COLLABORATION FOR INNOVATION IN THE CONSTRUCTION SECTOR
KEY ACTORS AND RESOURCE ALLOCATION DECISIONS

MAARTEN RUTTEN

Collaboration for innovation in the construction sector

Key actors and resource allocation decisions

Maarten E.J. Rutten

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When working on my Master thesis at Eindhoven University of Technology, I considered doing a PhD after my studies. I enjoyed conducting the research for my Master thesis that much, that it seemed an attractive option. Further, doing a PhD would give me the opportunity to learn a lot. Eventually, I decided otherwise. After my studies, I started working as a consultant in the field of sustainability. However, about a year later, I was once again considering doing a PhD. The job at the consultancy firm was not as I had expected. I then remembered that a friend of me, with whom I had discussed the idea of doing a PhD a year before, had said that he had once visited the department of Construction Management and Engineering at the University of Twente, and that the research and atmosphere at the department had been impressive. Not much later, I quit my job, and started the PhD research that led to this thesis. In the years that followed, I enjoyed travelling the road of PhD research. Along the way I became assistant professor, moved to the region of Eindhoven with the love of my life, changed jobs to work at Avans University of Applied Sciences, and became father of two lovely daughters. Now, about ten years later, I can conclude that it was a good decision to start doing a PhD. I had a good time, and I definitely learned a lot. I used the opportunities available to learn to review and integrate different fields of literature, to conduct both qualitative and quantitative empirical research, and to publish my work in peer-reviewed scientific journals. Overall, I am thankful to have had the opportunity to do a PhD.

There are many people who contributed to make my PhD an enjoyable and valuable journey. To all of them I say, thank you, thank you very much. Some I would like to mention in particular. Professor André Dorée and professor Joop Halman, you taught me what good research is about. I will remember the many conversations that we had, and take with me the important lessons that I learned from you. I would also like to thank all my other colleagues from the department of Construction Management and Engineering at the University of Twente, and from the School of Built Environment at Avans University of Applied Sciences. In particular for the good times and valuable discussions over the years.

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Contents

List of publications

The research presented in this thesis led to the following publications.

Journal papers

Chapter 2: Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2009) Innovation and interorganizational cooperation: a synthesis of literature. *Construction Innovation*, 9(3), 285-297.

Chapter 3: Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2016) Towards a deeper understanding of how champions influence the allocation of resources to collaborative innovation projects. *Manuscript submitted for publication*.

Chapter 4: Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2013) Exploring the value of a novel decision-making theory in understanding R&D progress decisions. *Management Decision*, 51(1), 184-199.

Chapter 5: Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2014) Together on the path to construction innovation: yet another example of escalation of commitment? *Construction Management and Economics*, 32(7-8), 653-657.

Conference papers

Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2013) To continue investment in a collaborative innovation project: a good decision? *Presented at the 29th Annual ARCOM Conference*, September 2 - 4, Reading, UK.

Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2008) How companies without the benefit of authority create innovation through collaboration. *Presented at the 24th Annual ARCOM Conference*, September 1 - 3, Cardiff, UK.

Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2008) Fostering commitment to cooperate when leading interorganizational innovation. *Presented at the 15th International Product Development Management Conference*, June 30 - July 1, Hamburg, Germany.

Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2007) Interorganizational cooperation in innovation: the role of systems integrators. *Presented at the 1st ManuBuild International Conference,* April 25 - 26, Rotterdam, The Netherlands. [awarded the 'Best Paper Award']

Other publications

Rutten, M. E. J. (2008) LamikonLongLife en de Q-woning: twee voorbeelden van samen innoveren. *Building Innovation*, September, Amsterdam: Building Business, 30-33.

Rutten, M. E. J. & Grevers, A. (2007) Leiderschap in open innovatie: voorbeelden uit de bouw. *Building Innovation*, October - November, Amsterdam: Building Business, 14-19.

Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2007). *Systeemintegratoren in de bouw: leiderschap in innovatie*. Gouda: PSIBouw.

Rutten, M. E. J. (2007) Steeds meer bedrijven nemen rol van systeemintegrator op zich. *Cobouw*, April 26, Den Haag: SDU.

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CHAPTER 1

Chapter 1 - Introduction

This chapter provides an introduction to the research presented in this thesis. The background and rationale for the thesis are described in the first four sections. This is followed by the research objectives in the fifth section. Subsequently, in the sixth section, an introduction is provided to the four studies that form the main body of the thesis. The chapter ends with an outline of the complete thesis.

1.1 Construction: a fragmented sector

Humans have been creating buildings for ages. From prehistoric dwellings out of wood and rock, to modern skyscrapers. Ever more ingenious combinations of materials and components have given rise to more and more sophisticated buildings. Today's buildings have been termed 'complex product systems' (Winch, 1998; Barlow, 2000; Gann and Salter, 2000). The term complex product systems refers to systems that are customized, made up of many different components, and produced in one-off projects or in small batches (Miller *et al.*, 1995; Hobday, 1998; Davies and Brady, 2000; Eriksson, 2000). Buildings are not the only systems that have been termed complex product systems. Other examples include telecommunications systems, flight simulators, high-speed trains, air traffic control systems, chemical process plants, and baggage handling systems.

As is the case with other complex product systems (Prencipe, 1997; Hobday, 1998), the production of a building is organized in a project involving a variety of specialized firms. Today's construction projects involve firms specialized in areas such as property development, architecture, structural engineering, mechanical and electrical engineering, project management, construction, and the fabrication of building components and materials. Further, within the two last mentioned categories – construction and the fabrication of building components and materials – both the number and diversity of firms are large. Consequently, when looking at the construction sector's value chain in its broadest sense, the general picture is that of a sector consisting of many different firms. Or, as others have put it, a sector that is characterized by high levels of fragmentation (Barlow, 2000;

Dulaimi *et al.*, 2002; BIS, 2013). The many different firms being the fragments, the sector being the whole.

1.2 Collaboration for innovation

The construction sector's fragmented nature does not only cause the production of a building to be a cooperative effort, but has also implications for how innovations are created (Toole *et al.*, 2013). In a seminal paper of Dubois and Gadde (2002) on the influence of construction sectors' characteristics on innovation, later extended by Dorée and Holmen (2004), it is argued that collaboration beyond the scope of an individual construction project is an important source of innovation in the construction sector. Similarly, Miozzo and Dewick (2004) argue that firms in the construction sector 'must rely on the capabilities of other firms to produce innovations and this is facilitated by some degree of continuing cooperation between those concerned with the development of products, processes and designs.' This includes continuing cooperation between firms such as architecture firms, engineering firms, construction firms, and suppliers of building components and materials. Overall, there are various studies and industry reports that stress the importance of inter-firm collaboration for innovation in the construction sector (Latham, 1994; Egan, 1998; Dulaimi *et al.*, 2002; BIS, 2013). Further, the notion that collaboration is an important source of innovation is also present in construction sector reform programmes around the world. Ambitions to enhance innovation by promoting collaboration between firms have been part of sector reform programmes in various countries (Barlow, 2000; Flanagan *et al.*, 2001; Ang *et al.*, 2004; Dorée, 2004; Holmen *et al.*, 2005; Cable *et al.*, 2013).

The notion that inter-firm collaboration is important for innovation applies to many industries. Studies presented in literature on innovation in complex product systems industries (see for example: Brusoni *et al.*, 2001; Prencipe, 2003; Hobday *et al.*, 2005), in literature on open innovation (see for example: Chesbrough and Crowther, 2006; Laursen and Salter, 2006; van de Vrande *et al.*, 2009), and in more general literature on innovation (see for example: Pittaway *et al.*, 2004; Dhanaraj and Parkhe, 2006) all point in the same direction. From low to high-technology industries, the same pattern can be observed. Due to economic specialization different firms carry out different activities along the value chain.

Such value chain fragmentation has an important consequence for innovation in such industries. The more value chain fragmentation, the higher the dispersion of resources such as knowledge, skills and technologies is among firms, and the more important inter-firm collaboration is to achieve innovation.

