangements in the construction industry. Most studies on the role of a no-blame culture are based on case studies done on specific project delivery methods, such as project alliancing (e.g. Lloyd-walker et al. 2014). Other fields found evidence that a no blame culture influences team effectiveness (Mathieu et al. 2008, Edmondson and Lei 2014). However, supply chains in the construction industry are different from many other supply chains, because of its fragmented nature (Eriksson 2015).

Also, research that uses project delivery methods as a proxy for collaboration reported inconsistent results in regard of project performance (e.g. Hale et al. 2009, Chen et al. 2015, Tran et al. 2016). Integrated project delivery methods, such as project alliancing, often set policies and procedures that are thought to support a no-blame culture (e.g. Lloyd-walker et al. 2014). However, project team members often encounter situations where the adoption of relational arrangements have opposite effects (Rose and Manley 2010, Chan et al. 2012). Therefore, emphasizing the type of project deliver method, while ignoring the actual level of collaboration, might explain the inconsistent results (Koolwijk et al. 2018). Indeed, other 'less relational' integrated working arrangements (Jobidon et al. 2019), such as Design-build, may also benefit from a no-blame culture. Therefore, irrespective of the integrated project delivery method used, integrated project teams may require an environment of a no-blame culture to become effective. This raises the question whether the relation between integrated project delivery methods and the effectiveness of project teams varies across levels of no-blame culture.

A no-blame culture is promoted as an important condition for teamwork that in turn will lead to higher project team effectiveness (Lloyd-walker et al. 2014). This would mean that the level of team effectiveness is indirectly, via teamwork, positively influenced by the no-blame culture. To date, there is a lack of studies investigating this mediational pathway for project teams in construction industry. Therefore, the researchers developed and tested the hypothesis that teamwork acts as a mediator between a no-blame culture and the effectiveness of project teams in construction industry. Understanding the mechanisms underlying team effectiveness, can help managers to enhance effectiveness.

The paper is structured as follows. First, the main concepts will be presented and a set of hypotheses will be developed. Then the research approach is described . Followed by the results and conclusions. Finally, the limitations and managerial implications will be discussed.

3.2 Theory and hypotheses

A no-blame culture can be described as an emergent state that stems or emerges from collaboration in a team. It influences the effectiveness of a team. A no-blame culture is an important condition for cross-functional design teams to become effective in integrative project delivery methods used in the construction industry (FIG. 3.1).

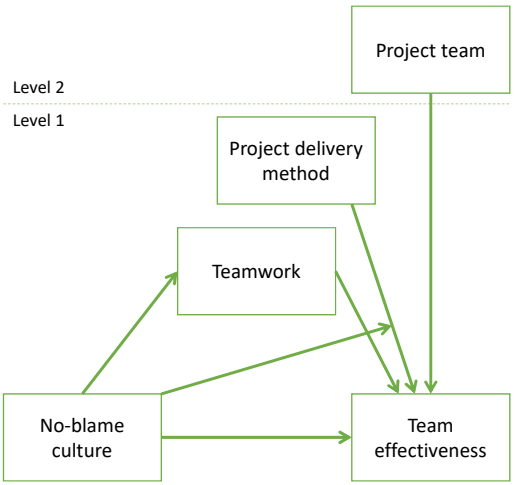

FIG. 3.1 Teamwork as a mediator between no blame culture and team effectiveness and no blame culture as an important condition for teams to become effective in integrated project delivery methods

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3.2.1 Project-based cross-functional design teams

In construction industry, teams are typically project-based cross-functional design teams (PBCFDT). A PBCFDT is made up of highly specialized professionals from different functional areas, such as architecture and structural engineering, who are brought together to make the design of, for instance, a museum or petrochemical installation. The team members are often employed by various organizations, such as design, engineering, or contracting firms, and collaborate for the duration of the project (Salas et al. 2000, Briscoe and Dainty 2005). Each member brings a different type of expertise to the team, enabling the timely integration of their information into the design (Ancona and Caldwell 1992, Edmondson and Nembhard 2009). The level of reciprocal interdependence between the team members is high, which means that to get the work done, team members need to closely collaborate to accomplish the task (Tesluk et al. 1997, Buvik and Rolfsen 2015). To work closely together implies that team members need to cooperate, coordinate their actions, and continuously exchange information to end up with a design that integrates the knowledge of all involved disciplines (Shen et al. 2018). Team collaboration, however, is not an easy task for a PBCFDT, as members need to deal with diversity and to engage in cross-boundary working (Shen et al. 2018).

3.2.2 Cross-functional Design teams in various project delivery methods

Projects can be delivered through various project delivery methods, such as Design-Bid-Build and Strategic partnering (Koolwijk et al. 2018). Each delivery method establishes different relationships among the members of the PBCFDT (Laurent and Leicht 2019).

The 'traditional' Design-Bid-Build (DBB) method is known for its phased approach where the owner has individual contracts with involved architectural/engineering (A/E) firms providing the design services. The team members of the different A/E firms deliver full plans and specifications for the construction project. These documents are subsequently used by the owner as a basis for a separate contract with a constructor. In this approach, the contractor and subcontractors are not involved in the design phase. Because the participants in the DBB method have separate contracts, they are believed to focus mainly on their organization's interests (Pesek et al. 2019). Therefore, when a problem arises, parties would not look for a solution, but try to put the blame on each-other (Baiden et al. 2006). This would foster a transactional mentality amongst the team members and acts as a barrier,

and thus hindering close collaboration, and impeding the development of trust, and integration of activities (Baiden and Price 2011).

In the Design-Build (DB), and also in Engineer-Procure-Construct (EPC) approach, the owner signs a contract with one entity (Shen et al. 2018), a design builder, often according to functional specifications and a basic design provided earlier by an A/E firm (Molenaar et al. 1999). The design builder brings together the design and construction specialists from different firms in a joint cross-functional design team. This team needs to closely collaborate and align their activities (Jobidon et al. 2019). DB is not considered a relational type contract, because the formal arrangement between the client and the design builder are not aimed at the alignment of project objectives and business goals and are not directed at creating a more collaborative atmosphere (Harper and Molenaar 2014, Jobidon et al. 2019). However, this formal arrangement does only structure the relationship between the owner and the design builder. Within the DB project organization, team members need to closely collaborate to develop the design. It may well be that the effectiveness of this DB-team is affected by the level of no-blame culture. DB can be extended with maintenance (DBM). In this case, also maintenance specialist are brought into the design team to add their knowledge about maintenance to the design. In this article DB, EPC and DBM are combined into one category DB(M).

Building Team (BT) is a Dutch approach in which the owner, contractor, A/E firms, and often key subcontractors together develop the basic design into a final design (Chao-Duivis et al. 2013). The owner selects the firms and signs separate 'traditional' contracts with them. In addition, an over-arching project partnering agreement is signed by all members of the building team. This agreement states mutual obligations, such as how to collaborate, task division, and joint decision making (Chao-Duivis et al. 2013). The project partnering agreement embeds core partnering principles of equity, respect and no-blame culture into the agreement, and therefore 'pushes' a transactional relationship towards a more relational relationship (Bennett and Jayes 1998).

Strategic Partnering (SP) is a delivery method in which the owner enters into a long-term multi-partner agreement with a contractor, key sub-contractors and one or more A/E firms (Koolwijk et al. 2018). The partners collaborate from the early design phase onwards. What makes this a *strategic* partnership is that partners are awarded a follow-up project when they deliver the project according to pre-specified targets. The partners form a joint project board and joint project team. The latter is responsible for the daily management of the design and construction activities. Other collaborative characteristics of SP include inclusive decision making, open book accounting, risk-reward sharing, open communication and joint team building

activities (Koolwijk et al. 2018). These characteristics should drive a no-blame culture, which in turn should foster teamwork and innovation (Walker and Lloyd-Walker 2015).

3.2.3 No blame 'culture'

Culture is the social context in an organization, and is embedded in the "values, beliefs, and assumptions held by organizational members" (Denison 1996, p. 624). A culture is deeply rooted in the systems of an organization, and is relatively stable and difficult to manipulate once established (Ostroff et al. 2013). Climate is what people 'see' happening to them when they are working in an organization. It is the employees' perception of what is going on between people, and often referred to as the 'atmosphere' on the work floor (Mathieu et al. 2008). Culture and climate are related, in that one cannot create a climate in which people feel safe to speak up, if the culture approves people not showing vulnerable (Quelhas et al. 2019). Therefore, deeper layers of no blame culture can be viewed through the eyes of employees who have to work in an organizational climate (Ostroff et al. 2013). Importantly, at the team-level climate is known to affect behaviors (Mathieu et al. 2008).

However, a climate is not stable (Ostroff et al. 2013). It is a shared cognition that is shaped through interaction and can be manipulated by actors (Denison 1996). It is therefore called an emergent phenomenon; "A phenomenon is emergent when it originates in the cognition, affect behaviors, or other characteristics of individuals, is amplified by their interactions, and manifests as a higher-level collective phenomenon" (Kozlowski and Klein 2000, p. 55).

Since the definition of a no-blame 'culture' emphasis how organizational members perceive the social environment and how this environment has impact on their feelings and behavior (Lloyd-walker et al. 2014), a no-blame 'culture' should be understood as construct that defines a specific dimension of the climate within a project organization or team.

3.2.4 Team effectiveness and no blame culture

Team effectiveness can be conceptualized in many different ways (Mathieu et al. 2008). Here, we consider team effectiveness as a blended concept that consists of team members' behaviors that is needed to achieve a desired result; the quality

and timeliness of their intermediate outputs; and team members' satisfaction with the general performance of the team (Hackman et al. 2000, Salas et al. 2004, Van den Bossche, Gijselaers et al. 2006, Mathieu et al. 2008). Furthermore, to measure the effectiveness of a team, the measures should be linked to the teams' context (Andersson et al. 2017). To understand what relevant behaviors and outputs of PBCFDT are, these behaviors are briefly described.

PBCFDT members are interdependent (Bankvall et al. 2010). To timely achieve the project goals, team members need to plan and deliver their mutual commitments within the time permitted. Furthermore, team members need to deliver high-quality design products, such as drawings and calculations, and rely on each other's work. Construction projects are characterized by high levels of complexity (Bosch-Rekveldt 2011). Team members often encounter many different problems and changes, which they have to effectively handle to finalize the project at large (Hamzeh et al. 2018).

Ideally, when there is a no-blame culture, team members do not try to put the blame on each other, and instead analyze the underlying problem to find a solution (Walker and Lloyd-Walker 2014, Walker and Lloyd-Walker 2015). A no-blame culture enables teams to learn, and therefore a team becomes more effective (Huang et al. 2008, Lacerenza et al. 2018). Therefore, a no-blame culture is here considered an important condition for team effectiveness. The following hypothesis describes the relation between a no-blame culture within a team and the team's effectiveness.

H1: A no-blame culture has a positive influence on team effectiveness

3.2.5 Teamwork and no blame culture

Teamwork is a multidimensional construct that explains how team inputs are transformed into outcomes (Mathieu et al. 2008). Teamwork consists of behaviors, cognitions and feelings of team members who interact with each-other to achieve desired mutual goals (Salas et al. 2004). After Mathieu and Salas, we here define teamwork as (1) a set of behaviors that consist of *collaboration, communication, joint decision making* and *mutual support*, (2) the shared cognition among team members about how to *coordinate* the efforts of the team , and (3) the *feelings* team members have about each other and each other's work, which consists of the level of *trust* team members have in the work of other team members and the level of *respect* they have for the other team members. The constructs are further defined as follows:

- *Collaboration* is the overarching notion of teamwork capturing how well team members work together towards a common goal (Daugherty et al. 2006).

- *Communication* is the extent to which team members effectively and timely inform each other (Hoegl and Gemuenden 2001, Baiden et al. 2006, Salas et al. 2015, Suprapto et al. 2015).

- *Mutual support* describes to what extent team members assist each other in performing their tasks. Through assistance, team members provide resources and task-related effort to each other, for instance when there is an uneven distribution of workload in their team (Hoegl and Gemuenden 2001, Salas et al. 2005).

- *Joint decision-making* gives team members equal opportunities to contribute to a project (Baiden et al. 2006). Teams where every team member can contribute their ideas, are found to be more effective (Dreu 2002).

- *Coordination* refers to the shared understanding of team members about who is responsible for performing particular tasks (Lim and Klein 2006, Salas et al. 2015). This shared understanding is necessary to synchronize and align the activities within the team to reach the team's goals (Hackman 1990, Hoegl and Gemuenden 2001).

- *Trust* is the "belief in the others' ability, dependability, or competence to perform a task" (Pinto et al. 2009, p. 640). Trust is fundamental to cross-functional teams where team members are highly interdependent, as no single member has the expertise to effectively deal with all design and project challenges (Chiocchio et al. 2011).

- *Respect* describes how well a team member feels appreciated by the other team members (Carmeli et al. 2015). When a team member feels respected, he feels he can be honest with other team members without getting a negative or strong emotional response.

  A no-blame culture is found to facilitate communication between team members (Lloyd-walker et al. 2014). If there is a climate in which team members do not have to fear the repercussions of speaking up, team members will be more willing to contribute their ideas and provide suggestions for improvements (Edmondson and Lei 2014). Furthermore, then team members will be also more likely to collaborate (Lloyd-Walker et al. 2014).

  The following hypothesis describes the relation between a no-blame culture and the level of teamwork.

  H2 A no-blame culture has a positive influence on teamwork

3.2.6 Teamwork and team effectiveness

The relation between teamwork and team effectiveness is evidenced in many studies (Lepine et al. 2008, Mathieu et al. 2008). The following hypothesis addresses the relation between the level of teamwork and the level of team effectiveness.

H3 Teamwork has a positive influence on team effectiveness

3.2.7 The mediating role of teamwork

On the basis of the relations described above, it can be stated that there is an indirect connection between a no-blame culture and team effectiveness where teamwork plays a mediating role. Therefore, the following focuses on the mediating role of teamwork between a no-blame culture and team effectiveness.

H4 Teamwork mediates the positive effect of a no-blame culture on team effectiveness

3.2.8 The moderating role of no-blame culture between project delivery methods and team effectiveness

One of the aims of integrated project delivery methods, such as DB, PT and SP, is to join the knowledge and skills of various firms from the early design phases onwards. This should enable the mutual use of skills and knowledge, resulting in a higher project performance (Baiden and Price 2011). However, bringing together people with various backgrounds does not ensure they will effectively collaborate and make appropriate decisions based on their joint knowledge (Baiden and Price 2011). Team members must feel safe to share their information and knowledge before the project organization is able to use this resource (Edmondson and Lei 2014). This will be true, irrespective of the used integrated project delivery method. Hence, the relation between a project delivery method and the effectiveness of project teams might vary across levels of no-blame culture.

H5 The relation between project delivery method and team effectiveness varies across levels of no-blame culture.

3.2.9 Control variables

To avoid any spurious relationships between the independent variable (no blame culture) the mediator (team work), and dependent variable (team effectiveness), this study includes the following control variables.

Team competences

The competences of project team members refer to knowledge and skills of all members that is required to successfully deliver the project (Rahman and Kumaraswamy 2008, Suprapto et al. 2015). Individual team members need to have enough task-related knowledge and skills to effectively perform their tasks (Mathieu et al. 2008). Furthermore, as a whole, the team needs to have enough knowledge and skills to perform all relevant tasks (Chiocchio et al. 2011). The following hypothesis specifies the relationship between a team's competences and team effectiveness.

H6 Team competences has a positive influence on team effectiveness

Goal clarity

A team goal specifies the outcome a team is aiming for (van der Hoek et al. 2018). A clear goal directs a team (Hackman et al. 2000), and will help a team to become effective (Bosch-Rekveldt 2011). Clear, challenging, but reachable goals are critical to energize a team and make it work harder (Hackman et al. 2000, Locke and Latham 2002, Toor 2009). Therefore, the following hypotheses describes the relation between goal clarity and team effectiveness.

H7 Goal clarity has a positive influence on team effectiveness

Relationship duration

The construction industry is often characterized by the discontinuous nature of its projects, which makes it difficult to build long-term relationships (e.g. Bygballe et al. 2010). On a project-team level, this discontinuous nature can affect the composition of teams across projects. Changes in team composition affect team learning, such as speaking up, because team members will only show these behaviors when they trust each other and feel safe (Edmondson and Lei 2014). Therefore,

the duration of the relationship between core team members affects team learning and subsequent team effectiveness (Edmondson and Lei 2014). Relationship duration is further expressed in the expected future length of the relationship. This 'shadow of the future' would foster collaboration and trust, because team members expect to interact with each other in the future (Eriksson 2015). The following hypothesis specifies the relation between relationship duration and the level of team effectiveness.

H8 Relationship duration has a positive influence on team effectiveness

By testing the eight hypotheses, this study aims to examine how a no-blame culture affects the effectiveness of project based design teams with different project delivery methods in the construction industry. The first main question is whether teamwork mediates the relationship between no-blame culture and team effectiveness (H4). The second main question aims to investigate whether the relationship between project delivery methods and team effectiveness is depending on the existence of a strong no blame culture. Thus, the second main question is whether the relation between project delivery method and team effectiveness varies across levels of no-blame culture (H5).

3.3 Method

3.3.1 Sample and data collection

Respondents widely varying in background and experience, type and size of projects, and project delivery methods, were recruited using two approaches. First, through their networks, the researchers invited companies that were active in the construction industry to participate in a survey. This resulted in 83 project team members who then received an invitation to complete an online questionnaire between January 2016 and March 2017. The net response rate was 83.1% (n=69).

Second, 1,099 architectural firms from the contact database of the Royal Institute of Dutch architects received an email invitation to participate in the survey between October and December 2017. This time, the net response rate was 5.1% (n=57).