Overall, previous research indicates that, since resources are dispersed among many different firms in the construction sector, collaboration beyond the scope of an individual construction project is an important path to innovation. Collaborative innovation projects represent an example of such collaboration between firms. A collaborative innovation project is a project in which firms join forces to cooperate in the development and commercialization of a new building component, system, or service for a range of potential customers or clients (Blindenbach-Driessen *et al.*, 2010: 577). The aim being that the new building component, system, or service will be adopted in a series of future construction projects. As a result of this, the relationships between firms participating in a collaborative innovation project exceed the scope of an individual construction project. The joint development and commercialization of a new modular housing system as described by Hofman *et al.* (2009) is an example of such longer-term collaboration aimed at innovation. In the collaborative innovation project examined by Hofman *et al.* (2009) a construction firm, architecture firm, a supplier of exterior sandwich walls, a supplier of technical floor modules, and a supplier of technical installation modules joined forces. By bringing together their individual resources they were able to jointly develop and commercialize a new modular housing system.

1.3 A barrier to collaborative innovation

Due to the sector's fragmented nature, collaborative innovation projects constitute an important path to innovation in the construction sector. However, the conditions for collaborative innovation projects to arise and advance are unfavourable. This is caused by another defining characteristic of the sector: the characteristic that construction projects are often made up of temporary coalitions of firms (Winch, 1998). That is, firms tend to assemble for the purpose of an individual construction project, and disperse when the construction project is finished. As a result, the construction sector is characterized by an organization of shifting coalitions of firms around individual construction projects (Holmen *et al.*, 2005). This has led scholars to characterize the relationships among firms outside construction projects as ‘loose couplings’, and the sector as a whole as a ‘loosely coupled system’ (Dubois and Gadde, 2002; Dorée and Holmen, 2004; Ingemansson Havenvid *et al.*, 2016). Since collaborative innovation projects require firms to work together beyond the scope of an individual construction project, an essential feature of collaborative innovation projects (i.e. longer-term collaboration) conflicts with the construction sector’s loosely coupled nature. Consequently, collaboration for innovation between firms beyond the scope of an individual construction project is not a matter of course. Or in other words, it seems to be against the culture of the construction sector (Holmen *et al.*, 2005).

Overall, previous research suggests that there are two aspects of the construction sector that together create a barrier to innovation. That is, the sector’s fragmented value chain makes that collaborative innovation projects are an important path to innovation, yet at the same time the sector’s loosely coupled nature acts as a barrier to such collaborative innovation projects. It is this impasse that prompted the research reported in this thesis.

1.4 Field of study: key actors and resource allocation decisions

Since the conditions for collaborative innovation projects to arise and advance are not favourable in the construction sector, it is important to study and understand collaborative innovation projects. There are at least two lines of research that provide valuable insights in this respect and that call for further exploration.

1.4.1 Key actors

The first line of research that can be distinguished is that of key actors in bringing together firms and resources for collaborative innovation. Previous research for example provides indications that systems integrators might potentially perform a crucial role in collaborative innovation projects. The term ‘systems integrator’ refers to a class of firms. Systems integrators have been defined as firms that design and produce complex product systems by integrating externally supplied components, technologies, skills and knowledge into a system for an individual customer (Davies *et al.*, 2007). Previous research indicates that in some industries producing complex product systems – such as in the flight simulator industry (Miller *et al.*, 1995) and the aircraft engine industry (Brusoni *et al.*, 2001) – systems integrators have a central role in collaborative innovation projects. Since also the construction sector has been categorized as an industry producing complex product systems (Hobday, 1996; Barlow, 2000; Gann and Salter, 2000), systems integrators might perform a similar crucial role in collaborative innovation projects in the construction sector. As Winch (1998) however argued, little is known about the role of systems integrators in the construction sector.

Furthermore, previous research provides indications that also champions might perform a crucial role in collaborative innovation projects in the construction sector. The term ‘champion’ refers to a class of individuals. Champions have been defined as ‘individuals who make a decisive contribution to an innovation by actively and enthusiastically promoting its progress through critical stages (Rothwell *et al.*, 1974: 291)’. The role of champions in innovation was first discussed in an article by Schön (1963) on the development of radical innovations. Schön argued that the successful development of a new product idea requires the presence of a champion. As he put it: ‘the new idea either finds a champion or dies.’ The research conducted by Schön (1963) and others (Chakrabarti, 1974; Rothwell *et al.*, 1974) inspired many researchers, both in the construction sector and in other industries, to further explore the role of champions (see for example: Howell and Higgins, 1990; Nam and Tatum, 1997b; Bossink, 2004b; Howell *et al.*, 2005; Caerteling *et al.*, 2009). Some of these studies indicate that champions may perform an important role in collaborative innovation projects by bringing together resources and keeping projects alive (Markham *et al.*, 1991; Markham, 2000; Markham and Aiman-Smith, 2001). Markham (1998) argued that future research should address the mechanism by which champions influence resource allocation. Recent literature suggests that champions’ advocacy skills play an important role in managers’ project funding decisions (Schlapp *et al.*, 2015). A deeper understanding of how champions influence resource allocation is, however, still lacking.

1.4.2 Resource allocation decisions

A second line of research that provides valuable insights in the allocation of resources to collaborative innovation projects, and that calls for further exploration, is that of research on the decision to invest resources in an innovation project. The so-called Radar-Blank Plane (RBP) experiments conducted by organisational behaviour researchers provide relevant results in this respect. The RBP experiments suggest that firms participating in a collaborative innovation project are likely to escalate commitment (see for example: Arkes and Blumer, 1985; Conlon and Garland, 1993; Van Putten *et al.*, 2010). A firm is said to escalate commitment when it, for economically unsound reasons, decides to invest additional resources to continue the project (Staw, 1976; Schmidt and Calantone, 2002). Escalation of commitment is an undesirable phenomenon since it represents a waste of scarce resources. It is therefore important to understand why firms escalate commitment. Narrative-based decision theory may aid in enhancing this understanding (Beach, 2009a; Beach, 2010). Narrative-based decision theory is a new theory from the field of naturalistic decision-making; a field of research that aims to understand how people make decisions in real-word settings (Klein, 1993; Kahneman and Klein, 2009). Since narrative-based decision theory is a relatively new theory, the question of how exactly it may aid in understanding firms' resource allocation decisions is still to be explored.

The most prominent effect in the RBP experiments is the sunk cost effect. That is, the effect of past costs, or in other words of resources already spent, on the outcome of resource allocation decisions (Arkes and Blumer, 1985). The results of various RBP experiments suggest that firms participating in a collaborative innovation project are likely to escalate commitment when they expect a large loss of sunk costs if they would abandon project (see for example: Moon, 2001a; Moon, 2001b; Van Dijk and Zeelenberg, 2003; Westfall *et al.*, 2012). The second most studied in the RBP experiments is the project completion effect; first reported by Conlon and Garland (1993). The term project completion refers to how close an innovation project is to completion. In general, innovation projects are really only completed when the newly developed product or service has become profitable in the market place. The results of the RBP experiments suggest that firms participating in a collaborative innovation project are likely to escalate commitment when the collaborative innovation project has reached an advanced stage of progress (see for example: Moon *et al.*, 2003; He and Mittal, 2007; Harvey and Victoravich, 2009). However, since the RBP experiments involve student participants in laboratory settings, and not firms in real-world settings spending real money, an important question remains. To what extent are the findings of the RBP experiments indicative of what happens in collaborative innovation projects in the construction sector?

1.5 Objectives of the thesis

Overall, against the background as described in the foregoing sections, this thesis aims to contribute to the understanding of collaborative innovation projects in the construction sector. It attempts to do so in two ways. That is by contributing to the understanding of:

A. the role of systems integrators and champions in collaborative innovation projects;
B. the decisions of firms to invest resources in collaborative innovation projects.

1.6 Four studies

In the following chapters a series of four studies is presented. The studies are referred to as study I, II, III and IV respectively. By addressing the gaps in literature described in section 1.4, the four studies aim to contribute to the understanding of (A) the role of systems integrators and champions in collaborative innovation projects, and (B) the decisions of firms to invest resources in collaborative innovation projects. Figure 1 provides an overview of how each of the four studies relates to the objectives of the thesis.

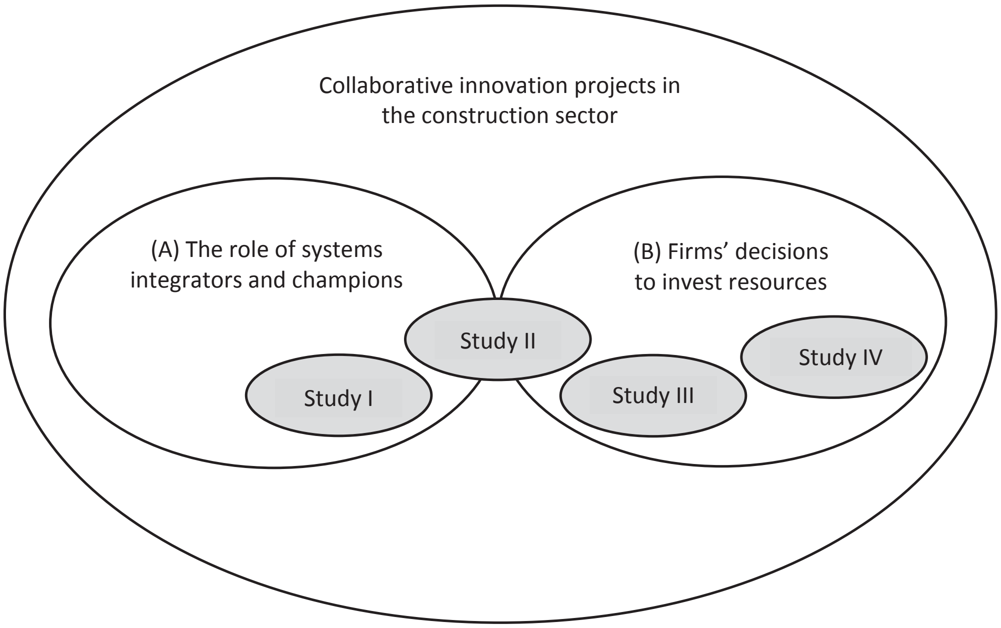

Figure 1. Connection between the four studies and the objectives of the thesis

The first study, study I, is a literature review. Study I aims to contribute to the understanding of (A) the role of systems integrators and champions in collaborative innovation projects. It does so by exploring the role of systems integrators in collaborative innovation in the construction sector. The study consists of three steps. First, the study reviews the literature on the role of systems integrators in complex product systems industries. Subsequently, the findings of this review are applied to the construction sector and used to elucidate what type of firms are the systems integrators of the construction sector. In addition, by integrating literature from related fields of research (i.e. literature on construction innovation, new product development, strategic networks and alliances, open innovation) the study further explores the role of systems integrators in collaborative innovation in the construction sector.

The second study, study II, is a case study of two collaborative innovation projects each involving multiple firms. In the first collaborative innovation project, a new renewable housing concept is developed and commercialized by a group of multiple firms. In the second collaborative innovation project, various firms joined forces in the development and commercialization of a new environmentally friendly window. Study II aims to contribute to

(A) the understanding of the role of systems integrators and champions in collaborative innovation projects, and (B) the understanding of the decisions of firms to invest resources in collaborative innovation projects. Study II does so by exploring how champions exactly influence the allocation of resources to collaborative innovation projects.

The third study, study III, is a literature review. Study III aims to contribute to (B) the understanding of the decisions of firms to invest resources in collaborative innovation projects. Study III does so by exploring the value of narrative-based decision theory (Beach, 2009a; Beach, 2010) as a theoretical lens for understanding such decisions. By applying narrative-based decision theory to a finding of previous experimental research on the decision to invest resources in an innovation project (i.e. the finding that instruction in the sunk cost principle may mitigate the sunk cost effect) study III explores how narrative-based decision theory might help in explaining firms' decisions about whether to continue investment in a collaborative innovation project.

The fourth study, study IV, is a survey study among 103 Dutch firms participating in 25 collaborative innovation projects developing and commercializing new building products, systems, or services. Study IV aims to contribute to (B) the understanding of the decisions of firms to invest resources in collaborative innovation projects. Study IV does so by examining the susceptibility of Dutch firms participating in collaborative innovation projects to escalate commitment when they expect a large loss of sunk costs if they would abandon the collaborative innovation project. And by examining the susceptibility to escalate commitment when the collaborative innovation project has reached an advanced stage of progress.

As a summary, Table 1 provides an overview of the central research questions addressed in the four studies and the methods used[1]. Each study addresses a gap in literature described earlier in this chapter (see section 1.4).

[1] To develop my research skills I followed various research method courses. See Appendix A for an overview.

Table 1. Research questions and methods

Study	Central research question	Method
Study I	What is the role of systems integrators in collaborative innovation in the construction sector?	Review and synthesis of literature on systems integrators in complex product systems industries, construction innovation, new product development, strategic networks and alliances, and open innovation.
Study II	How do champions influence firms' decisions to invest resources in a collaborative innovation project?	Case study of two collaborative innovation projects each involving multiple firms within the Dutch construction sector.
Study III	How may narrative-based decision theory aid in understanding firms' decisions to invest resources in a collaborative innovation project?	Review and synthesis of literature on narrative-based decision theory, the Radar-Blank Plane experiments, and the sunk cost effect.
Study IV	Are firms participating in a collaborative innovation project likely to escalate commitment when they expect a large loss of sunk costs if they would abandon the project? Or when the collaborative innovation project has reached an advanced stage of progress?	Survey among 103 firms participating in 25 collaborative innovation projects within the Dutch construction sector.

1.7 Outline of the thesis

The remainder of this thesis consists of five chapters. The findings of studies I, II, III and IV are reported in a series of papers presented in chapter 2, 3, 4 and 5 respectively. The papers presented in chapter 2, 4 and 5 have been published before in peer-reviewed scientific journals; i.e. in Construction Innovation, Management Decision, and Construction Management and Economics respectively. (The paper presented in chapter 3 is currently under review at a scientific journal.) Finally, chapter 6 of this thesis summarizes the main contributions and discusses the implications for future research and practice.

CHAPTER 2

Chapter 2 - The role of systems integrators in collaborative innovation in the construction sector (study I)

This chapter has been published in Construction Innovation [2]

2.1 Introduction

The construction industry is characterized by its highly fragmented supply chain. Knowledge, materials, technologies and skills are dispersed among many different organizations. Many studies have highlighted that construction industry's fragmentation in combination with poor interorganizational cooperation is hampering innovation (Latham, 1994; Egan, 1998; Dulaimi et al., 2002). Ambitions to enhance innovation in construction industry are part of many reform programmes in various countries (Barlow, 2000; Flanagan et al., 2001; Ang et al., 2004; Dorée, 2004).

Scholars have argued that it is interorganizational cooperation across project boundaries in particular, that is important for innovation in construction (Dewick and Miozzo, 2004; Dorée and Holmen, 2004; Miozzo and Dewick, 2004; Holmen et al., 2005). Researchers suggest that close and stable relations between the various organizations involved in the construction process, such as contractors, architects, engineers, suppliers, clients, research institutes and government bodies, contribute to the development and adoption of innovations. It is argued that close and stable relations facilitate sharing of knowledge and risks.