Combined, there were 116 respondents who completely or partially filled out the questionnaires. After discarding respondents with more than 50% of missing values, the final database consists of 92 respondents In this final database, 81 values (3.2%) were missing. Because Little's MCAR test showed that these missing values were missing at random (X2 = 61.890; df = 61; sig = .444), any imputation method could be applied to replace them. To replace missing values, the regression imputation method was applied.

The 92 respondents belonged to 34 different project teams designing different kinds of construction projects in the Netherlands. For eight teams all core team members participated; in two teams at least 75% of the core team members participated. There were five teams with 50% to 75% and eight teams with 25% and 50% of the core team members participating. In eleven teams less than 25% of all core team members participated. On average, a project team consisted of 5.83 core team members, with a standard deviation of 1.764.

Table 3.1 provides descriptive information on the individual respondents. They work for clients (n=6), construction management firms (n = 2), engineering firms (n=28), architectural firms (n = 33), contractors (n = 7), subcontractors (n = 13), or demolition companies (n =3).

TABLE 3.1 Descriptive information on the individual respondents

	n	%
Age (N=92)		
20-30	8	8.7%
31-40	30	32.6%
41-50	24	26.1%
51-60	25	27.2%
61-70	5	5.4%
Gender (N=92)		
Male	80	87.0%
Female	12	13.0%
Education (N=92)		
Primary	1	1.1%
Lower vocational	1	1.1%
Secondary vocational	11	12.1%
Bachelor's degree	38	41.8%
Master's degree	41	45.1%
Employment (N=92)		
Client	6	6.5%
Construction management	2	2.2%
Engineering	28	30.4%
Architectural	33	35.9%
Contractor	7	7.6%
Subcontractor	13	14.1%
Demolition / asbestos sanitation	3	3.3%

Table 3.2 shows the characteristics of the projects respondents worked on. The majority of the respondents came from housing (n=37) or the oil & gas (n=22) industry. The projects were delivered using different project delivery methods, such as design-bid-build (n=8) and strategic partnering (n=6). The construction costs of the projects ranged from 350,000 euros to 45,000,000 euros, with a median of 3,750,000 euros (TAB. 3.3).

TABLE 3.2 Characteristics of the projects and respondents

Characteristic	Projects	Respondents	Percentage of respondents
Project delivery method			
Design–bid–build	8	11	12.0%
Building team	9	13	14.1%
Design–build(-maintain) / Engineer, procure and construction management	11	40	43.5%
Strategic partnering	6	28	30.4%
Function of the buildings			
Housing	9	37	40.2%
Office	2	2	2.2%
Leisure (theatre, cinema)	2	2	2.2%
Utility	6	10	10.9%
School	6	9	9.8%
Care (home for the elderly)	1	1	1.1%
Cure (hospital, medical center)	1	6	6.5%
Oil & gas	4	22	23.9%
Multifunctional	3	3	3.3%
Type of construction works			
New building	19	54	58.7%
Maintenance / renovation	5	27	29.3%
Transformation (change function)	3	3	3.3%
Combination (new, maintenance, renovation, and/or transformation)	7	8	8.7%

TABLE 3.3 Construction costs of the projects in euros

	median	mean	sd	min	max
Construction costs in euros (N=92)	3,750,000	9,171,199	12,765,628	350,000	45,000,000

The data was collected using a single method based on self-reports of perceived team characteristics, such as the level of teamwork and team effectiveness. Self-reports are the most relevant measurement method when it comes to measuring perceptions (Conway and Lance 2010). Self-reports, however, may introduce systemic response bias. To rule out method effects, multiple ad hoc measures were taken. First, the researchers mainly used existing measurement scales that had been developed in literature (Podsakoff et al. 2003). Second, to reduce evaluation apprehension, the respondents anonymity is protected (Podsakoff et al. 2003). The outcomes of the study are only shared on an aggregated level in which individual and team level data cannot be recognized.

To see whether the majority of the variance can be explained by a single factor, the number of factors in the exploratory factor analysis was constrained to one in a post hoc analysis. The unrotated solution showed a variance of 30.81%, thus no general factor is apparent and it is therefore unlikely that a common method variance affects the results (Podsakoff and Organ 1986).

3.3.2 Measures

All measures, with the exception of measures related to respondents' background and project characteristics, such as project delivery method , were collected with a Likert-type 4-point scale ranging from 1 (representing a perfectly positive assessment of the trait, e.g., strongly agree) to 4 (representing a zero of the trait; e.g., disagree). Where possible, constructs were measured using existing measurement scales that had been developed in literature. All scales were part of the graduation project of researcher three (Gaviria Moreno 2015). In this graduation project, the conceptualization of the measures was supported in interviews with practitioners. Furthermore, the translation and phrasing of the items was piloted in an online survey. The adapted final Questionnaire S2 is available online in the ASCE library and in the appendixes.

Before a mean score was computed for each scale to perform the multilevel analysis, the researchers wanted to be sure that each scale represented only one construct. Therefore, the measurement scales were subjected to exploratory factor analysis (EFA) with varimax and Kaiser normalization rotation to explore the underlying structure of the questions (TABLE 3.4). A minimum factor weight of 0.40 was used for inclusion of questions onto a factor, and scree plots and eigenvalues were used to identify distinct variables or dimensions (Field 2009). A value of 0.5 for the Kaiser–Meyer–Olkin (KMO) criterion was used as a threshold for sampling adequacy (Field 2009). Items cross loading over 0.50 were removed. The determinant of the R-matrix was used to detect multicollinearity. The determinant should be greater than 1.0E-5 (Field 2009). Items with very high correlations (R>0.8) would be removed (Field 2009). Once redundant and cross loading items were removed, a factor analysis was conducted again without the removed items. This procedure was repeated until a clean factor structure was found. Subsequently, Cronbach's alpha was computed to assess the reliability of the factors identified. When the Cronbach's alpha of a factor was below 0.6 (Field 2009), the EFA was repeated (Field 2009). EFA identified the six factors of the theoretical framework that together explained 66.33% of the variance. Table 3.4 shows the final structure, consisting of the expected six factors with eigenvalues of one or higher. From the 30 variables,

seven were dropped because of collinearity, low loading, or cross loading (see Questionnaire S1 for details) (Osborne et al. 2008). The KMO (0.763) measure verified the sampling adequacy of the analysis, and all KMO values for individual items were above the threshold of 0.5. Bartlett's test of sphericity was significant. The determinant was above the threshold: 3.567E-5.

TABLE 3.4 Factor loadings after rotation, explained variance and Cronbach alpha's for each of the six components (No-blame culture, Teamwork, Team effectiveness, Goal clarity, Team competences and Relationship duration)

No.	Description	Components and factor loadings[a]					
		No Blame culture	Team-work	Team effectiveness	Goal clarity	Team competences	Relation-ship duration
No-blame culture							
1	In this team, my unique skills and talents are valued and utilized	.666					
2	In this team, it is easy to discuss difficult issues and problems						
3	When someone makes a mistake in this team, it is often held against him or her (R)	.504					
4	In this team, some people are rejected for being different	.759					
5	No one on this team would deliberately act in a way that undermines my efforts						
6	In this team, I feel safe enough to speak what's on my mind	.605					
7	In this team, it is difficult to ask other team members for help (R)	.696					
Teamwork							
8	Team members work together well						
9	Team members back each other up in carrying out team tasks where possible		.556				
10	Team members communicate openly with each other						
11	Team members value each other as a person						
12	Team members trust each other's products, such as drawings, calculations and documents		.605				
13	Team members agree on decisions made in the team		.586				
14	Team members have a joint understanding how to reach the goals of the project		.810				
15	Team members have a joint understanding who needs to perform which tasks						

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TABLE 3.4 Factor loadings after rotation, explained variance and Cronbach alpha's for each of the six components (No-blame culture, Teamwork, Team effectiveness, Goal clarity, Team competences and Relationship duration)

No.	Description	Components and factor loadings[a]					
		No Blame culture	Team-work	Team effectiveness	Goal clarity	Team competences	Relation-ship duration
16	Team members have a joint understanding how and when to communicate with each other		.749				
Team effectiveness							
17	How proud are you with the performance of the team?						
18	How satisfied are you with the performance of the team?			.600			
19	The quality of the teams' output is very high (think about design documents, calculations, etc)			.660			
20	The team delivers it commitments on time.			.623			
21	The team used the available time effectively			.842			
22	The team handles new problems effectively			.780			
23	The team copes with change very well						
Goal clarity and attainability							
24	At the start of the project, the project goals were clear to me				.856		
25	I feel the project goals were attainable						
Team competences							
26	To accomplish all tasks, my team as a whole has enough knowledge and skills					.454	
27	I feel that individual team members of my team have enough knowledge about their field					.876	
28	I feel that individual team members of my team have enough skills to perform their tasks at the required level					.835	
Relationship duration							
29	Have you worked with (a part of) this core team on a previous project?						.853
30	Do you expect to work with this core team in the future on another project?						.862
Explained variance after extraction and varimax rotation							
		13.03	12.96	14.59	5.92	10.34	9.49
Cronbach Alpha of each factor							
		.736	.796	.852	n/a	.757	.769

[a] *< .40 is surpressed.*

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The project team's *no-blame 'culture'* was measured using the team psychological safety climate indicators developed by Edmondson (1999). The no-blame culture was measured with seven items, such as "I feel safe enough to speak what's on my mind" and "It is difficult to ask other team members for help." The seven items were subjected to the EFA described earlier. Only one factor presented the no-blame culture. Two items were dropped because of cross loading. The Cronbach alpha of the 5-item scale was $\alpha = .736$, which can be considered reliable (DeVellis 2016).

The level of *teamwork* was measured using nine indicators that reflect *collaboration, mutual support, joint decision-making, communication, coordination, trust, and respect*. For example, coordination was measured with two items: "Team members have a joint understanding of how to reach the goals of the project" and "Team members have a joint understanding of who needs to perform which tasks." The solution of the EFA led to the conclusion that there was only one teamwork factor present. Three items were dropped because of cross loading. Subsequently, the six indicators were combined to form one overall scale of teamwork. The Cronbach alpha of the 6-item scale was $\alpha = .796$, which is considered reliable (DeVellis 2016).

Team effectiveness was measured with seven items based on scales adapted from Van den Bossche et al. (2006) and Pearce and Sims Jr (2002). Two items from Van den Bossche et al. (2006) were used to measure the *satisfaction of the team with their output*, for example "How satisfied are you with the performance of the team?" Five items from Pearce and Sims Jr (2002) were used to measure *output, quality, and change effectiveness*. An example of the last-mentioned items is "The team handles new problems effectively." The EFA showed that there was only one team effectiveness factor present. One item was dropped because of collinearity. The scale showed good reliability ($\alpha = .852$) (DeVellis 2016).

Three control scales were included, namely goal clarity, team competences, and relationship duration, because they may impact the level of team effectiveness. *Goal clarity* was measured with two items. One item was dropped because of cross loading. *Team competences* was measured with three questions about the knowledge and skills of the team as a whole and those of the individual team members. The EFA showed only one team competences factor was present. All items were retained. The scale had a reliability of $\alpha = .757$. *Relationship duration* was measured with two questions: "Have you worked with this team on a previous project?" and "Do you expect to work with this team in the future?". The three items were retained in the EFA. The reliability of this scale was $\alpha = .769$.

The project delivery methods used in each project were measured with a nominal scale. The Design-bid-build model was used as the reference category in SPSS. The integrated models, such as Design-build and Strategic partnering, were combined into one single category and were used as the category of interest.

3.3.3 Data analyses

To answer the two questions, and to test the eight hypotheses, the mean scores of each scale were computed per individual respondent. Although most variables represent team level constructs, such as no-blame culture, the mean scores were not aggregated on a team level to prevent artificial inflation of variances, which could affect the outcomes of the analysis. To allow for team effects, a multilevel model was developed with team number as a level two variable, and thus with the individual team members nested within teams. A multilevel model allows for the decomposition of the variance into different levels by specifying a random intercept for team to estimate the variance among teams. A forward stepwise model selection was applied (Seltman 2008). For each step in the multilevel model, a likelihood ratio test was performed to see whether the changes significantly improved the model (Field 2009).

The first step was to develop the null multilevel model, which includes the second level variable 'team' that denotes the separate teams, and the dependent variable team effectiveness. This null multilevel model was further extended in steps by adding the explanatory and control variables. The first step was to add no-blame culture (H1). This should demonstrate that no-blame culture is directly related with team effectiveness. In the second step, the mediator teamwork is added to the model (H4). When there is a mediator involved, introducing this mediator should change the direct effect from the independent variable no-blame culture on the dependent variable teamwork (MacKinnon et al. 2002). Then, the control variables were added to the multilevel model to estimate their effects (H6, H7 and H8). When a control variable has a significant effects on the model, interactions between the control variables and main variables were tested to see whether the control variable is a confounding variable. Finally, the contextual effect of project delivery methods was factored in to see whether these have an effect on the level of team effectiveness. Following the theoretical framework, the interaction effect between project delivery methods and no-blame culture was entered to explore if the effect of project delivery method on team effectiveness varies across levels of no-blame culture (H5). The multilevel model was built in SPSS 23.

To further assess the effect of no-blame culture on teamwork (H2), the effect of teamwork on team effectiveness (H3) and indirect effects of no-blame culture on team effectiveness through teamwork, separate statistical mediation analyses were performed using the PROCESS macro for SPSS (Hayes 2017).

3.3.4 Approval by the Human Ethical Research Committee

This study was formally approved by the Human Ethical Research Committee of Delft University of Technology (HERC). Following the ethical guidelines of the HERC, informed consent was obtained from each respondent before he/she started the survey, anonymity was ensured, and respondents were informed that they could withdraw at any time. The data were treated with confidentiality and stored in a secure data server that is accessible only by the researchers.

3.4 Results

3.4.1 Descriptive statistics and correlations

Correlations and descriptive statistics are presented in table 3.5. To support the hypothesis of mediation, there must be significant correlations between the dependent and independent variable, and the mediator and the dependent variable (Kenny 2018). The correlation table shows that study into the mediating role of teamwork is relevant because the three concepts show significant and positive correlations.

TABLE 3.5 Means, standard deviations, and correlations among variables

	Mean	SD	NB	TW	TE	TC	RD	GC
1. No blame culture	1.38	.44	1					
2. Teamwork	1.80	.52	.503**	1				
3. Team Effectiveness	1.89	.54	.393**	.545**	1			
4. Team competences	1.43	.49	.426**	.397**	.426**	1		
5. Relationship duration	2.64	.93	.199	.300**	.276**	276**	1	
6. Goal clarity	2.01	.78	.209*	.191	.231*	.103	.025	1

*Note: N=92. NB=No Blame culture, TW = Teamwork, TE = Team effectiveness, TC = Team competences, RD = Relationship duration, GC = Goal clarity. ** p < 0.01, * p < 0.05*

There is a significant correlation between the variable no-blame culture and the dependent variable team effectiveness (r=.393, p<0.01). The mediator teamwork is positively correlated with team effectiveness (r=.545, p<0.01). Furthermore, a no-blame culture is significantly correlated with teamwork (r=.503, p<0.01). Hence, the initial requirements for mediation are met. Several control variables showed significant correlations with the variables in the proposed model. First, the team's competences is correlated with teamwork (r=.397, p<0.01), team effectiveness (r=.426, p<0.01), and no-blame culture (r=.426, p<0.01). Second, the relationship duration had correlation with teamwork (r=.300, p<0.01) and weak correlations with team effectiveness (r=.276, p<0.01) and team competences (r=.276, p<0.01). Thirdly, the clarity of the goals had a weak correlation with no-blame culture (r=.209, p<0.05) and team effectiveness (r=.231, p<.0.05).

3.4.2 Multilevel model

Table 3.6 summarizes the forward steps taken to develop the final multilevel model (IX). For each step, the likelihood ratio test was performed to test the sufficiency of a smaller model versus a more complex model. In steps I to III and in step IX the Chi-square statistic is significant, thus the goodness of fit of the model significantly improved in these steps as compared to the preceding model.

In model III the control variable team competences had a significant effect on team effectiveness. To address the possibility that team competences acts as a confounding variable, interactions between team competences and the main variables were tested (see models IV and V in TABLE 3.6). The interactions showed insignificant, so team competences are no to be considered confounding factors. In models VI and VII (TABLE 3.6), relationship duration and goal clarity respectively were added to model III as control variables. Both had insignificant effects on team effectiveness and were therefore further discarded and both H7 and H8 were therefore rejected.