Based on the argument that interorganizational cooperation is an important factor in construction innovation, an interesting question is: What firms are creating and orchestrating the type of interorganizational cooperation that is needed? From this point of view, literature on complex product systems provides interesting insights. Complex product systems (CoPS) are products that are customized, made up of many components, based on multiple technologies, and produced in one-off projects or in small batches. Examples

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[2] Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2009) Innovation and interorganizational cooperation: a synthesis of literature. *Construction Innovation*, 9(3), 285-297.

include flight simulators, military systems, aircraft engines, chemical plants, buildings, and business information networks. Also construction industry can be categorized as a CoPS industry (Hobday, 1996; Winch, 1998; Barlow, 2000; Gann and Salter, 2000). In CoPS literature, scholars focus on a specific type of firm: systems integrators. The concept of systems integrator refers to firms that design and produce CoPS. Systems integrators add value through systems integration: they integrate components, technologies, skills and knowledge from various organizations into a unified system for an individual customer. To do so, systems integrators set up a strategic network of organizations and coordinate the process of integrating dispersed resources of the network members.

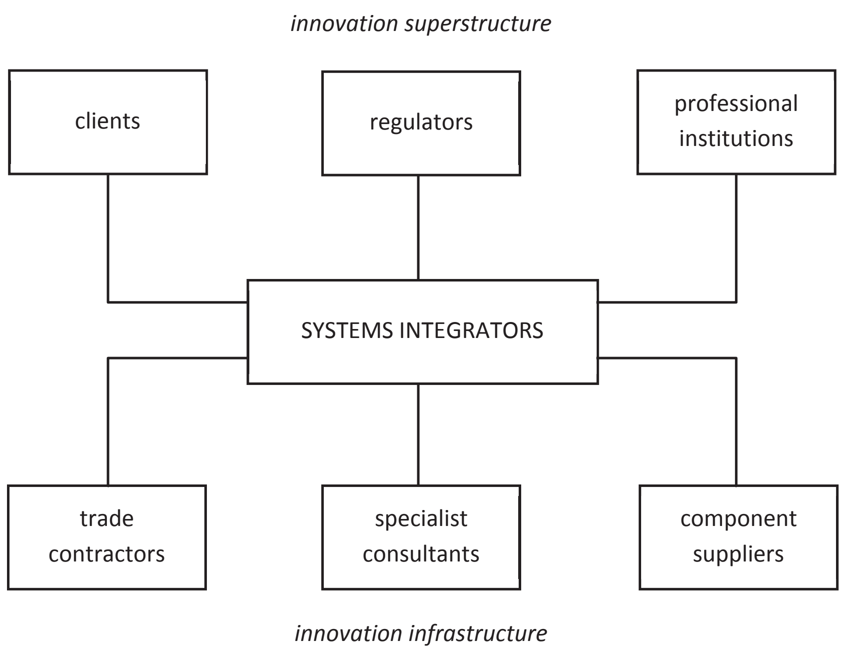

Figure 2. The innovation structure in CoPS industries; adapted from Miller *et al.* (1995) and Winch (1998)

When it comes to innovation in CoPS industries systems integrators are in a central position (see Figure 2). They are at the interface between innovation superstructure and innovation infrastructure (Miller et al., 1995; Winch, 1998). The innovation superstructure consists of clients, regulators and professional institutions. The innovation infrastructure comprises component suppliers, trade contractors and specialist consultants. Due to this central position, scholars argue that the main role of systems integrators in innovation of CoPS is to meet evolving customer requirements by orchestrating R&D activities of the innovation infrastructure (Brusoni et al., 2001; Prencipe, 2003).

By deductive reasoning an interesting conclusion can be drawn from CoPS literature. The line of reasoning is as follows:

- In CoPS industries systems integrators set up and coordinate interorganizational innovation (major premise).
- Construction industry can be categorized as a CoPS industry (minor premise).
- In construction industry systems integrators set up and coordinate interorganizational innovation (conclusion).

Following this line of reasoning it would of interest to identify systems integrators in construction industry and explore how they achieve interorganizational innovation. However, the term systems integrator is not a commonly used term in construction industry. Who are the systems integrators of construction industry? Before a theory can be developed of how systems integrators achieve interorganizational innovation, they need to be identifiable. Therefore, to clear the path to theory development, this paper captures the constituents of the term 'systems integrator' by reviewing CoPS literature and subsequently translates them to the context of construction industry.

Furthermore, interorganizational cooperation and innovation are being studied in various fields of research. The accompanying bodies of literature all contain information concerning factors that are critical for achieving success. Together, this information serves as a valuable foundation from which to develop a theory of how systems integrators achieve interorganizational innovation. Since the objective of this paper is to pave the way towards theory development, it also presents an overview of critical factors derived from various relevant bodies of literature.

2.2 A classification of firms in CoPS industries

The concept of systems integrator has been used to describe producers of CoPS: producers of flight simulators (Miller *et al.*, 1995), aircraft engines (Prencipe, 1997; Brusoni and Prencipe, 2001), buildings (Winch, 1998), aircraft engine control systems (Brusoni *et al.*, 2001), chemical plants (Brusoni and Prencipe, 2001), and military systems (Hobday *et al.*, 2005). In these industries both physical and human resources, such as subsystems, components, technologies, skills, information and knowledge are dispersed among various organizations. CoPS producers are positioned at the interface between customers and the supply network. The primary constituent of the term 'systems integrator' is systems integration: to bring together dispersed resources and integrate them into a coherent system. However, the term systems integrator comprises more than the act of systems integration. Two other constituents are: contractual responsibility for the functioning of the system, and project-based production (one-offs or small batches). Taken together, these three characteristics define a category of firms that add value through systems integration in project-based industries. These characteristics correspond with the definition of Davies *et al* (2007): 'In its pure form, a systems integrator is the single prime contractor organization responsible for designing and integrating externally supplied product and service components into a system for an individual customer.'

2.2.1 The twofold role of systems integrators

When examining the descriptions of systems integrators' activities (Brusoni *et al.*, 2001; Prencipe, 2003; Hobday *et al.*, 2005) it becomes clear that the role of systems integrator comprises two main tasks:

- Firstly, systems integrators set up a network of various organizations. From a strategic viewpoint, they configure the organizational network in terms of members, relationships and division of work. This includes decision making regarding issues such as sourcing (insourcing vs. outsourcing) and the type of contractual terms (formal vs. informal) to be adopted in relationships.
- Secondly, systems integrators coordinate the work of the organizations involved in the network. By orchestrating the activities of the network members (such as design, production and R&D) systems integrators guarantee the coherence of the network output.

2.2.2 Two analytical levels of systems integration

Besides two types of tasks, also two different analytical levels of systems integration can be distinguished. The first analytical level concerns the level of production. This level of systems integration has been labelled variously: static systems integration (Brusoni *et al.*, 2001), synchronic systems integration (Prencipe, 2003) and intrageneration systems integration (Hobday *et al.*, 2005). It refers to the role of prime contractors that set up and coordinate a network of organizations for the design and construction of a complex product system within a predefined time period and financial budget. Systems integration in production networks is aimed at achieving technological and organizational synchronization. Technological synchronization refers to the configuration of components and is related to the overall consistency and functioning of the complex product system. Organizational synchronization refers to the organization of the production process, and is related to the efficiency of the supply chain.

The second analytical level of systems integration takes a more long-term view on the cooperative relationships. Besides production, systems integration is also considered on the level of innovation. It concerns the creation of incremental or radical innovations to meet evolving customer requirements or changing regulatory requirements. This level of systems integration is labelled, respectively, dynamic systems integration (Brusoni *et al.*, 2001), diachronic systems integration (Prencipe, 2003) and intergeneration systems integration (Hobday *et al.*, 2005). It refers to CoPS producers that develop new product families in cooperation with various organizations, such as suppliers, trade contractors, consultants and clients.

2.3 Systems integrators in construction industry

The three characteristics that constitute the basis for classifying a firm as a systems integrator can be used to identify systems integrators in construction industry. Taking into account the single point responsibility for the system as a whole, the role of systems integrator manifests itself in a specific set of construction projects: construction projects in which a single firm is contractually responsible for the performance of the structure. In other words, in design-build projects or turn-key projects. Firms that act as single prime contractor in these types of construction projects, and that perform the task of systems integration, can be categorized as systems integrator. At least, if they also meet the third condition: project-based production. However, in most cases, this last condition will be met when a firm already meets the first two conditions, since construction industry is a typical example of a project-based industry.