TABLE 3.6 Estimation of fixed effects on Team Effectiveness with team number as second level variable and model fit

Model	Variables	Team Effectiveness			95% CI		Model fit			
		Estim.	SE	p	Lower	Upper	-2LL	param.	X^2_{change}	df_{change}
0	-	1.890	0.059	0.000	1.767	2.013	144.632	3		
I	No blame culture	0.480	0.118	0.000	0.245	0.714	129.492	4	1	15.140**
II	No blame culture	0.178	0.123	0.150	-0.066	0.421	108.858	5	1	20.634**
	Teamwork	0.508	0.105	0.000	0.298	0.717				
III	No blame culture	0.070	0.126	0.577	-0.179	0.320	102.608	6	1	6.250*
	Teamwork	0.449	0.104	0.000	0.241	0.656				
	Team competences	0.284	0.111	0.013	0.062	0.505				
IV	No blame culture	0.128	0.291	0.661	-0.451	0.708	102.559	7	1	0.049^{ns}
	Teamwork	0.448	0.104	0.000	0.240	0.655				
	Team competences	0.333	0.250	0.186	-0.163	0.830				
	No blame culture*Team comp.	-0.031	0.140	0.825	-0.309	0.247				
V	No blame culture	0.069	0.129	0.594	-0.188	0.326	102.606	7	1	-0.047^{ns}
	Teamwork	0.441	0.241	0.071	-0.038	0.920				
	Team competences	0.273	0.327	0.407	-0.378	0.923				
	Teamwork*Team competences	0.005	0.151	0.971	-0.294	0.305				
VI	No blame culture	0.042	0.126	0.741	-0.208	0.291	100.480	7	1	2.128^{ns}
	Teamwork	0.431	0.104	0.000	0.225	0.637				
	Team competences	0.294	0.110	0.009	0.075	0.513				
	Goal clarity	0.087	0.060	0.146	-0.031	0.206				
VII	No blame culture	0.067	0.125	0.591	-0.181	0.315	101.424	7	1	1.184^{ns}
	Teamwork	0.429	0.105	0.000	0.220	0.638				
	Team competences	0.265	0.112	0.020	0.043	0.488				
	Relationship duration	0.056	0.051	0.278	-0.046	0.158				
VIII	No blame culture	0.055	0.123	0.655	-0.190	0.300	98.996	7	1	3.611^{ns}
	Teamwork	0.456	0.102	0.000	0.253	0.660				
	Team competences	0.258	0.110	0.021	0.040	0.477				
	PDM-Integrated	-0.263	0.137	0.058	-0.536	0.009				
	PDM-DBB	0	.	.						
IX	No blame culture	0.764	0.316	0.017	0.137	1.391	93.284	8	2[a]	9.324**
	Teamwork	0.432	0.100	0.000	0.234	0.630				
	Team competences	0.281	0.107	0.010	0.068	0.493				
	PDM-DBB	0.928	0.508	0.710	-0.081	1.937				
	PDM-Integrated	0	.	.						
	PDM-Integrated*No blame culture	-0.786	0.324	0.017	-1.429	-0.143				
	PDM-DBB.*No blame culture	0	.	.	.	.				

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The test of fixed effects of the final model IX showed that a no-blame culture $F(1, 89.99) = 4.41$, $p<0.05$, teamwork $F(1, 88.68)=18.80$, $p<0.01$, team competences $F(1,89.182)=6.89$, $p<0.01$, and the interaction of no-blame culture and project delivery methods $F(1, 89.99)=5.90$, $p<0.05$ significantly predicted the level of team effectiveness in project-based design teams in construction industry. The project delivery methods alone did not significantly predict the level of team effectiveness $F(1, 89.97)=3.34$, $p>0.05$. H1, H3 and H6 were therefore accepted.

In table 3.6, model IX shows that the estimated values of integrated project delivery methods on the level of team effectiveness varies across levels of no-blame culture, estimate= -0.786, $p < .05$, CI (-1.429, -0.143). H5, which states that the relation between integrated project delivery method and team effectiveness varies across levels of no-blame culture was therefore supported. That is, higher levels of no-blame culture in integrated project delivery methods, lead to higher team effectiveness.

Table 3.7 shows the variance explained by each variable that was added to the null multilevel model. Based on model 0, it can be concluded that 1.7% of the total variance in team effectiveness can be attributed to the difference between teams. It reflects how teams differ in their mean difference in team effectiveness. The variance explained by no-blame culture (model I, TABLE 3.6) is 24% between teams, and 15% within teams. The larger reduction in the between team variance suggests the level of no-blame culture differs from team to team. The lower within team variance shows that a no-blame culture is indeed a team level construct (Edmondson 1999). The addition of the variable teamwork (model II, TABLE 3.6) explains an additional 37% of the variance between teams and 17% within teams. Team competences (model III, TABLE 3.6) explains an additional 33% of the variance between teams and 4% within the teams. Finally, the interaction between project delivery methods and no-blame culture explains another 2% of the variance between teams and 7% of the variance within teams (TABLE 3.6, model IX). This finding supports the idea that within teams, the no-blame culture moderates the effects of project delivery method on team effectiveness. In total, 96% of the between team and 43% of the within team variance of team effectiveness was explained by multilevel model IX as compared to the null model.

TABLE 3.7 Covariance parameters and variance explained in comparison to null multilevel model and difference between models

Model	Variables	Variance	Team Effectiveness			
			Estimate	SE	R	Δ R
0		between team	0.0051	0.0497		
		within team	0.2871	0.0269		
I	No-blame culture	between team	0.0038	0.0210	24%	
		within team	0.2431	0.0414	15%	
II	No-blame culture	between team	0.0020	0.0158	61%	37%
	Teamwork	within team	0.1943	0.0327	32%	17%
III	No-blame culture	between team	0.0003	0.0140	94%	33%
	Teamwork	within team	0.1828	0.0306	36%	4%
	Team competences					
IX	No-blame culture	between team	0.0002	0.0116	96%	2%
	Teamwork	within team	0.1649	0.0271	43%	7%
	Team competences					
	PDM					
	PDM*No blame culture					

Note: PDM = Project delivery method

The direct relation of no-blame culture with team effectiveness was significant (see TABLE 3.6, model I). This effect was reduced when controlling for the mediating variable teamwork (see TABLE 3.6, model II). Partial mediation was therefore indicated (MacKinnon et al. 2002, Kenny 2018). To further investigate the mediating effect of teamwork between no-blame culture and team effectiveness, a separate mediation analyses was performed using bias-corrected confidence estimates (Hayes 2017). In this analysis, team competences was modelled as a control variable. The results of the mediation analysis confirmed that the positive effect of no-blame culture on team effectiveness is predominantly mediated by teamwork (TABLE 3.8). The indirect effect of no-blame culture on team effectiveness was β= 0.204, BCB-CI = 0.074 to 0.383. H2 and H4 were therefore accepted.

TABLE 3.8 Test of indirect effect of no-blame culture on team effectiveness through teamwork

	Total effect		Direct effect		Indirect effect			
	Coeff.	p	Coeff.	p	Point estimate		95% BCB-CI	
							Lower	Upper
No blame culture	0.314	0.01	0.110	0.38	0.204	sig.	0.074	0.386

Note: sig. = significant based on 95% bias-corrected bootstrapping confidence interval of 5000 subsamples.

3.5 Conclusion and discussion

This study aims to examine how a no-blame culture affects the effectiveness of project based design teams with different project delivery methods in the construction industry. The first main question is whether teamwork mediates the relationship between no-blame culture and team effectiveness (H4). The second main question aims to investigate whether the relationship between project delivery methods and team effectiveness is depending on the existence of a strong no blame culture. Thus, the second main question is whether the relation between project delivery method and team effectiveness varies across levels of no-blame culture (H5).

The main finding is that the relation between integrated project delivery method and team effectiveness varies across levels of no-blame culture. The second main finding is that the effect of no-blame culture on team effectiveness is predominantly mediated by teamwork. This means that if a no-blame culture exist, this does not lead to an effective team unless project team members collaborate as a team, thus in the presence of teamwork.

The findings add to the body of knowledge about the role of a no-blame culture as an antecedent in promoting team effectiveness in integrated project delivery methods, such as Design-build and Strategic partnering (Lahdenperä 2012, Lloyd-walker et al. 2014). The study provides further proof for the relations between no-blame culture, teamwork and team effectiveness in project-based design teams in construction (Lloyd-walker et al. 2014). Moreover, this study shows the mediating role of teamwork and corroborates the results of Suprapto et al. (2015), who found that teamwork mediates the effects of relational attitudes and collaborative practices on perceived project performance.

This research further identified team competences as a variable that, in addition to no blame culture and teamwork, has a strong impact on team effectiveness. This finding is consistent with earlier studies that found that teams are only effective, if the team members have the appropriate task-related knowledge and skills (Mathieu et al. 2008). Especially in cross functional design teams where individual team members have different, task-specific competences, and team members are highly interdependent, the competence level of each team member can influence the effectiveness of the whole team (Salas et al. 2000, Chiocchio et al. 2011).

Surprisingly, goal clarity did not influence the level of team effectiveness. This was not expected, because such a direct relation between goal clarity and team effectiveness was found before (Bosch-Rekveldt 2011). However, teams in construction industry often have to cope with multiple goals at the same time. It may well be that this goal complexity moderates the relationship between goal clarity and team effectiveness (Luo et al. 2017). An alternative explanation may be that, projects in construction industry involve inter-organizational collaboration. Individual organizational goals might contradict or parties might understand the targeted outcomes differently, with the associated effects on performance (Senescu et al. 2012). This deserves further study.

That lack of an association between relationship duration and team effectiveness was another unexpected outcome. In many studies, long-term relationships are found to strengthen the level of information sharing and alignment of activities between firms and their representatives, because partners know each other and build mutual trust (Eriksson 2015). Furthermore, in many different team related studies, a lack of team longevity has been found to negatively influence the level of team effectiveness (Yeh et al. 2005, Edmondson and Nembhard 2009). However, other studies suggested that team members who have been working together for a longer period of time, tend to communicate less amongst themselves and individuals outside their team, which reduces the level of information sharing and idea generation (Katz 1982). Isolated teams may suffer from a lack of performance feedback from external sources, which in turn can lower team effectiveness (Katz 1982, Pesämaa et al. 2018) Alternatively, this result might also emphasize the fragmented nature of project teams in the construction industry (Dubois and Gadde 2002, Suprapto et al. 2015).

This study contributes to the growing body of research that examines the dynamics of integrated and multidisciplinary teams in the construction industry (e.g. Manata et al. 2018, Pesämaa et al. 2018). In construction industry projects, project team members are often confronted with unplanned or emergent situations, which require joint analysis of the situation, exploration of a wide range of alternatives and evaluation of the risks of failure (Hamzeh et al. 2018). To solve these situations, together, team members often have to improvise and think out of the box and challenge each other's' assumptions (Hamzeh et al. 2018, Manata et al. 2018). A no-blame culture is a supportive environment that encourages innovation amongst team members, because it enables them to speak up and share their ideas (Edmondson and Lei 2014). Therefore, a no-blame culture is a 'sharing culture', which is an important facilitator of knowledge transfer across construction project cooperation networks (Sun et al. 2019). Finally, this study suggests that if project managers ignore the importance of no blame culture and collaborative teamwork within a cross functional design team, the impact of integrated project delivery methods will be severely compromised.

Limitations

This study was based on a sample of respondents with various backgrounds involved in a wide range of Dutch construction projects. The Dutch are known for their consensus seeking culture and rather direct and open ways of communication. Therefore, further study is required to assess the effects of a no-blame culture in other cultures, with lower acceptance of speaking up and admitting mistakes.

Unfortunately, the researcher were not able to get all members of each core team to respond to the survey. There is a possibility that this has affected the level of variance within teams. However, the outcomes of the multilevel model the researchers used, were consistent with the outcomes of separate mediation analyses using bias-corrected confidence estimates (Hayes 2017), and this lends support to the robustness of these findings.

Finally, the dependent variable used in this study was team effectiveness, measured by self-report. Further investigation of relationships with other relevant dependent variables, such as cost, time, work quality, and outcomes for different stakeholders is therefore warranted.

Future research

It is often argued in literature that certain relational project delivery methods, such as project alliancing, foster a no-blame culture (e.g.Kumaraswamy and Rahman 2006, Lahdenperä 2012, Lloyd-walker et al. 2014, Walker and Lloyd-Walker 2015). It is, however, the question what elements of these relational project delivery methods shape the perceptions of team members. Are project team members influenced by formal arrangements and procedures, or do actual processes between people and other practices such as team building play a larger role in developing a joint no-blame culture? Therefore, the researchers aim to further investigate the level of no-blame culture in different integrated project delivery methods and the relative importance of contractual conditions and practices to the level of no-blame culture in project teams. Furthermore, the construction industry is project-based industry where multiple firms work together in a temporary organization. It would be an interesting study to see whether and how different organizational cultures influence the team level climate of an inter-organizational project team.

No-blame culture is a psychological state of a team. This state is dynamic (Edmondson and Lei 2014). Construction projects often have long life spans. Hence, a longitudinal study has a strong potential to uncover the dynamics and antecedents of a no-blame culture.

Managerial implications

The findings show that the development of a no-blame culture does not automatically lead to an effective team in integrated project delivery methods. For a no-blame culture to have effect on the effectiveness of the team, managers should develop the level of teamwork and encourage collaboration within a project team. Managers of project-based design teams in the construction industry should, therefore, invest both time and effort in creating a no-blame culture and the level of teamwork in parallel. Research shows that selected teambuilding activities can be considered to develop the different elements of teamwork (Lacerenza et al. 2018). However, to get most out of this team training, a no-blame culture is critical, because team members will be more willing to discuss their errors and learn from them (Lacerenza et al. 2018). Furthermore, when the teamwork and a no-blame culture are established, managers should nurture the no-blame atmosphere and teamwork throughout the project.

In addition, team competences were uncovered as having a strong influences on team effectiveness. Managers should therefore bring together team members with sufficient abilities.

Data availability statement

Some or all data, models, or code generated or used during the study are proprietary or confidential in nature and may only be provided with restrictions (e.g. anonymized data).

Data concerning personal information of the respondents and the projects on which they have worked may not be made public due to restrictions imposed by the Human Ethical Research Committee of Delft University of Technology. The data contains information that could compromise the privacy of the research participants.

Declaration of interest

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Supplemental Data

Questionnaire S2 is available online in the ASCE Library (ascelibrary.org) and in the appendixes.

4 The interplay between financial rules, trust and power in strategic partnerships in the construction industry

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ABSTRACT This study explores how and why the social structures of strategic partnerships are shaped by actors and how these interrelate with a team's interpersonal relationships over time. Grasping the complexity of this interplay is essential if we want to comprehend what actually goes on in these partnerships and understand why actors often disengage from them. In three cases, 14 in-depth interviews were held with knowledgeable actors about important events and activities that influenced the relationships between partners. Interview data were triangulated with journals kept by the lead author, who participated as an engaged scholar in the three cases. Because this study took an interdisciplinary approach, new insights could evolve from the multi-level analysis. The main finding was that trust has a moderating effect on the relation between open-book accounting and the degree of

control a dominant party wants to exercise. When the level of control is raised, this can signal distrust to the other partners, which can harm the relationship. When partners feel more dependent on each other's capabilities to reach their long-term goals, the parties seem to be less likely to put the blame on one of the partners in the case of undesirable events. Managers should be aware of their power position and acknowledge the effects of power on their relationships. If long-term and close collaboration does not emerge in their partnership, it may be due to how they use their power position. Thanks to the interdisciplinary approach, this is the first study that shows the significance of trust and power in maintaining strategic partnerships in the construction industry, and how trust can affect the financial rules of actors.

KEYWORDS Strategic partnering, Structuration theory, Power relations, Trust, Construction industry.

4.1 Introduction

In many industries, strategic partnerships have become an important way for firms to cope with the challenges of doing business today (Gomes et al. 2016). Challenges such as climate change necessitate firms to innovate, which typically requires them to collaborate with complementary firms, as it allows them to share and integrate their knowledge and production capacities (Buckley et al. 2009, Edmondson and Nembhard 2009, Sambasivan et al. 2013).

In the construction industry, long-term and cross-project partnerships are also thought to have many positive effects, such as providing learning opportunities and allowing cost reductions (Cheng et al. 2004, Ingirige and Sexton 2006). To foster the development of strategic partnerships in the construction industry, much research has been done to understand the critical structural and relational elements of such partnerships (e.g. Cheng et al. 2004, Eriksson 2015, Walker and Lloyd-Walker 2015). Despite its potential, the concept of strategic partnering has not developed as strongly in the construction industry as in other industries (Bygballe et al. 2010, Sundquist et al. 2018). Case studies report that team members struggle with the partnership's social system, because it contradicts earlier experiences that are often gained in more traditionally procured projects (Venselaar et al. 2015, Bygballe and Swärd 2019).

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Social systems consist of multiple dimensions that are constituted by social structures and individual actions that produce, reproduce and change these structures (Giddens 1984). Social structures consist of rules and resources that help actors to give meaning to what they are doing and enable them to acquire power within the social system (Reimann and Ketchen Jr 2017). Partnering is based on different rules and power relations than is the case in traditional procurement, which can cause individuals who are new to this social system to feel disembedded (Hartmann and Bresnen 2011, Giddens 2013). Whereas traditional procurement is based on short-term and arm's-length relationships, the aim of strategic partnering is to utilise the capacities of different firms by fostering long-term and close collaboration between individuals and integrating processes between firms (Koolwijk et al. 2018). For close collaboration to emerge, it is important that individuals have trust in both the rules of the social system and the individuals who constitute this system (Mathieu et al. 2008, Kähkönen 2014). Furthermore, the power relations between the partners must be balanced (Kähkönen 2014). A dominant partner that uses its power to influence the social system might be regarded as unfair by its partners, causing harm to the relationship (Pulles et al. 2014).

There is only limited knowledge about how and why the social structures of strategic partnerships are shaped by actors and how these interrelate with a team's interpersonal relationships over time (Giddens 1984, Bresnen et al. 2005, Bygballe and Swärd 2019). Grasping the complexity of this interplay is essential if we want to comprehend what actually goes on in these partnerships and understand why actors often disengage from them. In this study, we aimed to understand the significance of trust and power relations in maintaining strategic partnerships. Specifically, we sought to understand when dynamics in trust legitimise dominant actors to change the financial rules in strategic partnerships. In turn, we wanted to explore the effects of these changes on the interaction between parties in the supply chain and eventually their commitment to the partnership.