This way of classifying firms in construction industry as systems integrators differs from previous literature. Winch (1998) was the first to translate the concept of systems integrator to the organizational actors as we know in construction industry. According to Winch 'the systems integrator role is shared between the principal architect/engineer and the principal contractor. Thus construction typically has two separate systems integrators - one at the design stage and one at the construction stage'. We share Winch's view that the task of systems integration is often split among these two actors. This is the case in construction projects in which the design-bid-build method of contracting is being used. However, as can be derived from the growing body of literature, the classification of systems integrator comprises more than performing a part of the task of systems integration. Systems integrators perform the complete task of systems integration. They take care of both design and construction of a system. Therefore, we suggest classifying firms that only provide design or construction not as systems integrators. Furthermore, besides the design and construction of a system, some systems integrators also provide additional services, such as maintenance, financing or operational services. Examples of this type of systems integrators include the Special Purpose Vehicles that can be found in PFI projects (Brady *et al.*, 2005).

Since the percentage of construction projects in which one firm is contractually responsible for both design and construction is rising in various countries, such as the UK (Khalfan and McDermott, 2006), Netherlands (Dorée, 2004), and US (Pietroforte and Miller, 2002), it is plausible that the percentage of construction projects contracted to a systems integrator is rising. This theoretical deduction follows from the second constituent of the term 'systems integrator': contractual responsibility for both design and construction of a system.

2.3.1 Examples from practice

Two examples from the Netherlands show the existence of firms in construction industry that act as a systems integrator and setup and coordinate interorganizational innovation. Table 2 lists the characteristics of both examples. We derived the data about the examples through a desk study and interviews with the firms. In both examples the initiative started with the firm having an idea for a new system and the aspiration to put it on the market as a systems integrator. However, in both examples the firms lacked the complete range of resources, skills and knowledge which were needed to develop the idea into a ready-to-market system. Therefore, they started searching for organizations such as component suppliers, trade contractors and specialist consultants that were willing to cooperate. Subsequently, the firm orchestrated the interorganizational innovation process. In other words, the twofold role of systems integrators as displayed in CoPS projects, was also present in both innovation processes (network setup and network coordination). In both examples the co-developers also constitute the value chains for the individual projects in which the new systems are adopted.

To typify both innovations, a well-known classification scheme can be used. The innovations can be described as new sets of components that constitute the core of a new family of projects. To achieve innovation, the systems integrators and co-developers jointly developed new components or new ways of linking components together (or a combination of both). This distinction between the novelty of the components of a system and the novelty of the way components are linked together, aligns with the distinction between modular and architectural innovation, as introduced by Henderson and Clark (1990).

Table 2. Two examples from practice

Systems integrator	Description of innovation	Co-developers
Manufacturer of prefabricated accommodation	Qbiz®: modular building system for buildings with a high degree of flexibility through the use of new components which are easy to decouple.	Supplier of interior wall/ceiling systems Concrete technology consultant Innovation management consultant Steel contractor Electrical/mechanical contractor
Manufacturer of wooden windows	Lamikon LongLife®: a system for wooden windows. The focus of the system is on lowering life cycle costs by reducing maintenance costs.	Technology development firm Maintenance contractor Supplier of glass Supplier of wood Supplier of coatings Supplier of fasteners Supplier of finishing elements Supplier of building protection products

Both examples illustrate the existence of firms in construction industry that act as a systems integrator and perform a central role in interorganizational innovation. However, it is not clear what factors are critical in achieving such interorganizational innovation. Theory is needed to bridge this gap. The next section provides a solid base for such theory development.

2.4 Understanding interorganizational innovation

Four different but related fields of literature provide relevant insights with regard to interorganizational innovation:

1. literature on new product development (Montoyaweiss and Calantone, 1994; Brown and Eisenhardt, 1995; Cooper and Kleinschmidt, 1995; Griffin and Page, 1996; Song and Parry, 1997; Henard and Szymanski, 2001);
2. literature on strategic networks and alliances (Thorelli, 1986; Lorenzoni and Badenfuller, 1995; Powell *et al.*, 1996; Dyer and Singh, 1998; Gulati, 1998; Ahuja, 2000; Das and Teng,

2000; Gulati *et al.*, 2000; Zollo *et al.*, 2002; Gerwin, 2004; Dhanaraj and Parkhe, 2006; Lavie, 2006);

3. literature on open innovation (Chesbrough, 2003; Chesbrough and Crowther, 2006; Dodgson *et al.*, 2006; Fetterhoff and Voelkel, 2006; Laursen and Salter, 2006).
4. literature on construction innovation (Pries and Janszen, 1995; Nam and Tatum, 1997a; Bossink, 2002; Dubois and Gadde, 2002; Xiao and David, 2002; Blayse and Manley, 2004; Bossink, 2004b; Dewick and Miozzo, 2004; Dorée and Holmen, 2004; Miozzo and Dewick, 2004; Holmen *et al.*, 2005; Pries and Dorée, 2005; Blindenbach-Driessen and van den Ende, 2006; Hartmann, 2006; Kulatunga *et al.*, 2006; Veenstra *et al.*, 2006).

Firstly, literature on new product development provides insight in factors that are critical for the success of new products (Montoyaweiss and Calantone, 1994; Brown and Eisenhardt, 1995). The dependent variable in this field of literature is close to interorganizational innovation. The difference is that the focus is on new product development within a single organization, instead of the development of a new system by a network of several organizations.

Secondly, literature on strategic networks and alliances provides insight in the factors that are critical for the performance of networks of cooperating organizations. However, the organizational networks that are being studied in this stream of research are not necessarily aimed at the deliberate creation of innovations (Gulati, 1998). Only part of the literature in this field is solely concerned with innovation networks. In this subset of literature, scholars argue little is known about how new product development is successfully coordinated in strategic networks and alliances (Gerwin, 2004; Dhanaraj and Parkhe, 2006).

Literature on open innovation can be regarded as complementary to the literature focusing on innovation in strategic networks and alliances. Scholars argue that firms in various industries are currently shifting to an ‘open innovation’ model, a more open strategy towards innovation (Chesbrough, 2003; Laursen and Salter, 2006). Firms try to create customer value through active search for new technologies and ideas outside of the firm, but also through cooperation with suppliers and competitors. Literature on open innovation is of interest because it provides insight in the process of interorganizational cooperation in innovation.

Lastly, in literature on construction innovation researchers describe the characteristics of the process of innovation in construction industry and discuss how specific industry characteristics affect this process (Blayse and Manley, 2004). These insights are helpful for understanding the context in which systems integrators operate. Furthermore researchers discuss factors that are critical for innovation.

Table 3 shows an overview of dependent variables and accompanying critical factors, as reported in the four fields of literature (sources are papers providing an extensive literature review or papers presenting findings from empirical research). Besides the dependent variables also the indicators are mentioned which are used to measure the various dependent variables. As the dependent variables in the other fields of literature are closely related to interorganizational innovation, it is possible that the factors play a role for systems integrators to achieve interorganizational innovation. In Table 3 the factors have been assigned to one of the two main tasks of systems integrators: network setup and network coordination.