This article is organised as follows. First, the conceptual framework with sensitising concepts is described together with the three research questions. Then the methodology is explained, together with a further detailing of the three cases and the inductive approach used to identify interrelations in the data. Next, in the findings, we elaborate on the dynamics between rules and actions and the role of trust in balancing power relations in the three cases. Finally, we present our main conclusions and a discussion.

4.2 Conceptual framework

Giddens's structuration theory provides an ontological vision about how to understand the interrelation between individual actions and social structures, in the sense that individuals shape social structures, but at the same time these structures influence the choices individuals make (Giddens 1984). Structuration theory provides a basis on which research can be grafted. This basis must be provided with more substantial theory in order to be able to sensitise what actors know about why they exhibit certain behaviours and how they understand the social world around them. In the following paragraphs, a conceptual framework with sensitising concepts is developed on the basis of structuration theory.

4.2.1 Structuration theory

Giddens (1984) distinguishes three dimensions of a social system that can constrain or enable actors in their action: signification, legitimation and domination (FIG. 4.1). These dimensions are constituted by social structures and individual actions. In their daily practices and interactions, individuals form, reproduce and transform structures (Gherardi and Strati 2012).

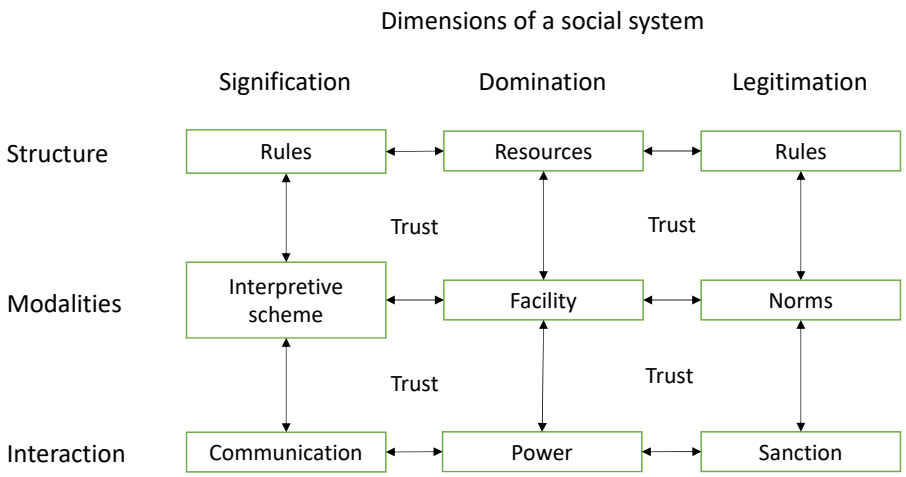

FIG. 4.1 Structuration theory (adapted from Giddens 1984, p. 29)

Structures in a strategic partnership consist of rules and resources (Giddens 1984). Rules define the inter-organisational objectives, procedures, formal relations and performance criteria. Rules help actors to give meaning to what they are doing, and to define and perform particular activities (Giddens 1984). Rules should not be understood as static 'norms' for action, but are interpreted and negotiated in situated interaction (Gherardi and Strati 2012). Resources enable a partner to acquire and possess power. Power is the capability of a partner to initiate a process or to take a decision in the supply chain by being in a dominant position in the social structure (Reimann and Ketchen Jr 2017). The concept of control in structuration theory suggests that partners that are in a subordinate position can still influence the social system, such as decision-making or behaviour, because they have a reciprocal relationship with the dominant partner (Reimann and Ketchen Jr 2017).

Actors use modalities – namely interpretive schemes, facilities and norms – to connect their processes of interaction with these structures. Systems of signification enable actors to interact by the use of their interpretive schemes. An interpretive scheme operates as an assumption about how and why people act in particular situations, and makes it possible for an individual to identify an event in their life and to give meaning to this event (Bartunek 1984). Systems of legitimation make it possible to sanction the interaction if an actor does not comply with norms (Falcone et al. 2013). Norms define how team members should interact, communicate and conduct themselves as members of the team. Systems of dominance facilitate actors to influence the course of action by the use of power. Actors use the three modalities simultaneously and interdependently when they produce, reproduce or transform social systems (Jones and Karsten 2003). Trust is the 'glue' that holds the social system together (Luhmann 2000).

4.2.2 Rules in strategic partnerships

Strategic partnering (SP) is a delivery method in which the owner enters into a long-term, cross-project and multi-partner agreement with a contractor and key sub-contractors (Koolwijk et al. 2018). The term 'strategy' is associated with the long-term objectives related to the organisation's long-term value and growth (Cheng et al. 2004). In the construction industry, this means that the contractor and other supplying partners are awarded a follow-up project when they deliver the project according to pre-specified project and partnership performance targets (Tennant and Fernie 2014). The client's organisation benefits from the early involvement of key firms down the supply chain (Eriksson 2015). Through early involvement in an integrated project team, these firms can contribute their organisation-specific

knowledge to the design and increase their efficiency by integrating activities across firms, from which the clients benefits . Integration between firms includes inclusive decision-making, financial integration and information sharing (Koolwijk et al. 2018). Inclusive decision-making concerns the level of involvement of top and middle management in the project and joint decision-making by the client and suppliers (Koolwijk et al. 2018). Key partners need to be involved in decision-making and allowed to voice their concerns and opinions (Eriksson 2015). Unless there is inclusive decision-making, sub-optimisation of the chain may occur (Arshinder et al. 2011). Information sharing is an important facilitator of an effective and efficient supply chain because it provides enhanced coordination between partners and opportunities for innovation within the joint team (Edmondson and Nembhard 2009). This lowers the total costs of the supply chain, which is a major motivating factor in the formation of partnerships (Sambasivan et al. 2013).

Financial integration is realised through the sharing of risks and rewards and financial information (Koolwijk et al. 2018). Sharing risks and rewards should make partners look beyond the goals of their own organisation to the performance of the whole chain. Risks and rewards need to be shared across the partners on a fair basis (Narayanan and Raman 2004). If incentives are not aligned, firms may revert to optimising their production (Rose and Manley 2010). The sharing of financial risks and rewards by partners legitimises close collaboration and the sharing of information (Rose and Manley 2010), because the partners will 'sink or swim together' (Walker and Lloyd-Walker 2015).

4.2.3 Power relations in strategic partnerships

In strategic partnerships in the construction industry, firms develop collaborative relationships to utilise the complementary capabilities and resources of their partners (Walker and Lloyd-Walker 2015). Based on their capabilities, resources and position in the supply chain, firms have different power positions (Kähkönen 2014). In the construction industry, a client has a dominant position in the supply chain because it is the sponsor of a project and is closest to the end-user (Kähkönen 2014). Its contractor, however, has power because it has specific capabilities and resources that the client needs (Terpend and Krause 2015). This power is often relative because there is a difference in dependence between the parties (Tennant and Fernie 2014). When a client can easily replace a contractor, the client has a stronger position than in a situation where the client is more locked-in (Kähkönen 2014).

Developing a collaborative long-term relationship requires a certain balance of power between the partners (Van Weele and Rozemeijer 1996). This does not mean that both partners need to have a similar amount of power. It is the willingness of a partner to use its power position that determines the balance of power and in turn the collaboration between partners (Kähkönen 2014). A powerful partner may use its power to change the rules, for instance the distribution of profit within the chain. If this action makes the weaker partner feel mistreated, it can decide to end the partnership (Pulles et al. 2014). However, a dominant partner whose long-term objectives are more dependent on the other partner might refrain from using its powers in order to maintain the long-term relationship (Reimann and Ketchen Jr 2017).

4.2.4 Trust in strategic partnerships

For close collaboration to emerge in a social system, it is important that individuals have trust in both the rules of the social system and the individuals who constitute this system (Giddens 1991, Kähkönen 2014). Without this trust, there is no rationale to continue the relationship (Luhmann 2000), because it will negatively affect information sharing and close collaboration (Edmondson and Lei 2014).

The decision to join a strategic partnership requires actors to place trust in the partnership's social system (Giddens 1991). Especially inexperienced actors need to take a 'leap of faith' to trust the rules, because they are rather unknowing about its inner workings (Hartmann and Bresnen 2011, Jacobsson and Roth 2014, Venselaar et al. 2015). Actors also need to place trust in each other. When the directors of two firms decide to integrate their activities in a strategic partnership, they know that they will become vulnerable to the actions of the other partner (Leuschner et al. 2013, Koolwijk et al. 2018). They are willing to accept the risks of integration, because they hold positive assumptions about the other partner. They perceive the other partner as someone who does not take advantage of them (McKnight and Chervany 2001), and who has the "ability, dependability, or competence to perform a task" (Pinto et al. 2009, p.640). In other words, they decide to trust their partner based on past experiences or selection procedures that in some way are believed to be reliable indicators of the future (Glaister and Buckley 1997).

The decision to place trust in both the partnership's social system and the actors within it does not mean that this trust will be sustained over time (Giddens 1991). During their collaboration, each partner will learn about the true trustworthiness of the others (Kostis and Näsholm 2018). By monitoring the behaviours of a partner

regarding a particular situation, an actor can develop a notion of this partner's trustworthiness. Norms and trust are therefore closely linked (Falcone et al. 2013). Trust is reinforced by positive experiences and increased knowledge of the other, and declines when expectations are not met (Lewicki et al. 2006). Trust within a project team is crucial to information sharing and close collaboration (Edmondson and Lei 2014, Koolwijk et al. 2020). To develop and maintain this environment, norms are developed through team building activities, policies and contracts (Buvik and Rolfsen 2015, Walker and Lloyd-Walker 2015). When trust declines, however, the desire to control the behaviours of the partner is likely to increase in order to lower the exposure to risks posed by the relationship (Das and Teng 1998). By increasing control, however, one could also signal distrust, which can lower the level of information sharing amongst team members and eventually their commitment to the partnership (Das and Teng 1998, McKnight and Chervany 2001).

4.2.5 Interpretive schemes in strategic partnerships

The interpretive schemes that people hold are formed by their backgrounds, experiences, values and interests (Putnam and Holmer 1992). Therefore, any given event can be understood in multiple ways by different people (Giddens 1984). Interpretive schemes can enable people to take action, as such schemes allow them to interpret ambiguous situations and reduce uncertainty in complex situations. However, interpretive schemes can also constrain people in their view of reality and inhibit reflexive thinking. When a team tries to understand a complex situation, the team members need to develop joint frames (Putnam and Holmer 1992). These joint frames are developed through a process of interaction in which team members come to a joint understanding (Van Maanen and Schein 1977). Because of their interpretive schemes, however, this process does not guarantee that the issue is well defined (Putnam and Holmer 1992).

Case studies on strategic partnerships show that team members who are new to partnering often developed their perceptions about other partners in more traditionally procured projects (Venselaar et al. 2015, Bygballe and Swärd 2019), which are characterised as low-trust relationships between firms (Hartmann and Bresnen 2011). Team members need to discard these beliefs about their potential partners and develop new ones before they can trust and sustain the partnership's social system and the individuals who constitute this system (Jacobsson and Roth 2014). Buvik and Rolfsen (2015) suggest that in the early stages of a project, this 'leap of faith' can be taken through the early development of integrative work practices and norms within the project team. However, there is a possibility that

this perception proves impervious to change (Mathieu et al. 2008). Hartmann and Bresnen (2011) report that deeply rooted values and beliefs are difficult to converge in the construction industry.

4.2.6 The interplay between financial rules, trust and power relations

Open-book accounting and financial incentive schemes are often used in the construction industry as tools for financial integration (Badenfelt 2010, Walker and Lloyd-Walker 2016). Under the condition of trust, open-book accounting can be considered an integrative activity that enables information sharing between partners (Fabbe-Costes and Jahre 2008). Financial information is shared openly to facilitate discussion about design solutions and identify cost reductions (Cooper and Slagmulder 1999). Under the condition of low trust, one might argue that open-book accounting is a control tool used as a safeguard against opportunism in the process of managing strategic partnerships (Vosselman and Meer-Kooistra 2009). It is used to monitor the performance levels of each partner, comparing their individual contributions against standards and correcting or adjusting these as necessary (Vosselman and Meer-Kooistra 2009). Cognitively, then, when the use of open-book accounting is changed by a dominant partner, this can signal that partners distrust one another (Badenfelt 2010). Further, a dominant partner that uses its power to change the distribution of value in the chain can be perceived as unfair by the other partners and harm the relationship (Pulles et al. 2014). In contrast, when clients misperceive contractors as being opportunistic (Aminian 2015), open-book accounting can also be used to counter those potential misperceptions and provide facts about the partners' actual performance (Cheung et al. 2013). Therefore, for the dominant partner trust plays a moderating role between open-book accounting and the level of control. In turn, the outcomes of control measures can affect the way partners perceive each other. This perception can be influenced by past experiences, especially in construction, where many actors learn to distrust each other in a traditional procurement environment (Hartmann and Bresnen 2011). However, the issue of how and when partners decide to use their power positions in supply chain relationships has hardly been researched (Reimann and Ketchen Jr 2017). Trust might play an important role in balancing power relations (Kähkönen 2014). Drawing upon the theoretical basis and research gap identified above, this study explored the following research questions:

1 *How does trust legitimise the use of power to change the financial rules in strategic partnerships?*

2 *Under what conditions do partners refrain from using their power?*

3 *How does the experience of individual agents affect the interplay between financial integration, power and trust in strategic partnerships?*

The aim of answering these three questions was to deepen our understanding of why some strategic partnerships are maintained, whereas others are dissolved.

4.3 Methodology

4.3.1 Rationale

This exploratory research sought to develop a theory on the interplay between structure and individual actions grounded in data collected in strategic partnerships. To gain theoretical sensitivity, an initial conceptual framework was developed (Bowen 2006, Charmaz 2006). Data collection, data analysis and the development of the conceptual framework occurred concurrently (Bowen 2006). Throughout the study, the initial theoretical background was supplemented with emergent concepts that provided clarity in thinking. To keep an open mind and counteract the possible negative effects of early engagement with literature on the research process, the trustworthiness standard was a key element of the research approach (Shenton 2004). Because the stories that emerged from the data are complex and many-sided in nature, thick descriptions were made that allow this diversity (Flyvbjerg 2006).

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4.3.2 Case study selection

This study sampled cases that were homogeneous at the organisational and the contextual level in order to identify how internal structural characteristics might be related to informal processes in the partnership (Bennett 2004). The comparison of multiple cases with similar structural properties made it possible to explore patterns of similarities and differences in how and when structural properties and informal processes interact.

A list of possible cases was created based on the knowledge held personally by the lead author and by the head of a management consulting firm both active in facilitating strategic partnerships in the Dutch construction industry. Additionally, data from a previous study by the lead author was used to identify strategic partnerships that met the selection criteria (Koolwijk et al. 2018). The cases selected met criteria for strategic partnering that had already been used by others in this field. They incorporated the main components of strategic partnerships in the construction industry and involved high levels of integration between the participating firms (Ingirige and Sexton 2006, Koolwijk et al. 2018). Further details are provided below (section 3.3).

4.3.3 Case description

Project and client characteristics

The three selected strategic partnerships were engaged in similar large-scale housing renovation projects in the Netherlands, initiated by a housing corporation. This gave a similar context to the partnerships. The projects were renovations of terraced houses and all involved similar works, such as roofing, installing new central heating systems and insulating outer walls. Tenants could also opt for new bathrooms, kitchens and toilets, with room for personal choices such as appliance selection.

Scope and duration of the partnerships

Table 4.1 shows the scope of the organisations involved in each partnership. ‘Scope of integration’ refers to the “nature and number of organisations or participants included in the integrated supply chain” (Fabbe-Costes and Jahre 2008, p.135).

Partnership A consists of four partners, partnership B of five and partnership C of six. Furthermore, all three use 'co-makers', namely parties that become involved when the construction phase is being planned, so as to align their activities with the main partners and other co-makers.

TABLE 4.1 Scope of integration per case

Partnership	Partners											
	Client			Contr.		Specialized subcontractors						
						I			D&A		R	W
A	X			X		X			X			
B		X		X		X			X		X	
C			X		X		X	X		X		X

Abbreviations: Contr. = contractor; I = installations; D&A = demolition and asbestos removal; R = roofing; W = window frames.

'Duration of integration' refers to the length of an established relationship in the form of projects previously delivered by the partnership (Eriksson 2015). Participants in partnership A were interviewed when they were developing their third project. All the firms in partnership C had collaborated on two earlier projects and were working on their third when the first round of interviews was held; a second round was held during their fourth project. Finally, participants in partnership B were interviewed during the course of their first project. Three supplying firms in this partnership had previously participated in partnership A. For the client, this was the first project done on the basis of partnering.

Level of integration between partners

The head of the management consulting firm was involved in all three partnerships at the board level, and organised them in the same way. Consequently, they were similar in terms of their formal organisational structure. We elaborate on this in more detail below.

With regard to the timing of involvement (Eriksson 2015), partners become involved in a project during its definition phase. This is the point at which a partnership develops various design solutions and business cases showing the total cost of ownership for the client (here, the housing corporation). The client's board then decides which business case the partnership should develop further. Following that decision, the partnership continues to develop the design and project budget. Once the final plan fits within the business case and the project budget is approved by an external cost auditor, the works are awarded to the partnership by the client.

Organisationally, the partnership structure consists of three layers. At the top is the joint leadership team composed of board members from each partner. To prevent suboptimal performance along the chain of partners, each needs to be involved in decision-making (Arshinder et al. 2011, Eriksson 2015). It takes the high-level decisions and allocates primary resources, such as project engineers and a project office, to the partnership. The middle layer is the senior management team, which leads the partnership on a day-to-day basis. This team is composed of project managers representing their own partner organisations. Project managers are important agents here, as they are responsible for tactical decisions and occupy a central position in communications between the boards of the partner organisations and the project team . They are the information brokers (Karrbom Gustavsson and Gohary 2012, Müller et al. 2013) and they facilitate the sharing of financial information between the project team and the partner organisations (Walker and Lloyd-Walker 2015) – a process that could affect the development of trust in the individual team members. They also have an important role in nurturing a no-blame atmosphere and teamwork throughout the project (Koolwijk et al. 2020). At the lowest level are the operational teams, composed of project engineers and quantity surveyors, who produce the design documents and realise the building. This operational layer is directed and informed by the senior management team (Müller et al. 2013).

Various integrative activities are undertaken jointly by the partners, such as risk identification and lean planning sessions. To stimulate close collaboration between the partners, a range of partnering practices are applied, such as a two-day teambuilding workshop at the start of each project and weekly team meetings to allow for ongoing communication (Buvik and Rolfsen 2015, Lacerenza et al. 2018).

All three partnerships use the activity-based costing method to calculate their costs and share cost data; this is a technique in which the allocation of costs is based on the activities responsible for them. In the design phases, the partners are paid for their advice and design activities. On top of the costs it actually incurs, each partner receives a percentage of those costs as a profit margin. Once the design is finished and uncertainties are reduced, a guaranteed maximum price for the construction works is agreed. The project-related risks and cost savings are shared between the partners through a risk-reward fund, to provide an economic incentive for collaboration (Walker and Lloyd-Walker, 2015; Rose and Manley, 2010). This form of contract is not common in this branch of the construction industry, where fixed-price contracts with unit prices are still standard. The partnerships' performances were monitored on the basis of tenant participation in energy-efficiency measures, tenant satisfaction with the process and product, number of items per home on the punch list, cycle time per home and costs.

Outcomes of the four projects

In general, the four projects were seen as a success. They were delivered within the agreed budget and schedule, and production times per home were within the agreed limits. Each project received an A+ for tenant satisfaction. The level of participation in the energy-efficiency measures was above 95%, which is regarded as very high. Each project experienced challenges as well, including unforeseen situations like hidden asbestos, but these were solved by the partners without great difficulties, major delays or excessive cost overruns.

4.3.4 Case study protocol

TABLE 4.2 Interviewed firms and employees for cases A, B and C.

Case A			
Firm	Role/position	Date of interview	Size*
Contractor	Project manager - SMT	January 2017	Medium
Installations subcontractor	Project manager & co-owner - SMT	January 2017	Medium
Client	Head of real estate department - JLT	January 2017	Medium
Case B			
Contractor	Project manager & co-owner – SMT	November 2016	Medium
Contractor	Project communications manager – SMT	November 2016	Medium
Client	Deputy head of real estate department – JLT	November 2016	Medium
Client	Project manager (externally hired) - SMT	November 2016	Medium
Case C			
Contractor	Project manager A (project 3) - SMT	April 2016	Medium
Electrical subcontractor	Project manager & co-owner (project 3) – SMT	April 2016	Micro
Client	Project manager A (project 3) – SMT	April 2016	Large
Contractor	Director (project 4) – JLT	December 2017	Medium
Contractor	Project manager A (project 4) – SMT	December 2017	Medium
Client	Project manager B (project 4) - SMT	December 2017	Large
Client	Head of real estate department (project 4) - JLT	December 2017	Large

** Definition based on staff head count: micro < 10, small < 50; medium < 250; large > 250.*

Between April 2016 and December 2017, interviews were conducted with key actors selected for their experience with the three strategic partnerships. We mainly focussed on members of the senior management team who represent client, contractor and subcontractor organizations, because of their central position within the partnership and to provide information from a variety of perspectives

(Shenton 2004). In some cases, we interviewed members from the joint leadership team to provide context to some of the stories that emerged from the data. In all, 14 interviews were held with key actors from different firms (TABLE 4.2). All informants were interviewed in Dutch, their native language.

The in-depth interviews focused on important events and activities that, in the eyes of the key actors, could influence the relationships between partners. Probing questions were asked to encourage the interviewees to provide examples from practice and to elucidate their meaning (Moerman 2010).

Because the lead author is affiliated with the firms involved in the cases, for the sake of impartiality the interviews were conducted by the second author. Each interview lasted 50–70 minutes and was audio recorded with the subject's permission. The interviews were transcribed verbatim for the purpose of analysis and to provide an audit trail. The transcripts were then checked for accuracy by the third author, who acted as research assistant, before being further analysed.

The thematic analysis began with the lead author and the research assistant reading and rereading the transcripts in search of patterns of meaning and issues of potential interest in the data (Braun and Clarke 2006). Both then separately performed an initial coding using the sensitising concepts as interpretive devices (Bowen 2006). Intimate involvement with the data led to the emergence of the theory. In this process, Atlas TI 7 was used as a tool. The research assistant is a novice researcher with little experience in studying the construction industry. The lead author is an experienced writer in the field of supply chain integration and collaboration and is active as a management consultant in the construction industry. Being an engaged scholar in the cases, he could add his own viewpoint and review his personal journals to help in understanding the complexity of each of them (Bäckstrand and Halldórsson 2019). However, the interviews were used as the primary source to develop narratives to keep them close to how the individual actors experienced each situation. The constant comparison method was used to assess the coding categories that evolved from team meetings . The double-coding approach by two authors with different backgrounds ensured that neither forced their preconceptions upon the data (Kelle 2007). This is important, as being an engaged scholar, tension could have emerged as a result of his company relations (Bäckstrand and Halldórsson 2019). Finally, to establish the links between the salient features of the data, further content analysis was conducted using the different quotations under each code (Saldaña 2015). The final thematic structures and story lines that emerged from the data were reported by the lead author and the research assistant in the form of thick descriptions, then discussed with the second author, who had performed the initial interviews. The second author is an expert

in psychology. Because the lead and second author have different backgrounds, they had to cross boundaries, creating synergies and avoiding their disciplinary narrowness. Any differences in individual viewpoints about the main themes and plotlines were resolved through discussion and by closely rereading parts of the data until consensus was achieved. When the data did not uncover any new ideas about the theory, the coding stopped.

The interviews were held while the partnerships were still working on building projects. At the time they were conducted, it was unclear whether these partnerships would be continued after the projects were finished. Information about their continuation or termination was therefore obtained later, from the interviewees and from the head of the management consulting firm that had facilitated the three partnerships. After the four projects were completed, the authors conducted further short interviews with the client's project managers about their outcomes. In addition, they were shown the projects' periodic performance reports. Partnerships A and C were continued, whilst partnership B was put on hold for at least 18 months after the first project was delivered.

4.4 Findings

4.4.1 Case A: Trust balancing power relations between contractor and subcontractor

In case A, a potential financial conflict developed between the contractor and an installation subcontractor who was running behind schedule and thus creating problems for the other firms in the production chain. The subcontractor's project manager explained:

"When an installations subcontractor falls behind schedule, often the whole supply chain falls behind." (Installations subcontractor's project manager, case A)

To get back on track, the subcontractor's project manager tried to increase production speed by hiring more personnel.

However, *"the supply of personnel was scarce at that time."* He therefore "*called 40 companies to ask whether they had hands available. In this specific case I found two plumbers. Or I thought they were plumbers, but they proved to be more like demolition workers… They caused me even more problems… So I put in a lot of effort to turn the situation around, but the project manager for the contractor thought I was messing up and that we were not in control."* (Installations subcontractor's project manager, case A)

Initially, the subcontractor's project manager kept quiet about his difficulty in finding enough skilled personnel, which caused a considerable delay to the project. To get back on track, the other partners had to incur additional costs. Actual staffing levels were below those envisioned when the partners drew up a joint production schedule. The subcontractor's project manager explained that:

"[The contractor] hired extra tilers to make up for the lost time, [and] because they had to be brought in at the last minute they were more expensive than we had agreed with the client." (Installations subcontractor's project manager, case A).

The subcontractor stated that he had caused cost overruns for the contractor and expected to be billed for them irrespective of the rules of financial integration, thus evidencing the relative power of the contractor over the subcontractor. In this case, however, the subcontractor was not billed for the cost overruns. The financial issue was solved in a different way, showing that the contractor values his long-term relationship over short-term profits. The contractor's director and the subcontractor's co-owner had

"an open and honest talk, discussing how they should do things differently in the future." (Installations subcontractor's project manager, case A)

In the previous few years, the partners had developed a trusting and collaborative relationship, one that had created a unique value for both of them.

"We have a history together. We won a [supply chain] prize together. That gives us a lot of togetherness. We think we're really good together. However, we also think we can always improve… We have a relationship. We've also done a lot of good projects." (Installations subcontractor's project manager, case A)

Because the collaboration is significant for both the contractor and the subcontractor and there is a basis of trust, they prefer to collaborate and commit to the partnership. The project manager of the contractor explained:

"*My director told me that we are a partnership together; this time it happened to the installations partner, the next time it will be us or the demolition partner… That's strategic partnering: you know you'll do a project together next year, and another one a year after that. And so on."* (Contractor's project manager, case A)

He underlined the importance of trust in building long-term collaborative relationships:

"The basis of strategic alliancing is trust. If there is no trust, you can better stop."

Additionally, the contractor's project manager said that it is important to believe in the good intentions of your partner when there are issues, as that enables project team members

"to put their knowledge on the table, because that is the strength of the partnership." (Contractor's project manager, case A)

4.4.2 Case B: Distrusting client uses its power to change the rules

In case B, the deputy head of real estate at the housing corporation was inexperienced in strategic partnering. In the past, he had bad financial experiences with contractors in traditional projects and therefore started experimenting with other procurement approaches, such as design & build and partnering. The interviews took place immediately after an overt financial conflict at the time the first part of the renovation project was finalised. Neither the externally hired project manager nor the deputy head of real estate at the housing corporation entirely trusted the costs presented by the contractor and subcontractors. The deputy head explained:

"*In a strategic partnership, a contractor and subcontractors are involved early on and are paid for their activities. I felt that those costs were too high. The contractor was concealing profit by shifting things in the budget and thereby calculating the profit three times over."* (Deputy head of real estate at housing corporation, case B)

He also stated that:

"There is no trust between me and the contractor, [and] if you were to ask me if I would apply strategic partnering again, I would say no." (Deputy head of real estate at housing corporation, case B)

The externally hired project manager of the housing corporation had experienced a similar situation when working for another corporation in a strategic partnership.

"The contractor and subcontractors were misusing the situation. They kept on booking hours, to the extent that it got out of proportion." (Project manager at housing corporation, case B)

Because they perceived the contractor as opportunistic, the deputy head of real estate and the project manager at the housing corporation felt legitimised to enhance the level of financial control. According to the contractor's project communications manager:

"The deputy head at the corporation demanded more cost-specific information from the contractor['s project manager]." (Contractor's communication manager, case B)

The contractor's project manager explained the situation further, evidencing that when a dominant partner raises the level of control it can cause the subordinate partner to feel distrusted and unfairly treated (Pulles et al. 2014).

"*It is being suggested that we make a scandalous amount of money, while we can show them every offer and purchase invoice. We can refute everything ... First the client told us they wanted a [basic] list of materials. I showed them an example, which was agreed. However, eight weeks later they [the project manager of the client] wanted far more itemised documents. [Consequently, I am] working overtime, producing all these documents they require. At the same time the client tells me I'm booking too many hours... It's getting on my nerves [and] it also feels like everything is going in one direction."* (Contractor's project manager, case B)

Because the deputy head of real estate and the externally hired project manager at the housing corporation did not trust the calculations presented by the contractor and the subcontractors, they raised the level of control further and hired an external cost consultant without informing the other partners. This shows how a dominant partner can use its position to change the rules of the social system.

After an initial review of the project budget, the external cost consultant told the deputy head that:

"The costs were not in line with current market prices." (Deputy head of real estate at housing corporation, case B)

However, at the time of the interview:

"The cost consultant still needed to deliver the evidence." (Deputy head of real estate at housing corporation, case B)

Later, an expert on the activity-based costing method was asked to intervene after the contractor's project manager threatened to step out of the project. It turned out that the externally hired project manager at the housing corporation had not informed the external cost consultant that the partnership was using activity-based costing methods, and that the contractor and the subcontractors also provided design and other services to the partnership. This led him to make the false allegation against the contractor of hiding profit in the additional costs.

Increasing the level of financial control, however, undermined the level of trust between the partners. Six months later, the situation in case B brought the contractor's project manager to the point where he resigned from the project. The whole situation was exceptional for the supplying partners, to the extent that it made them reconsider their involvement in the project even though the tenants were highly satisfied with its outcomes.

4.4.3 Case C: The effect of carrying frames from a traditional social system

In case C, no clear conflict in respect of costing was reported. However, the case resonates what has been mentioned concerning case B. The head of the real estate department explained how they framed contractors in the past and how much effort it takes to change these preconceptions. She also underlined the importance of trust in building long-term relationships.

"*We came from an era in which we procured our projects in a traditional way based on the lowest price. We saw contractors as parties that only wanted to make money from us. The word trust wasn't part of our dictionary at that time. Therefore, we could not trust each other in advance. When we started with strategic partnering, we did not speak about long-term agreements. It started with a project in which we needed to manage particular risks. We could only manage these risks together with the contractor. So, I started to ask my board members if we could select a contractor in a different way. There was a lot of resistance, but after a while they gave me permission to go ahead, but cautiously. We started with a first pilot project, then a second and a third pilot project [with different contractors]. We started with*

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contractor X, but why not Y and Z? So we also tried it with those contractors. And then one of these pilot projects slowly developed into something that looked like a trustworthy relationship, something that could last longer. It was actually in this project that, for the first time, we really started to talk about the long term." (Head of the real estate department at housing corporation, case C)

Furthermore, the contractor's project manager mentioned the difficulties that arose when a new project manager at the housing corporation had a background in traditional procurement. In two subsequent projects in case C, the new project manager at the housing corporation clearly lacked partnering experience. As the other five supplying partner firms kept the same project managers on the team, and thus had developed partnering routines earlier, they went too fast for the newcomer.

"*I had to work with a new project manager, who was inexperienced in strategic partnering and came directly from 'traditional procurement land', so didn't have a clue what was going on."* (Contractor's project manager, case C)

This resulted in numerous heated discussions between him and the representatives of the other partners about, for instance, costing. Project manager A at the housing corporation talked about the 'leap of faith' people need to take when they start working in strategic partnerships:

"You need to see the advantages. If you have doubts about it, it is not going to work. I've got colleagues who think 'This is not going to work'. When they think like that, it's of no use." (Project manager A at housing corporation, case C).

And about how trust and financial integration are related:

"Trust is the basis: we should be able to assume that the costs presented by our partners are the actual costs." (Project manager A at housing corporation, case C)

The housing corporation acknowledged the difficulties caused by repeatedly changing its project manager, as the one assigned to the final project admitted:

"*It would be better if there weren't as many changes... Changing the team for every project isn't very effective."* (Project manager B at housing corporation, case C)

Echoing this, the head of the real estate department said that:

"*It takes time for them to learn and understand their new role."* (Head of the real estate department at housing corporation, case C)

The housing corporation changed its project managers on purpose, however, in order to make itself less vulnerable to staff turnover by familiarising more project managers with this kind of role.

Table 4.3 presents the similarities and differences across the three cases to support the theoretical predictions.

TABLE 4.3 Cross-comparison of the three cases

Case	Power position		Experience in partnering	Trust	Power use	(Expected) rule change	Outcome
	Dominant	Subordinate					
A	Contractor	Subcontractor	Contractor PM Subcontractor PM	Yes	No	Financial integration	Engage
B	Client	Contractor	Contractor PM	No	Yes	Financial integration	Disengage
C	Client	Contractor	Contractor PM	Yes	No	Financial integration	Engage

4.5 Conclusions and discussion

The aim of this research was to investigate the interplay between rules, trust and power relations in strategic partnerships in the Dutch construction industry, and to answer three questions: (1) How does trust legitimise the use of power to change the rules in strategic partnerships? (2) Under what conditions do partners refrain from using their power? (3) How does the experience of individual agents affect the interplay between rules, power and trust in strategic partnerships?

It can be concluded that trust has a moderating effect between open-book accounting and the degree of control a dominant party wants to exercise. The dominant party, in particular, is in a position to adjust the rules regarding the use of open-book accounting. In case B, the dominant party used its position to increase its control. Initially, the dominant party demanded more information from the subordinate party. It then hired an external cost expert without involving the subordinate party. As a result, the subordinate party felt distrusted by the dominant party. Ultimately, this made the representative of the subordinate party disengage. In case A, we see that the parties had built up a relationship of trust over the years.

This kept the dominant party from redistributing the financial value of the project and instead focus on what is needed to avoid the same mistakes in future projects.

In cases A and C, the parties indicated that the collaboration is of unique value to them. Because they feel dependent on each other's capabilities, they seem to be more committed to long-term cooperation and less likely to put the blame on one of the partners. The combination of the two factors makes the dominant party less inclined to increase control when problems arise. In case B, the construction client appeared to have taken a more dominant role and saw partnering as a way to obviate the type of financial problems that arise in more traditional projects. The lack of trust, however, prompted the dominant party to apply more control over the contractor. This decision ultimately had disastrous consequences for the collaboration.

The three cases seem to suggest that the experiences of the involved actors play an important role in the development of a financial conflict and a lack of confidence. In case B, both the head of the real estate department and the project manager were relatively inexperienced in partnering. In addition, both had had bad experiences with contractors in the past. The results seem to suggest that these experiences had greatly influenced their view of contractors, despite the team building and other group activities the joint team had been through together. Case C appears to support this finding: the interviewees clearly indicated that a lack of partnering experience can lead to discussions about money and the way of working together. In contrast to case B, however, in case C the head of the real estate department expressed his trust in his department's partners. Actors must have confidence in the principle of partnering from the start, otherwise it is of no use to embark on it. In addition, trust must be confirmed in the collaboration. In case C, a number of projects had to be carried out with a number of contractors before there was sufficient confidence in one of these contractors.