Table 3. Factors, dependent variables and measures as reported in the four related fields of literature

Research field	Network setup factors	Network coordination factors	Dependent variables & measures
New product development	(Brown and Eisenhardt, 1995) → customer involvement, supplier involvement, gatekeepers, moderate tenure (Montoyaweiss and Calantone, 1994) → marketing synergy, technological synergy, strategy, company resources, protocol	(Brown and Eisenhardt, 1995) → internal/external communication, senior management support, organization of work (Montoyaweiss and Calantone, 1994) → product advantage, proficiency of predevelopment activities, proficiency of market-related activities, proficiency of technological activities, speed to market, costs, financial/business analysis, internal/external communication	(Brown and Eisenhardt, 1995) → success of product development: profits, revenues, market share (Montoyaweiss and Calantone, 1994) → new product performance: profit, sales, payback period, costs, market share (Griffin and Page, 1996) → product development success: customer satisfaction, customer acceptance, market share goals, revenue goals, revenue growth goals, met profit goals, met margin goals, IRR or ROI, competitive advantage, met performance specs, met quality specs
Strategic networks and alliances	(Gulati, 1998) → complementary resources, critical strategic interdependence, partners of known reputation, social embeddedness (Das and Teng, 2000) → resource alignment	(Gulati, 1998) → governance structure, trust between partners, opportunistic behaviour, regular information exchange, long term commitment (Dhanaraj and Parkhe, 2006) → knowledge mobility, innovation appropriability, network stability	(Gulati, 1998) → alliance performance: survival of alliance, participants' assessment of success (Dhanaraj and Parkhe, 2006) → network innovation output (Das and Teng, 2000) → alliance performance: alliance longevity, alliance profitability, agreed goal achievement

Table 3. (continued)

Research field	Network setup factors	Network coordination factors	Dependent variables & measures
Open innovation	(Chesbrough, 2003) → porosity of firm boundaries	(Laursen and Salter, 2006) → breadth of external search, depth of external search	(Chesbrough, 2003) → firm's innovative success (Laursen and Salter, 2006) → firm's innovative performance: turnover relating to products new to the world market, turnover pertaining to products new to the firm, turnover pertaining to products significantly improved
Construction innovation	(Blindenbach-Driessen and van den Ende, 2006) → senior management involvement, team composition, involvement of outside parties (Bossink, 2004b) → environmental pressure, technological capability, boundary spanning (Dewick and Miozzo, 2004; Dorée and Holmen, 2004; Holmen *et al.*, 2005) → tightness of inter-organizational relations (Nam and Tatum, 1997a) → owner's involvement, presence of champion, technological competence of leader	(Blindenbach-Driessen and van den Ende, 2006) → planning of work, activities undertaken (Bossink, 2004a) → leadership style (Bossink, 2004b) → knowledge exchange	(Blindenbach-Driessen and van den Ende, 2006) → success of innovative projects: on time, within budget, quality, use of service by clients, possibly as part of other services, impact on reputation, learning effects for future innovation activities (Nam and Tatum, 1997a; Bossink, 2004b) → construction innovation: project innovativeness (Dewick and Miozzo, 2004) → adoption of new technologies (Dorée and Holmen, 2004; Holmen *et al.*, 2005) → technological innovativeness of projects

2.5 Conclusion

Following Schumpeter (1934), innovations can be regarded as 'new combinations'. This definition of innovation seems particularly appropriate for construction innovation. In construction industry innovations do not only comprise an innovative combination of materials, but, due to the fragmentation of the value chain, also a combination of organizations. This is reflected in the argument in construction literature that interorganizational cooperation is important for achieving construction innovation, in particular interorganizational cooperation across project boundaries. This paper contributes to the extant literature by integrating knowledge from various bodies of literature in which the subject of interorganizational cooperation and innovation is addressed. Firstly, we structure the current knowledge on the role and characteristics of systems integrators, of whom it is stated in CoPS literature that they set up and coordinate interorganizational innovation. Subsequently we translate this knowledge to the context of construction industry and discuss the basis for classifying a firm as a systems integrator in construction industry. Furthermore, we present an overview of success factors derived from literature on new product development, strategic networks and alliances, open innovation, and construction innovation. This overview provides a solid base for future theory development on how systems integrators achieve interorganizational innovation in construction industry. Such a theory should be parsimonious (Eisenhardt, 1989; Whetten, 1989) and should also explicate the causal logic that explains why certain factors are of importance (Sutton and Staw, 1995). Since the number of factors in Table 3 is high, we suggest therefore identifying critical factors by uncovering causal logic during case studies.

2.5.1 Business implications

To study interorganizational innovation in the construction industry is especially relevant due to the current situation in construction industry. In many countries industry reform programs have been set up to improve construction industry's performance. One of the goals of these reform programs is to enhance innovation. This paper is especially valuable for those firms in construction industry who seek to create competitive advantage through interorganizational innovation. It provides them with an overview of factors that have been related to interorganizational cooperation and innovation.

CHAPTER 3

Chapter 3 - Towards a deeper understanding of how champions influence the allocation of resources to collaborative innovation projects (study II)

This chapter is under review at a scientific journal [3]

3.1 Introduction

The first studies on the role of champions in the construction industry are from the 1980s and 1990s (Tatum, 1984; Nam *et al.*, 1991; Nam and Tatum, 1997a). New studies in this field are continuing to increase our understanding of the role of champions (Toole *et al.*, 2013; Sergeeva, 2014; Herazo and Lizarralde, 2015; Shibeika and Harty, 2015). The effect that has received the most attention from construction management researchers is that of champions on the innovativeness of construction projects (Tatum, 1984; Nam *et al.*, 1991; Nam and Tatum, 1997a; Barlow, 2000; Bossink, 2004b; Dulaimi *et al.*, 2005; Gambatese and Hallowell, 2011a). Other effects studied in this field include the effects of champions on the extent to which technical innovations diffuse within the construction industry (Gambatese and Hallowell, 2011b), on the social outcomes of 'Percent for Art' projects (McCabe *et al.*, 2011) and on the performance of technology development projects in road infrastructure (Caerteling *et al.*, 2009).

The present study focuses on a champion effect that has been found in other industries, such as the aeronautics and space industry, the steel industry and the chemical industry (Chakrabarti, 1974; Markham *et al.*, 1991; Markham, 2000), but that has remained unexplored in the construction industry. Here we refer to the effect of champions on resource allocation. Studies conducted by Chakrabarti (1974), Markham *et al.* (1991) and Markham (2000) indicate that the presence of a champion in an innovation project makes it more likely that resources will be allocated to the innovation project. It has been argued in recent literature that champions' advocacy behaviour may explain this effect (Schlapp *et al.*,

[3] Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2016) Towards a deeper understanding of how champions influence the allocation of resources to collaborative innovation projects. Manuscript submitted for publication.

2015). A deeper understanding of how champions influence resource allocation is, however, lacking.

Drawing on a case study, we explore how champions in the construction industry affect firms' willingness to allocate resources to collaborative innovation projects. The term 'collaborative innovation project' refers to projects in which firms join forces to cooperate in the development and commercialization of a new building product or system for a range of potential customers or clients. (This definition is based on the definition of an innovation project offered by Blindenbach-Driessen *et al.* (2010: 577).) To explore champions' effect on resource allocation in the context of collaborative innovation projects, instead of innovation projects within single firms, is of particular relevance since construction industry's fragmented and loosely coupled nature makes inter-firm collaboration an important path to innovation in the construction industry (Dubois and Gadde, 2002; Miozzo and Dewick, 2004; Hofman *et al.*, 2009; Rutten *et al.*, 2009; Toole *et al.*, 2013).

3.2 Previous research on champions

The role of champions in innovation was first discussed in an article by Schön (1963) on the development of radical innovations. Schön argued that the successful development of a new product idea requires the presence of a champion. As he put it: 'the new idea either finds a champion or dies.' In his article, champions are characterized as individuals 'who identify with the idea as their own, and with its promotion as a cause, to a degree that goes far beyond the requirements of their job. In fact, many display persistence and courage of heroic quality (Schön, 1963: 84-85).' Roughly ten years later, a study of 43 innovation pairs provided support for Schön's claim (Rothwell *et al.*, 1974). That study, entitled project SAPPHO, was designed to discover differences between successful and unsuccessful innovations. The study's findings indicated that the presence of a champion was positively related to the commercial success of an innovation. The study defined the presence of a champion as the presence of 'any individual who made a decisive contribution to the innovation by actively and enthusiastically promoting its progress through critical stages' (Rothwell *et al.*, 1974: 291). In the same year, the results of another study on the role of champions, based on an assessment of 45 NASA innovations, were also published

(Chakrabarti, 1974). Here, Chakrabarti argued that the presence of a champion increases the likelihood that a new product idea is actually developed into a new product that is then marketed. Further, he argued that the important role of the champion in the development of a new product lies in 'selling the idea to management and getting the management sufficiently interested in the project'. Together, the articles by Schön (1963), Rothwell *et al*. (1974) and Chakrabarti (1974) represent widely cited early work on the role of champions in innovation.