Previous studies in other industries indicated that long-term and close collaboration can arise only if there is a certain balance in power relationships between the parties involved (Van Weele and Rozemeijer 1996). The present research shows that when the dominant party uses its power to adjust the rules in the social system, this can lead to the disruption of the relationship. This finding is therefore in line with previous research (Kähkönen 2014, Pulles et al. 2014).

Trust is often cited as the 'lubricant' of long-term relationships (Venselaar et al. 2015). The present research shows how the degree of trust can influence the degree of control that the dominant party wants to exercise over the subordinate party. This finding confirms Das and Teng's (1998) ideas about the role of trust in strategic partnerships and its effects on the use of control measures.

Bresnen (2009) suggested that partnering emerges through the interaction of actors who work for different organisations. The results of this study support these findings. In particular, people's perceptions seem to have a major influence on how partnering evolves. Perceptions can differ from person to person and thus influence the dynamics and ultimate form of partnering. This finding may explain why partnering is shaped in different ways in the construction industry (Nyström 2008, Koolwijk et al. 2018).

Buvik and Rolfsen (2015) suggested that the creation of trust between parties can be accelerated by applying certain interventions at the start of a project. Although such interventions took place in all three cases, in one of the cases the interaction nevertheless led to a decline in confidence. Bringing moments of reflection into the process therefore seems very important to make people aware of their patterns (Hartmann and Bresnen 2011). However, trust can sometimes prove difficult to restore (Mathieu et al. 2008), especially when a collective feeling of mistrust arises within the team of one of the parties.

This research offers a new perspective on the actual problems practitioners face in strategic partnerships. It shows that both structural and relational elements are involved in the activities of actors, and highlights how trust can affect the financial rules of actors. Thanks to the interdisciplinary approach, these new insights could evolve from a multi-level analysis. In this sense, this study can act as a guide to new research into the field of inter-organizational collaboration in the construction industry. In this industry, the dominant approach is that collaboration is mainly determined by legal boundaries (Koolwijk et al. 2018). Koolwijk et al. (2018), however, provided evidence that long-term and close collaboration can emerge irrespective of the project delivery method used. In this industry, therefore, a new theory on inter-organizational collaboration can develop when researchers give up their disciplinary narrowness. More interdisciplinary research will facilitate theoretical development, because forces researchers to cross boundaries between fields, such as social psychology and supply chain management. This is not an easy task, but a necessary one if we want to deepen our insight into the dynamics practitioners face in strategic partnerships.

Limitations and suggestions for further research

Although the findings presented here are based on three cases, there are limitations with regard to the generalisation of the results. More in-depth and interdisciplinary research is needed to further clarify the specific power relationships and their effect on the practices of different parties. In addition, more research is needed into the relative importance of trust in regard to the power relation. Especially in situations

where one of the parties is highly dependent, it could be that trust is faked in order to maintain the relationship. More research is also needed into how people's frames affect their future interactions. Frames developed in the past can have a major influence on the way people interact with each other in the future and thus hinder new forms of collaboration.

Practical implications

The results of this study have implications for practitioners involved in strategic partnerships in the construction industry. A firms' capabilities, resources and position in the supply chain determine their power relations. Managers should be aware of their power position and acknowledge the effects of power on their relationships. If long-term and close collaboration does not emerge in their partnership, it may be due to how they use their power position.

Our findings show that the past experiences of actors can influence their future collaborations. Although the joint teams were trained in various ways in partnering practices, trust proved impervious to change in one of the cases. The slow and step-by-step development of a trusting relationship is therefore warranted if firms want to develop long-term partnerships in the construction industry.

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Data availability statement

The data used in this study cannot be made public due to restrictions imposed by the Human Research Ethics Committee at Delft University of Technology to prevent the release of information that could compromise the privacy of the research participants.

Declaration of interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

5 Conclusions and discussion

Koolwijk, J.S.J. & Van Oel, C.J. (2021). Interplay between Rules, Trust and Power in strategic partnerships in the construction industry. *International SEEDS conference 2021: Sustainable Ecological Engineering Design for Society*, 1-3 September 2021 Leeds Beckett University, Leeds, United Kingdom

Received best paper award for the theme Industrial Strategy

Koolwijk, J.S.J. & Van Oel, C.J. (2021). Interplay between Rules, Trust and Power in strategic partnerships in the construction industry. Research poster for the RISE AWARDS 2021, 3 September 2021, Leeds Beckett University, Leeds, United Kingdom. The award was presented by the Leeds Sustainability Institute, Technological University Dublin, Suffolk Sustainability Institute, and the University of the West of England.

Received the RISE award in the category Contracting and Construction Management.

This PhD project set out to provide insight into the interplay between inter-organizational structures and interpersonal relations in project-based organizations in the construction industry. Study 3 revealed an interplay between rules, trust and power that affects the long-term commitment and collaboration of partners in strategic partnerships in the construction industry. The narratives show that when a dominant actor has low trust in its partners, it might be tempted to change the rules and impose control measures. A dominant actor that changes the rules will make the other partners feel mistrusted, and this may affect their long-term commitment to the partnership if not properly addressed.

Strategic partnerships are characterized as long-term, highly integrated and collaborative relationships between construction clients and supply chain partners (Bygballe et al. 2010). Construction clients form strategic partnerships to better utilize the complementary knowledge and capabilities of their supply chain partners (Walker and Lloyd-Walker 2015). The early involvement of contractors and sub-contractors in a project could allow a client to gain access to their joint knowledge, for instance, to solve difficult design issues or identify and manage risks (Rahman and Alhassan 2012). Integration describes the activities that are organized to

structure the knowledge sharing between project partners (Koolwijk et al. 2018). Although integrational activities might be jointly decided on and may even be embedded in a social structure, there is no guarantee that good collaboration between the team members will emerge. Studies 1 and 3 provide further insights into the reasons for this. Strategic partnerships are strongly dependent on a no-blame culture for trusting relationships to develop. Not all projects with integrated project delivery methods will nurture an open atmosphere in which team members feel free to openly share information. However, as put forward by Edmondson and Nembhard (2009), and Cooper and Slagmulder (2004) in projects with integrated delivery methods, the effectiveness of integrated projects will increase if team members overtly share financial information as well as knowledge about potential risks. This will facilitate team discussions about design solutions that might result in cost reductions (Cooper and Slagmulder 2004).

This PhD project yielded important new insights by investigating the intricate, interpersonal relationships within inter-organizational, temporary project teams (Eriksson 2015). Indeed, by taking on a mixed-method approach, and acknowledging the importance of the interplay between project team (micro)- and strategic (meso) level variables in a project organization, this PhD project contributes some important insights into collaboration and integration in strategic partnerships in the construction industry.

The first major finding is that the way integration in the supply chain develops is highly dependent on the interaction between actors. Study 1 suggested that trusting and committed relationships between team members can develop irrespective of the project delivery method used, but that these relationships are more likely to be found in strategic partnerships. The third study provided further explanation for this. The way actors use the rules of a project organization influences the level of trust and no-blame culture that emerges through interaction. The narratives showed that as a project progresses, team members face different challenges, such as financial conflicts. In such a scenario, the level of trust is best considered a dynamic state that can influence the rules of actors (FIG. 5.1).

Changes in rules can affect the interaction between team members. More specifically, dominant actors seem to able to change the rules of the system. When a dominant actor uses his power position to change the rules of the social system, for instance, the way financial information is used, it can make other actors feel mistreated by this dominant partner. This can make them lose their commitment to the partnership. However, a dominant partner whose long-term objectives are more dependent on the other partner might refrain from using its powers in order to maintain the long-term relationship. Therefore, power relations need to be balanced to maintain

partnerships in the construction industry. This does not mean that both partners need to have equal power. It is the willingness of a dominant partner to use its power position that determines the balance of power and, in turn, affects the interaction between partners. This places dominant actors in a strategic partnership in a delicate and responsible position.

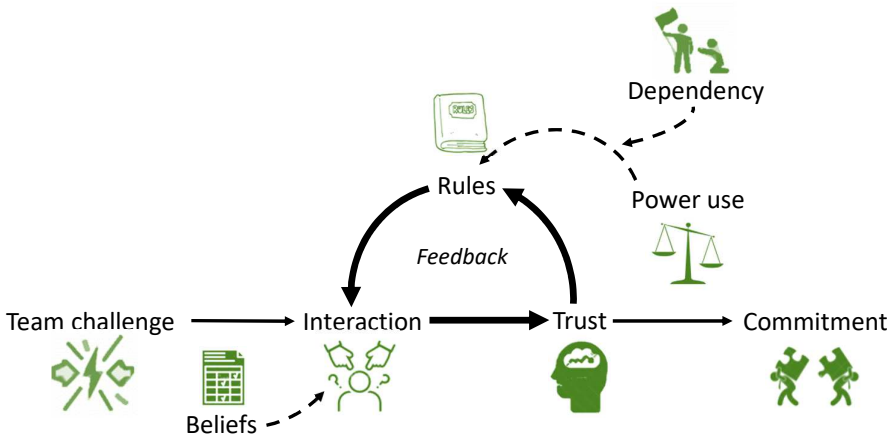

FIG. 5.1 The interplay between rules, trust, and power in strategic partnerships in the construction industry

Research into the temporal dynamics of teamwork and emergent states has been advocated by various researchers (Mathieu et al. 2008, Edmondson and Lei 2014). In the construction industry, this is one of the first studies in which this view is pursued. Importantly, the third study showed that dynamics in trust can affect the rules for actors in a building project organization, which in turn can affect the interaction between them (FIG. 5.1). This feedback loop between mediators, such as emergent states like trust and no-blame culture, and inputs, such as rules, has already been recognized by Ilgen et al. (2005) in their input-mediator-output-input (IMOI) framework for team effectiveness. However, they assumed that feedback loops between emergent states, such as trust, and inputs, such as rules, are less potent because inputs are less malleable. The importance of the current research is that these rules in building project organizations are more malleable than Ilgen et al. (2005) expected them to be. Indeed, Study 3 provided evidence that the malleability of such rules is under the influence of emergent states of the project team. Actors shape the rules as the team goes through different episodes, such as a conflict. This finding has important implications for future research in studies on collaboration and integration in strategic partnerships. It shows that emergent states evolve. The narratives in Study 3 show how trust can be maintained or destroyed by a

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single act. Furthermore, the findings seem to suggest that the level of trust can be asymmetrical, meaning that partners can have different levels of trust, which in turn may affect how they interact within building project organizations.

This research resonates the work of Luhmann (2000), who argued that trust should be seen as the glue holding a social system, such as a project organization, together. For close collaboration to emerge in a project organization, actors must have trust in both the rules of the system and the actors that constitute this system. Trust must also be sustained over time. Without trust, there is no rationale for continuing the strategic partnership, because it will negatively affect information sharing and close collaboration amongst actors. Study 3 shows that developing trust among the team members can prove a daunting challenge in construction. Relationships in the construction industry are often characterized as low-trust (Dewulf and Kadefors 2012). At the start of a project, actors often need to discard these beliefs about their partners and take a leap of faith (Buvik and Rolfsen 2015) (FIG. 5.1). However, there is a possibility that these perceptions may prove impervious to change (Mathieu et al. 2008). Even when team members are trained in partnering practices, trusting relationships may not emerge, as shown by one of the cases in Study 3.

*The first study addressed the question of whether integrative and collaborative practices can be exclusively attributed to integrated project delivery methods or whether traditional project delivery methods can also foster integration and collaboration.*The research shows that the degree of integration and collaboration is not so much dependent on the type of contract that parties have. Although in the literature it is often assumed that traditional forms of collaboration lead to poor and relatively short-term relationships (Dewulf and Kadefors 2012), this research shows that both traditional and more integrated project delivery methods can lead to long-term and close relationships in the construction sector over time. The findings of the third study suggest that this kind of relationship can only develop under the condition of mutual trust and power balance between partners. Study 1 also contributes to the existing literature on integration and collaboration because it has conceptualized both concepts for the construction sector.

The second study addressed two questions. *The first question was whether teamwork mediates the relationship between no-blame culture and team effectiveness.* It was found that the effect of no-blame culture on team effectiveness is mediated by teamwork. This means that if a no-blame culture exists, it does not lead to an effective team unless project team members collaborate as a team; that is, in the presence of teamwork.

The second question was whether the relation between project delivery method and team effectiveness varies across levels of no-blame culture. The finding was that the relation between integrated project delivery method and team effectiveness varies across levels of no-blame culture. Study 2 provided further evidence that the way team members collaborate and share knowledge is influenced by a team's no-blame culture. Team members should feel safe to speak their minds, ask questions, learn from their own and others' mistakes, and openly share information if the knowledge that resides within team members is to be unleashed. Knowledge sharing is crucial if we want these team members to solve complex design issues and other unplanned or emergent situations that often occur in complex construction projects. Study two also revealed a difference of no-blame culture between project teams that work under integrated project delivery methods. This means that integrated working arrangements may influence, but not determine, the level of no-blame culture in a project organization. Therefore, the team culture and interpersonal trust between actors have to be developed and maintained through interaction.

These findings add a new perspective to the current debate about how to develop effective partnerships in the construction industry (Venselaar et al. 2015). Some have argued that long-term and collaborative relationships can be 'engineered' by using structural elements, such as contracts and procedures (Croxton et al. 2001, Bygballe et al. 2010). This is consistent with the idea that the partnering organizations and the project team members can develop collaboration in a predetermined structure and enact this in fixed roles. It echoes a structural view of collaboration. Others have argued that for a strategic partnership to become effective, partners must develop trustworthy and committed relationships (Cheng et al. 2004, Kadefors 2004). Through their interactions, actors would develop a partnership relationship organically. Based on Giddens' structuration theory (1984), this research adopted a dialectic view of social structure and interactions. Study 3 provided supportive evidence that, consistent with the basic premise of structuration theory, team members shape and use the organizational structures, through their interactions, while at the same time these social structures influence how the team members interact. This echoes the conclusions by Papadonikolaki et al. (2019) who argue that a structurational view can better support the transition required for digital innovations, such as BIM, than a structural view. This new insight is an important notion as it provides guidance to the daily practices of consultants and practitioners in developing and maintaining successful strategic partnerships and other transitions in the construction industry.

5.1 Innovative research approach

This research is one of a kind in thoroughly examining the multi-level interplay between meso- and micro-level variables in a project organization in the construction industry. Typically, studies on strategic partnerships between building project organizations focused on a single level (e.g. Bygballe et al. 2010, Lahdenperä 2012, Jacobsson and Roth 2014, Eriksson 2015, Venselaar et al. 2015) . While these studies provided insights into the importance of collaboration and integrative activities in developing long lasting partnerships, this narrow focus masks the mutual interdependencies of inter-organizational structures and interpersonal relationships.

To reach its goal, an innovative and carefully crafted mixed methods research design was applied in this PhD project. The first two studies applied a quantitative research design that sampled multiple teams at some point in time. The aim was to conceptualize the main variables on the meso- and micro-level and explore their underlying relationships with team effectiveness. With the knowledge gained from these two studies, the researcher was able to perform the third qualitative study. This study explored the actual dynamics that occur between the two levels when partners interact in a project organization. This third study also provided a further explanation of why actors in the construction industry shape project organizations with various levels of integration and collaboration.

An important asset was the interdisciplinary approach. The merger of theories from organizational studies, project management and social sciences gave rise to new insights through the introduction of multi-level analyses. In the first two studies, the main concepts from various fields were clarified. This was followed by the third study in which the relations between the concepts were further explored. The need for interdisciplinary research approaches is growing, as we live in an era with increasingly complex problems. This research shows that interdisciplinary research can lead to new insights and contribute more substantially to solving current day challenges. In this sense, this study can act as a guide to new interdisciplinary research in the future.

5.2 Considerations for Project management

This research shows that successful long-term and close collaboration between firms continuously requires careful consideration of how the organizational structures are designed and used and their effect on relationships between actors. In turn, interactions between actors can affect the way how organizational structures are used. Therefore, one should not assume that integrated contracts and integrative practices that have been shown to work in one project, will automatically lead to close and long-lasting relationships between actors in another project. This understanding should be more at the forefront of project management.

Due to the current societal challenges, construction projects are getting more complex. Complexity means that requirements are evolving, there are significant uncertainties, there are high risks that need to be identified and managed, and the scope cannot be clearly defined at the start and will become better understood when the project progresses (PMI 2017). In complex projects, knowledge sharing between experts is crucial for team members developing an action plan (Edmondson 2012). This plan will be developed through multiple, collaborative iterations. In each iteration, new learnings by each discipline should be incorporated, such as information about particular risks that were unclear in earlier iterations. In each iteration, to develop a joint understanding, team members must openly discuss their ideas, challenge others' assumptions, share information, and integrate their diverse knowledge and viewpoints. These activities make team members cross the boundaries that exist between the different disciplines. Through interaction, team members learn about each other's perspectives of a situation and together develop a more enriched view. This PhD project shows that for teams to become effective, no-blame culture and trust are crucial. Furthermore, power relations need to be balanced else these might affect the collaboration between experts. This means that project managers should develop adequate soft skills to develop human capital in building project organizations.

Construction industry is considered a sector lacking innovation which is partly attributed to poor collaboration between the many different technical and non-technical experts involved in both the design and construction phase of building projects. Poor collaboration between partners might stem from a traditional approach in project management (Clegg and Palmer 1996, McAdam and McCreedy 1999) taught as the main model in Dutch academia (Wamelink 2009). Traditional project management uses a top-down approach to knowledge management (Clegg and Palmer 1996), not supporting team learning, knowledge

exchange and discouraging innovation (McAdam and McCreedy 1999). Psychological processes are typically overlooked and there is a lack of insight as of how to support psychological processes to improve team learning (Venselaar et al. 2015). Considering the outcomes of this research, an important role of a project manager is to develop and maintain a no-blame culture amongst team members and help them to develop learning behaviours. One way of learning practitioners these behaviours is by leading by example. By asking inquiring and open questions to team members, for instance about their issues or design solutions, project managers create a sharing culture (Syed 2017). The effect is that also other team members will start to ask open questions, which helps them to learn and develop a common understanding, for instance about a complex design issue.

Nowadays, early adopters enforce the integration of knowledge and skills by adopting novel operational practices including lean management tools (Koskela et al. 2002). Visual tools, such as a lean planning session, can help team members and other stakeholders develop a common understanding about the different activities that need to be aligned between firms. These tools should be understood as boundary objects that assist team members with different backgrounds discuss and understand their different views (Papadonikolaki et al. 2019). For effective discussions in a lean planning session, a no-blame culture is of utmost importance.

An effect of project complexity is that project teams are more fragmented. As a project progresses, the team's composition may alter because other competencies are needed on the team. Also, the interdependence of team members can variate, and interpersonal relationships are likely to change (Mathieu et al. 2008). It is known that these circumstances can affect the level of trust and culture amongst team members. These team dynamics require ongoing attention to maintain the right atmosphere amongst team members (Edmondson 2012). An important element is to bring new team members on board as soon as they join the organization.

6 Reflection

6.1 Personal development

Paradigm shift

A PhD is about how you develop as a researcher. When I started out, I was not *a tabula rasa* – a clean slate. I had clearly been trained and raised as an engineer; as someone who felt you could design and control social life. By implementing structures, such as contracts, one could steer behaviour in the requisite directions, I believed.

However, in practice I saw that this was not how real life works. I saw too many anomalies that I could not explain from a functionalist point of view. This motivated me to take a deeper look and to search for answers by adopting a different viewpoint. I found answers by talking about my experiences with Clarine. She gave me the first directions, for instance looking at concepts such as psychological safety. This was where my PhD was born.

These past six years, I've experienced my own paradigm shift. I've learned to see the world through an interpretative lens. This meant that I had to challenge my own preconceptions of the world and, step by step, I evolved – matured, if you will – into a different me.

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The mental challenge

FIG. 6.1 A PhD at the top of the Mont Ventoux in France in 2018

A PhD is like cycling up the Mont Ventoux from different sides of the mountain on a single day (FIG. 6.1).

When you start, you are enthusiastic and thrilled. You know you want to get to the top, but you have no idea what the journey will involve. You can only hope it will not rain too much and that the winds will stay within bearable limits.

You start cycling together with others who are trying to do the same thing. It is nice to have them around but, in the end, you need to cycle up the mountain yourself. If you are lucky, you have a good coach with you who can talk you through the difficult moments and help you when you need to decide on a specific route to take.

Cycling to the top goes very slow. Extremely slow in comparison with most other things in life. Along the way, you might enjoy the views from the mountain, but some parts are less pleasant and seem never-ending. It takes a lot of perseverance to keep going.

After a lot of hard work, you reach the top. The view is breathtaking, and you are elated: – I've made it! I'm able to write an article! You feel on top of the world. There is, however, not much time to party. You need to descend and start a new climb if you want to reach the top again before dawn.

The second climb is different. You have the experience of and feel the fatigue from the first climb, but now you want to try an even steeper climb. You know that this climb will make you suffer even more than the first one. You recall the suffering of the first climb. You start to wonder why you wanted this so badly. It becomes a mental challenge.

Sacrifices

In recent years, I have had to make sacrifices. Because my family is my top priority, it meant I had to spend less time on friends and hobbies. In 2019, a group of friends decided to participate in the Alpe d'huZes (Alpe d'huSix) fund raising event in which you try to cycle up the Alpe d'Huez six times (or as many times as possible) in one day. I knew it would be a legendary experience and that brilliant memories would be forged by my friends during the trip. These kinds of memories are only made once, as I learned when I participated in the event in 2017. One should not miss out on these things, as life exists in memories that you share with others. However, I had too much going on at that time and decided to turn down the opportunity. These kinds of mental struggles may be the worst thing you need to face when doing a PhD.

6.2 Navigating social systems

Balancing act

This part-time PhD started in June 2015, as a follow-up to previously conducted contract research where I was responsible for. These past six years, I had to balance many social systems in which I had to fulfil many different roles at the same time: my family with three young children, a career as a researcher and lecturer at TU Delft, the care for my parents, consultancy work at Noorderberg & Partners, work as a

commissioner at a small housing association, trainer of young soccer pupils, a fund raiser and, last but not least, several groups of close friends and family.

In recent years, there were moments of difficulty that needed immediate addressing. These were moments that affected the balance between social systems. At times like these, it's the PhD that suffers the most, although the fact that I was doing my PhD part time allowed me to put things on hold and return at a later moment. However, my PhD hardly progressed at the time.

In one case, the situation in question made me work extremely hard, day and night. Although pressure can help you work harder, I also learned that under extreme pressure you can easily make wrong decisions. The stress caused me to not really think anymore, but only produce text. I feel a lot of valuable time was wasted at that time. In retrospect, I see this as a very valuable experience because it showed me the fine line between the positive and negative sides of pressure.

Experience

When I compare myself with other part-time PhD students, I feel privileged that I work at a research institution. In recent years, I have gained more research experience than many other PhD students. This made it easier for me to complete a part-time PhD in six years and to find a balance between the different activities that I perform.

Autonomy and flexibility

When you do a part-time PhD, flexibility and having control over your own schedule is important. My promoters, I feel, really understood my position and let me follow my own course. Fortunately, during the first years of my PhD, my promotor was also my line manager in the organization, which made it possible for me to balance my workload and PhD progress. Those times when he needed me, for instance to step up for a course, he understood that my PhD would take more time. We always managed to balance these things by mutual agreement. In the final years of my PhD, Paul Chan became our new professor. He understood what I needed and gave me the time and space to finish my PhD. I am very grateful to him for this.

6.3 Doing research

Supervision

When I decided to pursue a PhD, my aim was to deliver a PhD of the highest standard. I wanted to produce three articles using mixed methods and publish them in established journals. To deliver this PhD, I knew I needed a copromotor who had complementary skills to mine, and capabilities that I needed to learn from him/her to reach my goal.

From previous research projects that we had done together, I knew Clarine would be the perfect supervisor for me. Her profound knowledge of methods and her background in psychology would be of great value.

In my view, it was important that Clarine sees the world as the way I do. That the world is socially constructed in the minds of humans. We both feel the social world can be investigated using both qualitative and quantitative methods; you only need to figure out which method is most useful to answer a particular question.

Clarine is Dutch just like me. We could discuss all issues in our native language and we didn't run into challenges caused by cultural differences. Clarine can also be very direct in her communication, which works fine for me.

Because we also work closely together on teaching courses and research projects, we talked on a weekly basis, at the least. This made it possible for me to understand what was going on and made me understand what I could expect at particular times. I always got prompt, well-structured responses from her.

Work groove

My research was done in phases and each phase had a different 'groove'. Each year, I managed to find a relatively quiet period of two to three months in which I could focus mainly on my PhD. During these phases, I would reach a sort of hyper focus. This meant I would literally work day and night to put as much time as possible into my PhD. There were days when I went to bed at 2 AM after 14 hours of doing statistics and woke up again at 5 AM with a full SPSS protocol in my head. I simply had to get out of bed and continue coding. Sometimes my wife asked me 'where I was' when we were having dinner. I was figuring out how to do an analysis. The world around me just blurred.

‘Thinking time’ is not the first thing that crosses my mind when I think of work. Throughout my PhD, however, thinking time was perhaps the most productive time I had. Research takes place while you are reading, analyzing, writing, and allowing ideas to gestate. The gestation phase is particularly important and I needed to find ways of optimizing this phase. The brightest ideas came to me while I was doing hobbies, playing sports or just taking a walk.

Collecting data

Collecting data in the construction industry takes a lot of effort. You need networks and to use your resourcefulness to get enough data together. This is especially true if you want to gather data from different subsectors of the construction industry. To gather data from many different subsectors, I mined my personal networks, used our courses, involved graduates and interns, and used open source databases. For example, for the second article we used a database of addresses of architectural firms that could be mined through the internet.

Statistics

I am not a statistician. I have not had any serious training in statistics, my only training being a crash course in applied statistics. Fortunately, I am able to understand statistics on a more conceptual level. Therefore, I was always able to figure out what kind of analysis I should (and could) perform on the data to get an answer to my research questions.

However, this did not mean that I was able to perform the statistical analysis straight away. Throughout my PhD, I used many different resources to figure out how to do the statistical analysis. Andy Field’s book became a bible to me. I also followed a self-paced online course about multilevel analysis at the University of Bristol. Articles in which the same methods were applied proved very useful too. Often they gave me ideas about the different tests I could do and how I could interpret the data.

Publishing

In the Netherlands, we have children's stories featuring a childhood duo *Jip and Janneke*; these are simple, easy-to-understand stories about daily life. The best articles I have ever read are like Jip and Janneke stories. I have by now come to understand that it takes a lot of time and effort to reach this level of clarity and simplicity in an article; it can take up to sixty versions before you feel an article is good enough to send to a journal.

I was lucky to have very good reviewers. My reviewers not only pointed out to me the weak spots in my research, but also gave me guidance in adopting a different view or approach to my findings. Despite harsh lessons they sometimes gave me, I always enjoyed the discussions with them.

Views on power

One can hold different views on power. For instance, Giddens and Foucault take another view on this concept (Foucault 1982, Bevir 1999). To clarify my view on this concept, I asked myself the following question:

What constitutes the specific nature of power?

Foucault and Giddens agree that power is exerted on things which gives the capacity to modify, use, take or even annihilate it. This power stems from the subject directly or is transferred through an element external of this subject, for instance a particular resources that is held by the subject and of great value to another party. Another characteristic of power is that it brings into play relationships between individuals (or groups). When power is being exercised, people are exercising power over others.

Exercising power means that an individual (or group) takes an action to modify the present or future actions of others. Therefore, the existence of power is the result of social construction. Power can take many forms in the relations between individuals (or groups). It can constrain or forbid, in the extreme, but it can also induce or seduce a subject to modify or take a possible action.

Both Giddens and Foucault agree that to analyse power relationships, one must look at the actions and interactions of people. Within these actions, one might identify different forms of power that affect how people behave. These forms or power might reinforce one another, but might also cross or cancel one another out.

Foucault and Giddens take a different perspective when it comes to the sources of power. Giddens reveals that power is mainly exercised through resources and rules. Foucault, however, explains that power should be analysed from numerous points of view (Foucault 1982). Power can be very explicitly brought into being, for instance by the use of words, means of control or introduction of rules. Power can also emanate from traditions, norms and hierarchical structures that affect how people behave. Power can also be derived from resources, differences in know-how, and so forth.

Foucault and Giddens have a debate about the concept of agency. Foucault rejects the idea that an individual can be an autonomous agent that can stand outside of society. He argues that no individual can construct himself as an autonomous free agent free from all regimes of power (Bevir 1999). Foucault argues that an individual may look like he/she is living in accord with his/her commitments, however, this person is only regulating his/her live in accord with regimes of power. Giddens takes another point of view. In his eyes, agents can decide to act outside any norms prescribed by a regime of power (Bevir 1999). Although agents exist within regimes of power, these individuals can always decide what beliefs to hold and actions to take. Furthermore, regimes of power do not determine how an agent experiences events, the beliefs that he/she adopts, or the actions he/she performs. These things occur in a social context, a social system that influences them, but is also formed by them. Agents that are able to modify/transform norms possess a capacity for innovating the social system.

In chapter 4, the concept of power (paragraph 4.2.3.) resembles how Giddens applies this concept. It is mainly focused around the idea of having 'resources', and having a specific position in the supply chain. However, taking a Foucauldian perspective, paragraph 4.2 as a whole can also be understood as taking a wider view on the sources of power. Paragraph 4.2.5, for instance, tells that team members who are new to partnering often developed their beliefs about other partners and norms in more traditionally procured projects. These beliefs and norms can affect their actions in the new partnership, which in turn can affect the actions of the other partners.

As noted under paragraph 4.2, Giddens structuration theory provided a lens about how to understand the interrelations between individual actions and social structures and the role of agents in transforming the social system. In my view, the subjects in my study held their own beliefs and decided themselves what actions to perform. This means that within the same social structures, individuals have (at least) some space to modify (f.i.) the norms and rules in a social system. Therefore, I adopt a more liberal view of the human agent than Foucault and felt that Giddens' view fitted better with the data.

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Appendices

APPENDIX A

Supplemental Data S1: Questionnaire items study 1

(translated from Dutch)
The variable numbers shown between <…> correspond with variables shown in Table 2.1, Table 2.2, and Table 2.6.

The variable names shown between […] correspond with the items in Table 2.4 and Table 2.5.

Respondent individual and organisational backgrounds

1 What is your gender? [gender]
- Male
- Female

2 How old are you? [age]
- 20 thru 30
- 31 thru 40
- 41 thru 50
- 51 thru 60
- 61 thru 70

3 What is your highest educational degree?* [Education]
- Secondary vocational training
- Bachelor degree
- Master degree
- [own answer]

4 What is the name of the company you work for? (open question)
5 How many people work for this company? (open question)
6 What is the location your company is located (zip-code)? (open question)

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Project information

7 Please provide the name that you will use to refer to this project (open question)

8 Where is the project located? (open question)

9 What kind of building is being delivered? [Function of the buildings]
- Office
- Retail
- School
- Industrial
- Homes, high rise
- Homes, low rise
- [own answer]

10 What is the nature of this project? [Type of construction works]
- Demolition and new building
- New building
- Transformation
- Maintenance
- Renovation

11 What is the size of the project in m^2 gross floor area? (open question)

12 How does your organisation typify the project delivery method used in this project? [Project delivery method]
- Design, bid, build
- Design & Build
- Project Partnering (*Bouwteam*)
- Strategic partnering (*Ketensamenwerking or co-makership*)
- Other: [own answer]

13 How would you define the technical complexity* for this project? [Technical complexity]
- Very low (recoded to not complex)
- Low (recoded to not complex)
- High (recoded to complex)
- Very high (recoded to complex)

*Low - Characterized by the use of proven technology, simple systems, standard designs, previously used configuration or geometry, proven construction methods, etc. High - Characterized by the use of unproven technology, complicated systems, non-standard designs, new configuration or geometry, new construction methods, etc.

14 In which phase is the project currently?
- Feasibility
- Design
- Realisation
- Completed

15 What is the realised or expected project completion date (mm/dd/yy)

Scope of integration

16 What kind of parties are part of the project team?* <1>
- Client
- Municipality
- Main contractor
- Architect
- Technical design office
- BIM provider
- Structural engineer
- Advisor all-round
- Advisor building physics
- Advisor Installations
- Advisor building regulations
- Advisor Environmental
- Advisor acoustics
- Advisor fire safety
- Advisor asbestos sanitation
- Specialty contractor Electrical installations
- Specialty contractor Heating installations
- Specialty contractor Electrical and Heating installations
- Specialty contractor Roofing
- Specialty contractor Masonry
- Subcontractor Plasterworks
- Supplier windows and window frames
- Demolition company
- Asbestos sanitation company
- Users/tenants
- Others [own answers]

17 When did these parties get involved? (this question uses answers of previous question to build a matrix question)* <2>

- Feasibility
- Design
- Realisation
- (after) completion

* Variables <1> and <2> are combined to determine the amount of parties that are part of the project team in the design phase.

Integration of activities

18 Did project team members participate in team building activities? (more than one answer is possible)* <3>

- No (0)
- Yes, some of them did, informally (such as going to a bar) (1)
- Yes, all of them, informally (2)
- Yes, some of them did, formally (such as workshops) (3)
- Yes, all of them, formally (4)

** a sumscore is calculated based on all answers.*

19 Does the project team work and meet in the same location? <4> No.

- Yes, at the office of either the client or the (main) contractor
- Yes, we have our own (separate) office
- Yes, we rotate our between the offices of all project partners

20 To which level did the client prescribe the design? <5>

- In a traditional manner with a full design and technical specifications.
- The client prescribed functional specifications and left the development of technical specifications to the partners
- The client defined some basic/high level functional specifications and involved the partners in further refinement of them.
- The client involved the partners in defining the functional specifications from the start.

Duration of integration

21 Does the way this project is organised fit with the company vision of the client and partners involved? <6>

- No
- I think it does, but it was never expressed by either of them explicitly
- Yes, however it mainly fits with the company vision of the client
- Yes, it fits the company vision of both the client and partners

22 To what extent is this project part of a joint long term strategy to work together? <7>

- None, there is no long term strategy.
- Not explicitly, however it would be logical step to develop a long term strategy to work together.
- There has been talks between the partners to develop a long term strategy to work together.
- This project is part of a long term strategy to work together .