It is important to note that whereas the early work characterizes champions as heroes of innovation, later work provides a more balanced view (Schilling, 2010). For example, more recent work also suggests that champions sometimes want to go too fast in the beginning of an innovation project (Boersma, 1994), or may ignore important negative information and persist in the mistaken belief that their ideas will be successful (Walter *et al.*, 2011). In addition, it has been suggested that firms may benefit from cultivating so-called 'anti-champions' or 'exit-champions', i.e. individuals who play the role of devil's advocate, to counter the risks of champions' behaviour (Devaney, 1991; Royer, 2003).

3.2.1 Champions' behaviour

The importance attributed to the role of champions in innovation, as articulated in the early literature, has inspired researchers, both in the construction industry and in other industries, to further explore what it is that characterizes champions. For example, based on a study of 28 information technology innovations, Howell and Higgins (1990) argue that champions exhibit transformational leadership behaviours (inspiration, intellectual stimulation and charisma) to a greater extent than non-champions, that they display greater achievement, risk taking and innovativeness than non-champions and that they make more attempts to influence and use a greater variety of influence tactics than non-champions. In addition, based on the same study, Howell and Boies (2004) argue that champions provide more enthusiastic support for new ideas than non-champions, that they more often tie the innovation to a greater range of positive organizational outcomes than non-champions and that they use informal selling processes more often than non-champions. Based on a study of ten innovative construction projects, Nam and Tatum (1997a) argue that, in the construction industry, champions usually occupy senior managerial positions and possess technical competence. Overall, a characteristic that has sparked discussion is the capacity of champions to influence others (Howell and Higgins, 1990). A study of eight champions in the UK facility management sector (Leiringer and Cardellino, 2008) contributed to this discussion by concluding that champions seem to influence others by using rhetorical strategies.

Taken together, these studies have contributed to identifying behaviours that characterize champions. However, a related question that remained unanswered for quite some time was which behaviours best characterize champions? In other words, which behaviours are prototypical of champions? A study by Howell *et al.* (2005) provided the first rigorous attempt to answer this question. The study was designed to develop and validate a measure of champion behaviour. It involved champions from various industries and consisted of three empirical phases. In an initial study, a list of 102 different champion behaviours was generated. Subsequently, the prototypicality of each of these behaviours was examined through a second study that led to the identification of 29 champion behaviours that appeared 'to represent the core of the domain of championship' (for an overview see Howell *et al.*, 2005: 649). Finally, the results of a third study indicated that the 29 champion behaviours reflected three core behaviours: (1) expressing enthusiasm and confidence about the success of the innovation; (2) persisting under adversity; and (3) getting the right people involved. Thus, according to this study, these three behaviours are prototypical of champions across industries.

3.2.2 Effects of champions

Besides studying the behaviour of champions, researchers have also studied the effects that champions have. Although the champion concept gained rapid popularity, there was still little empirical evidence at the start of the 1990s as to the effects of champions (Markham *et al.*, 1991). However, since then, empirical evidence on the effects of champions has grown steadily. This includes empirical studies of champions in the construction industry (Nam *et al.*, 1991; Nam and Tatum, 1997a; Barlow, 2000; Bossink, 2004b; Dulaimi *et al.*, 2005; Caerteling *et al.*, 2009; Gambatese and Hallowell, 2011a; Gambatese and Hallowell, 2011b; McCabe *et al.*, 2011) and in other industries (Markham *et al.*, 1991; Day, 1994; Markham, 1998; Markham and Griffin, 1998; Andersson and Bateman, 2000; Howell and Shea, 2001; Howell and Shea, 2006; Lichtenthaler and Ernst, 2009; Walter *et al.*, 2011). Tables 4 and 5 summarize the findings from the construction industry studies on the effects champions have on the innovativeness of a construction project (Table 4) and on other variables (Table 5). For studies of the effect of champions on resource allocation to innovation projects, we have to turn to studies conducted in other industries.

The effect of champions on the allocation of resources to innovation projects has been studied in two studies in other industries. The first study is the one already mentioned into 45 NASA innovations (Chakrabarti, 1974). The results showed that the presence of a champion in an innovation project made it more likely that, after technical feasibility testing, additional resources would be allocated to start marketing the new product. A later study of 213 innovation projects found similar results (Markham *et al.*, 1991; Markham, 2000). This later study examined innovation projects in various industries: steel; agricultural chemicals and pesticides; packaged processed foods; and industrial chemicals. Further, the study focused on a specific phase of innovation projects: from the moment of formally committing resources to the innovation project to the moment that the R&D department transferred the new product to another department for commercialization. The results showed that, during this phase, the presence of a champion made it more likely that additional resources would be allocated to the project. Overall, both studies suggest that the presence of a champion makes it more likely that additional resources will be allocated between the start of an innovation project and it moving to the commercialization stage.

Relatively little is, however, known about how champions' presence exactly affects resource allocation. A study by Markham (1998) examined whether champions' use of cooperative and confrontational tactics increases decision-makers' willingness to participate in an innovation project. The results indicated that neither champions' use of cooperative nor confrontational tactics increases the likelihood of resource allocation. In response to the results, Markham argued that future research should address the mechanism by which champions affect resource allocation. In recent literature it is argued that champions' advocacy behaviour plays an important role in managers' project funding decisions (Schlapp *et al.*, 2015). A deeper understanding of how champions' behaviour exactly influences resource allocation is, however, still lacking. The case study presented here provides a step towards such deeper understanding.

Table 4. Studies in the construction industry on the effect of champions on the innovativeness of a construction project

Study	Findings
Six innovative US construction projects (Tatum, 1984)	In each of the innovative construction projects there was an energetic individual in the planning team willing to serve as a champion for the proposed innovation.
One innovative US construction project (Nam et al., 1991)	Various individuals in the innovative project exhibited champion behaviour; including the structural designer, concrete supplier, owner, material consultant and the contractor's consultant.
Ten innovative US construction projects (Nam and Tatum, 1997a)	In many of the cases in this study, it seemed likely that the absence of one specific individual would have prevented or delayed innovation success. These individuals were described as champions by other professionals involved in the project, and most of them possessed both power and technical competence.
One innovative UK construction project (Barlow, 2000)	The presence of champions contributed to project innovativeness. Each of the main partners had an identifiable individual providing support and selling the innovative partnering concept to senior executives within their own organization.
Ten innovative Dutch construction projects (Bossink, 2004b)	Each of the innovative projects had two or three champions who acted as driving forces behind the initiation and realization of innovative ideas.
32 Singapore construction projects (Dulaimi et al., 2005)	Statistical analysis showed no significant relationship between championing behaviour as exhibited by the project manager and the innovativeness of the project.
Ten US construction projects (Gambatese and Hallowell, 2011a)	The results showed a positive relationship between the extent to which there was a champion, shepherding the innovation and eliminating potential blocks, and project innovativeness.

Table 5. Studies in the construction industry on other effects of champions

Study	Findings
115 technology development projects by US road infrastructure firms (Caerteling et al., 2009)	The results show a positive relationship between championing behaviour exhibited by government officials and both *the process performance of the technology development project* (in terms of budget, quality and development time) and *the benefits of the technology to customers*.
34 technical construction innovations (Gambatese and Hallowell, 2011b)	Three-quarters of the respondents rated champion presence as an enabler in implementing their innovative product in projects. However, statistical analysis showed no significant relationship between champion presence and *the extent to which the innovative product had diffused throughout the industry*.
Four Australian 'Percent for Art' projects (McCabe et al., 2011)	The presence of champions within the Artwork Selection Committees contributed to *the social outcomes of the 'Percent for Art' projects*.