23 How many projects did the project partners work together before this project? <8>

- None
- One
- Two or three
- More than three

24 Do the project partners have the intention or agreement to work together on the next project? <9>

- No, we have no intentions nor an agreement to work together on the next project
- Yes, we have the intention to work together on the next project
- Yes, we have an oral agreement to work together on the next project
- Yes, we have a written agreement to work together on the next project

25 To what extent is the project team composed out of members that have worked together before? <10>

- No, this team is new.
- To a small extent, most members of the team have been changed
- To a large extent, most members of the team are the same
- Completely, the team is completely the same

Financial integration

26 To what extent do suppliers have insight in the project and maintenance budget of the client? <11>
- None. The client keeps this information to himself.
- Partly, only the main items are shared.
- Extensively, most items have been translated into performance targets
- Completely, including all background information such as policy documents and calculations.

27 To what extent does the client have insight in the breakdown of the contract sum (hourly rates, material prices, general costs, …) of the suppliers? <12>
- Only the information that is given in the project estimate by the (main) contractor
- By and large of all suppliers including the main contractor.
- In detail of the main contractor, and by and large of all other suppliers
- In detail of all suppliers including the main contractor.

28 To what extent do all suppliers have insight in each other's cost breakdown structure? <13>
- Only the information that is given in the project estimate by the (main) contractor
- By and large of all suppliers including the main contractor.
- In detail of the main contractor, and by and large of all other suppliers
- In detail of all suppliers including the main contractor.

29 To what extent do all suppliers have insight in each other's purchase/cost price? <14>
- Only the information that is given in the project estimate by the (main) contractor
- By and large of all suppliers including the main contractor.
- In detail of the main contractor, and by and large of all other suppliers
- In detail of all suppliers including the main contractor.

30 What kind of arrangement is used to settle pains and gains? <15>
- We used the 'additions and omissions' arrangement.*
- Both benefits and setbacks are for the supplying parties.
- We use a risk-fund to cover for setbacks.
- We use a risk/reward fund in which setbacks and benefits are brought together.

* an arrangement used in Dutch Design-Bid-Build contracts

31 When a risk/reward fund is used, what happens (or happened) with the deficit or surplus at the end of the project? <16>

- In case of deficit, this is paid by the suppliers
- In case of deficit, this paid by the client
- In case of deficit, this is shared by the client and suppliers together
- In case of surplus, this is paid to the suppliers
- In case of surplus, this is paid to the client
- In case of surplus, this is shared by the client and suppliers together
- [own answer]

32 What kind of incentives are used to stimulate the project team to perform better? <17>

- None
- They receive a reward when project performance is higher.
- They receive a penalty when project performance falls short.
- They can receive both a reward or penalty depending on project performance.

Information sharing

33 Are project files shared and edited on a shared digital portal? <18>

- No, we use our own systems for file storage. We share our files through email.
- Yes, we use a file storage and sharing system from one of our partners.
- Yes, we use a file storage and sharing system of an external party.
- Yes, we use a file storage and sharing system of an external party. We can also edit files together on this system.

34 Can all project information be accessed by all project team members? <19>

- No
- Partly, the client screens particular information from the rest of the team
- Partly, only the client and (main)contractor have access to all information
- Fully, all project team members have access to all information

Inclusive decision making

35 What is the level of involvement of clients' top management in the project? <20>

- Distant, they only take decisions
- They want to be informed on a regular basis
- They want to be informed and involved on a regular basis
- They want to be highly informed and involved.

36 What is the level of involvement of clients' middle management in the project? <21>
- Distant, they only take decisions
- They want to be informed on a regular basis
- They want to be informed and involved on a regular basis
- They want to be highly informed and involved.

37 What is the level of involvement of partners' top management in the project? <22>
- Distant, they only take decisions
- They want to be informed on a regular basis
- They want to be informed and involved on a regular basis
- They want to be highly informed and involved.

38 What is the level of involvement of partners' middle management in the project? <23>
- Distant, they only take decisions
- They want to be informed on a regular basis
- They want to be informed and involved on a regular basis
- They want to be highly informed and involved.

39 Are decisions made by the client (one-sided) or by client and suppliers together? <24>
- The client takes the decisions
- The client takes the decisions after being advised by the project partners
- The client and project partners take decisions together

40 Are project goals formulated by the client (one-sided) or by client and suppliers together? <25>
- No goals have been formulated
- Goals have been formulated by the client (one-sided)
- Goals have been formulated by the client first, and later adjusted to fit with the goals of the other partners
- Goals have been formulated by the client and partners together. We tried to optimize them for both.

41 Did the client and project partners formulate joint objectives that go further than a single project? <26>
- No
- I think they did, but it was never expressed by either of them explicitly
- Yes, it was mainly the client that formulated these joint objectives
- Yes, both the client and project partners formulated these joint objectives

Collaboration

42 Based on which criteria were most partners selected? <27>
- Mainly price
- Price/Quality
- Mainly Quality

43 Do you expect that this project team will be kept together on the next project? <28>
- No, I do not expect this team will be the same on the next project
- To a small extent the team will be the same
- To a large extent the team will be the same
- The team will be completely the same

44 How would you describe the amount of effort team members put into the project? <29>
- They do what is required from them based on their contractual obligations
- They actively search for solutions, however, only when it concerns problems regarding their own discipline
- They actively search for solutions, also when it concern problems regarding the other disciplines
- They do not only actively search for solutions when problems arise, they also show initiative and creativity in finding better solutions.

45 To what extent do team members feel responsible to speak up and give feedback to each other? <30>
- They hardly speak up or give feedback
- They only speak up or give feedback when asked
- They speak up and give feedback on a regular basis, however not on all aspects
- They speak up and give feedback on all aspects when they feel it is necessary.

46 Is there a sense amongst team members that they are doing this together? <31>
- I do not see this
- I see this sometimes
- I see this very often
- I see this every time/always

APPENDIX B

Supplemental Data S2: Questionnaire items study 2

No Blame Culture - α = .736

1 In this team, my unique skills and talents are valued and utilized (respect each other's abilities)
- Strongly agree
- Agree
- Partly agree
- Disagree

2 In this team, it is easy to discuss difficult issues and problems (seeking and giving feedback) *[dropped: factor analysis, cross loading]*
- Always
- Very often
- Sometimes
- Never

3 When someone makes a mistake in this team, it is often held against him or her (R) (problem and fault analysis)
- Always
- Very often
- Sometimes
- Never

4 In this team, some people are rejected for being different (R) (being yourself)
- Always
- Very often
- Sometimes
- Never

5 No one on this team would deliberately act in a way that undermines my efforts (intentions of others) *[dropped: item rest]*
- Strongly agree
- Agree
- Partly agree
- Disagree

TOC

6 In this team, I feel safe enough to speak what's on my mind. (being vulnerable)
- Strongly agree
- Agree
- Partly agree
- Disagree

7 In this team, it is difficult to ask other team members for help (R) (being vulnerable)
- Strongly agree
- Agree
- Partly agree
- Disagree

Teamwork - α=.796

8 Team members work together well (collaboration) *[dropped: factor analysis, cross loading]*
- Strongly agree
- Agree
- Partly agree
- Disagree

9 Team members back each other up in carrying out team tasks where possible (mutual support)
- Strongly agree
- Agree
- Partly agree
- Disagree

10 Team members communicate openly with each other (communication) *[dropped: factor analysis, cross loading]*
- Strongly agree
- Agree
- Partly agree
- Disagree

11 Team members value each other as a person (respect) *[dropped: factor analysis, cross loading]*
- Strongly agree
- Agree
- Partly agree
- Disagree

12 Team members trust each other's products, such as drawings, calculations, documents (trust)
- Strongly agree
- Agree
- Partly agree
- Disagree

13 Team members agree on decisions made in the team (joint decision making)
- Strongly agree
- Agree
- Partly agree
- Disagree

14 Team members have a joint understanding how to reach the goals of the project (coordination)
- Strongly agree
- Agree
- Partly agree
- Disagree

15 Team members have a joint understanding who needs to perform which tasks (coordination) *[dropped: factor analysis, cross loading]*
- Strongly agree
- Agree
- Partly agree
- Disagree

16 Team members have a joint understanding how and when to communicate with each other (communication)
- Strongly agree
- Agree
- Partly agree
- Disagree

Team effectiveness - α = .852

17 How proud are you with the performance of the team? (satisfaction with the product)
[dropped: factor analysis, cross loading]
- Very proud
- Proud
- A little proud
- Not proud

18 How satisfied are you with the performance of the team? (satisfaction with the product)
- Very satisfied
- Satisfied
- Partly Satisfied
- Not satisfied

19 The quality of the teams' output is very high (think about design documents, calculations, etc) (quality effectiveness)
- Strongly agree
- Agree
- Partly agree
- Disagree

20 The team delivers it commitments on time. (planning effectiveness)
- Always
- Very often
- Sometimes
- Never

21 The team used the available time effectively (planning effectiveness)
- Strongly agree
- Agree
- Partly agree
- Disagree

22 The team handles new problems effectively (change effectiveness)
- Strongly agree
- Agree
- Partly agree
- Disagree

23 The team copes with change very well (change effectiveness) *[dropped: factor analysis, multicollinearity with 22]*

- Strongly agree
- Agree
- Partly agree
- Disagree

Goal clarity & attainability - α = n/a

24 At the start of the project, the project goals were clear to me

- Strongly agree
- Agree
- Partly agree
- Disagree

25 I feel the project goals were attainable *[dropped: factor analysis, cross loading]*

- Strongly agree
- Agree
- Partly agree
- Disagree

Team competences α =.757

26 To accomplish all tasks, my team as a whole has enough knowledge and skills

- Strongly agree
- Agree
- Partly agree
- Disagree

27 I feel that individual team members of my team have enough knowledge about their field

- Strongly agree
- Agree
- Partly agree
- Disagree

28 I feel that individual team members of my team have enough skills to perform their tasks at the required level

- Strongly agree
- Agree
- Partly agree
- Disagree

Relationship duration - α=.769

29 Have you worked with (a part of) this core team on a previous project?

- Yes, with the whole core team
- Yes, with a large part of this core team
- Yes, with a small part of this core team
- No, this is the first time I work with this core team

30 Do you expect to work with this core team in the future on another project?

- Yes, with the whole core team
- Yes, with a large part of this core team
- Yes, with a small part of this core team

Curriculum Vitae

Jelle Koolwijk

Jelle Koolwijk (41) is a research associate in the Design & Construction Management group at the Department of Management in the Built Environment (MBE), Faculty of Architecture and the Built Environment, Delft University of Technology. His research interests lie in integrated and collaborative project delivery methods, with a focus on the challenges that practitioners face when they have to work in these complex environments.

In recent years, he has been involved in acquiring four Dutch Research Council (NWO) funded research projects. He acquired and acted in more that 1million euros' worth of research projects for ministries, national bodies, branch organizations, social housing corporations and contractors about a range of construction-related topics, such as supply chain management, project alliance, supplier monitoring, and empowerment of end-users. He published scientific articles, books, a professional guide and numerous research reports, and participated in research conferences. His work received several prizes, such as the RISE award. He is a reviewer for several scientific journals, such as Engineering Construction and Architectural Management, Management in Engineering, and Supply Chain Management: an international journal.

As an engaged scholar, he is associated with consultancy firm Noorderberg & Partners. Together with the managing partner of this firm, he designed and implemented multiple award-winning strategic partnerships between housing associations and supply chain partners. He was a member of the supervisory board of a housing association. In the past, he worked as a project developer for large international investment companies and as procurement manager for the general Rail Agency *(ProRail)* in the Netherlands.

Koolwijk is the course manager for Research Methods 2 and 3 (MSc level) and teaches case studies and construction management. He has contributed to the MBE Edx course about managing building adaptation and is mentor to three to five Master's graduates per year. Several of his MSc students graduated Cum Laude.

As to his private life: Jelle is married to Suzan (41) and the father of three children: Stijn (12), Floor (8) and Siem (5). In his spare time, he is a junior soccer coach. His current hobbies are cycling and playing water polo. To raise funds for cancer and Multiple Sclerosis research, he participated in the fundraising events Alpe d'huZes (Alpe d'huSix) at Alpe d'Huez in France in 2017 and Klimmen tegen MS (Climbing against MS) at Mont Ventoux in France in 2018. In 2022, he hopes to participate in Climbing against MS again.

Jelle started this part-time PhD project in June 2015. He graduated with an honorary mention for his research on the project alliance delivery method at the faculty of Architecture of Delft University of Technology in 2003. To gather data for his Master's thesis, he travelled to Australia to learn about this new project delivery model. In 2006, he published a book on this topic. During his studies, he was the student assistant of *ir*. Rob Geraerdts of TU Delft and Prof. Spiro Pollalis of the Harvard Design School. He completed his secondary education (VWO) in 1998 at *Het Schoonhovens College* in Schoonhoven.

List of publications and awards

Articles in refereed journals

Koolwijk, JSJ, Van Oel, CJ, Bel, M. (2021). The interplay between financial rules, trust en power in strategic partnerships in the construction industry. Engineering, Construction and Architectural Management, ahead of print, https://doi.org/10.1108/ECAM-09-2020-0713

Koolwijk, JSJ., van Oel, CJ, Gaviria Moreno, CJ (2020). No-blame culture and the effectiveness of Project-Based Design Teams in the Construction Industry: the mediating role of teamwork. Journal of Management in Engineering, **36**(4), https://doi.org/10.1061/(ASCE)ME.1943-5479.0000796

Koolwijk, JSJ, van Oel, CJ, Wamelink, JWF, & Vrijhoef, R (2018). Collaboration and Integration in Project-Based Supply Chains in the Construction Industry. Journal of Management in Engineering, **34**(3), https://doi.org/10.1061/(ASCE)ME.1943-5479.0000592 *Received an Editor's choice award*

Conference papers

Koolwijk, J.S.J. & Van Oel, C.J. (2021). The interplay between financial rules, trust en power in strategic partnerships in the construction industry. Proceedings of the International SEEDS conference 2021: Sustainable Ecological Engineering Design for Society, 1-3 September 2021 Leeds Beckett University, Leeds, United Kingdom *Received best paper award for the theme Industrial Strategy*

Research poster for the *RISE AWARDS 2021*, 3 September 2021, Leeds Beckett University, Leeds, United Kingdom. *Received the RISE award in the category Contracting and Construction Management.* The award was presented by the Leeds Sustainability Institute, Technological University Dublin, Suffolk Sustainability Institute, and the University of the West of England.

Koolwijk, J., & van Oel, C. (2019). The mediating role of teamwork between a no-blame culture and team effectiveness in project-based design teams in the construction industry. Project Management Congress: "*ADAPT or DIE", Research meets Practice: towards Project Management 3.0.*", Delft, Netherlands.
Received best paper award for the theme Collaboration

Koolwijk, JSJ., van Oel, CJ., & Wamelink, JWF. (2015). Supply chain partnership in construction a field study on project team level factors. In MA. Farshchi, & C. Egbu (Eds.), Proceedings of the joint CIB international symposium - Going north for sustainability: Leveraging knowledge and innovation for sustainable construction and development (pp. 81-91). London: IBEA Publications Ltd.

Koolwijk, JSJ., van Oel, CJ., Vrijhoef, R., & Wamelink, JWF. (2015). Partnering in construction: A field study to further develop the framework of supply chain integration. In AB. Raiden, & E. Aboagye-Nimo (Eds.), Proceedings of the 31st annual ARCOM conference (pp. 1209-1218). Reading, UK: ARCOM, Association of Researchers in Construction Management.

Koolwijk, JSJ., Vrijhoef, R., van Oel, CJ., van der Kuij, RS., & Wamelink, JWF. (2014). Organizational effectiveness of building project organisations and greenfields to develop. In D. Amaratunga, R. Haigh, L. Ruddock, K. Kermiminiyage, C. Kulatunga, & C. Pathirage (Eds.), Proceedings of the 2014 CIB W55/65/89/92/96/102/117 & TG72/81/83 International Conference on Construction in a Changing World (pp. 1-12). s.l.: s.n.

Vrijhoef, R., Koolwijk, JSJ., van der Kuij, RS., van Oel, CJ., & Wamelink, JWF. (2014). Developing a monitor for the characterisation of supply chain collaboration and the measurement of its effectiveness in the Dutch social housing sector. In D. Amaratunga, R. Haigh, L. Ruddock, K. Kermiminiyage, C. Kulatunga, & C. Pathirage (Eds.), Proceedings of the 2014 CIB W55/65/89/92/96/102/117 & TG72/81/83 International Conference on Construction in a Changing World (pp. 1-13). s.l.: s.n.

22#01

Rules, Power and Trust

Interplay between inter-organizational structures and interpersonal relationships in project-based organizations in the construction industry

Jelle Koolwijk

The aim of this PhD project was to explore the multi-level interplay between the inter-organizational structures and interpersonal relations in building project organizations. In the first two studies, quantitative approaches were used to validate assumptions about how inter-organizational structures are shaped by actors and how interpersonal relationships affect the effectiveness of project teams in the construction industry. These two studies were integrated in a third qualitative case study that explored the interplay between inter-organizational structures and interpersonal relationships in long-term partnerships.

The third study sampled three cases of strategic partnerships which are characterized as long-term, highly integrated and collaborative relationships. To gain theoretical sensitivity in this third study, a conceptual framework was developed using the concepts from the first two studies. The major finding across the three studies is that the way integration in the supply chain develops is highly dependent on the interaction between project actors. The way actors use the inter-organizational rules of a project organization, influences the level of trust and no-blame culture that emerges through interaction. In turn, the level of trust can influence the rules of actors. More specifically, dominant actors seem to able to change the rules of the system. When a dominant actor uses his power position to change the rules of the social system, it can make other actors lose their commitment to the partnership.

This research shows that successful long-term and close collaboration between firms continuously requires careful consideration of how the organizational structures are designed and used and their effect on relationships between actors. One should not assume that integrated contracts and integrative practices that have been shown to work in one project, will automatically lead to close and long-lasting relationships between actors in another project.

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