Note: the dependent variables studied are shown in italics.

3.3 Method

The case study we conducted is a case study of two collaborative innovation projects within the Dutch construction industry. Both innovation projects involved new product development and commercialization activities by groups of firms. In the first innovation project, a new renewable housing concept was developed and commercialized. We refer to this innovation project as the 'RHC project'. The second innovation project developed and commercialized a new environmentally friendly window. We refer to this innovation project as the 'EFW project'. Table 6 lists the natures of the firms that participated in the two collaborative innovation projects.

Table 6. Firms that participated in the collaborative innovation projects

RHC innovation project	EFW innovation project
Architecture firm	Maintenance contractor
Bank	Manufacturers of windows
Environmental engineering firm	Suppliers of coatings
Straw-bale building firm	Supplier of wood
Supplier of wall heating systems	Supplier of sills
Structural engineering firm	Supplier of sealants
Property developers	Supplier of glass
Manufacturer of wooden walls	Supplier of fasteners, aluminium profiles and ventilation systems
Manufacturer of wooden floors	Technology development firm
Innovation consultancy firm	
Construction firm	
Various other firms	

3.3.1 Data sources

To collect data, we conducted interviews and examined documents. In total, we conducted 20 interviews varying in length from 50 to 160 minutes, with an average duration of 90 minutes. We interviewed 21 people in total from 17 firms (one person was interviewed twice and two interviews included two informants). The interviews for the RHC project covered eight firms that had invested resources in the innovation project. The interviewees for the EFW project came from five firms that had invested resources in the innovation project plus three firms that had been involved in the innovation project in other roles and one client who had adopted the new product. We conducted semi-structured interviews to allow ourselves the opportunity to probe deeper into informants' perceptions and to address informant-specific topics. We recorded and transcribed all the interviews. Besides conducting interviews, we collected documents such as internal memos, minutes, e-mails, brochures, newsletters, newspaper articles, magazine articles, product specifications and a product handbook. The document collection process involved asking informants if they could provide documents that illustrated their statements or that they thought that would be of interest to us. We also performed an internet search to retrieve additional information. In total, we collected 31 documents containing information about the RHC project and 38 documents containing information about the EFW project. To facilitate data analysis, the interview transcripts and documents were imported into qualitative data analysis software (NVIVO 9).

3.3.2 Data analysis

We analysed the data using a process outlined by Eisenhardt (1989). First, we induced tentative constructs and propositions by searching for recurring themes and patterns of relationships in the data from the EFW project. Subsequently we analysed the data from the RHC project in the same way and also searched for similarities and differences between the two collaborative innovation projects. The cross-case pattern search provided an opportunity to refine and extend the constructs and the relationships between them. Further, we compared the results with existing literature. This first cycle of theory development resulted in the identification of a relationship between champion behaviour and firms' willingness to allocate resources. Next, we went through the data analysis process a second time to further explore this relationship.

3.4 The collaborative innovation projects

Drawing on the case study data, we provide an overview of the two collaborative innovation projects in this section. We do so by describing them from their initiation through to their state at the time that we conducted the case study. We first describe the Renewable Housing Concept (RHC) project, and then the Environmentally Friendly Window (EFW) project. See Figure 3 for a timeline of the two projects.

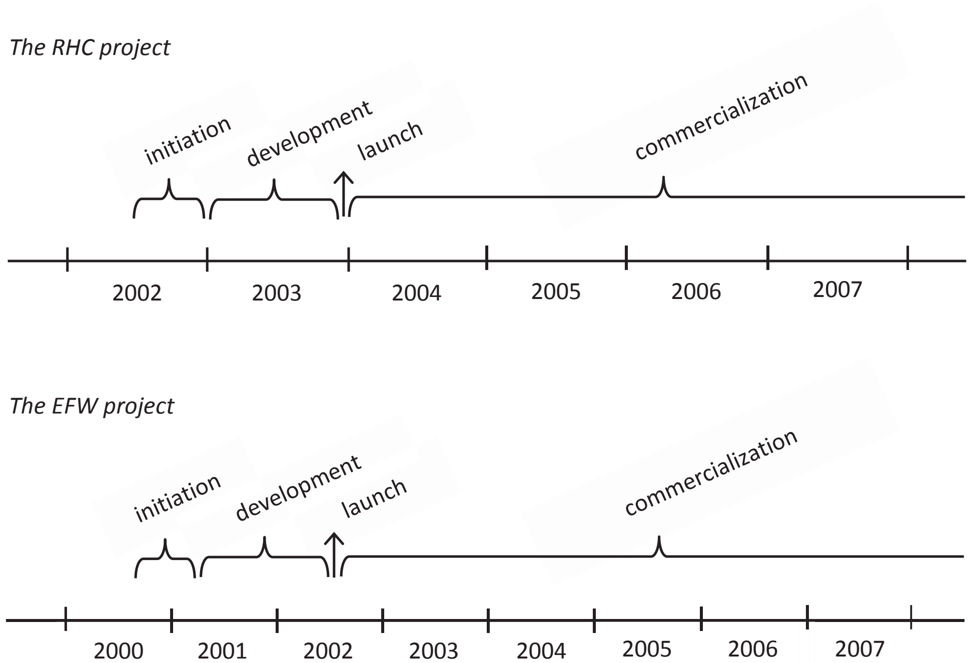

Figure 3. Timelines of the two innovation projects

3.4.1 The RHC project

In 2002, the RHC project was initiated by a group of four firms: a bank, an environmental engineering firm, a straw-bale building firm and an architecture firm. During a conference on the use of renewable materials in construction, a manager from the bank had met the owners of the environmental engineering firm and the straw-bale building firm. They had realized that they shared a vision of the future. As one of them said, '…and then I met these people, and we noticed that we shared the same aspirations. So you could say that the basis of our contact was that we had the same vision: to build and renovate sustainably.' They agreed to meet again to discuss what they could do together to realize their vision. The idea formed to develop a new type of renewable house. However, they needed help from other types of firms to realize this vision. As the manager from the bank noted, '… to really develop a house you need more than only philosophers, you also need a heating installer, a manufacturer of windows, a foundations worker and an architect.'

Soon after, a partner of an architecture firm who shared the same vision, and who had considerable experience in designing timber-framed houses, linked up with the three firms. (Later in the article this person will be identified as the champion for the new renewable housing concept.) Together they set up an innovation project to develop a new system for the construction of renewable houses. The renewable houses should have three characteristics. First, the houses should be characterized by a very high use of renewable materials with the use of non-renewable materials kept to a minimum. Second, the houses should be cheaper than conventional houses so that they would be affordable to large parts of society. Third, compared to standard houses, the houses should provide a healthier environment.

From that moment on, various other firms joined the innovation project. The partner in the architecture firm (referred to as Anderson) was particularly successful in making other firms enthusiastic about joining the innovation project. Since it was decided that the houses should be timber-framed, the first firm that was invited to join the innovation project was a structural engineering firm that specialized in wood constructions. As a manager of the structural engineering firm described it, ‘At a certain point someone has an idea and says, “What do you think about this?”, and then you start. That was Anderson.’ A second firm that Anderson invited to join the innovation project was a manufacturer of wooden floors: ‘At a certain moment, Anderson had an idea about a way of building in which he got other organizations involved, like us.’ Further, a third firm, a supplier of wall heating systems, joined the innovation project: ‘We are innovative so when the question of how to use a low temperature heating system given the wooden floor system was put to us, we owed it to ourselves to think about how to do this.’ Once they decided to join the innovation project, all three firms contributed to the development of the renewable house concept by investing resources in specific development activities. The structural engineering firm contributed by developing a structural design for the building system. The manufacturer of wooden floors contributed by developing a wooden floor system and, similarly, the supplier of wall heating systems developed a wall heating system. For all these firms, as well as for the four firms that had initiated the innovation project, the time and money spent was from their own accounts. The hope was that these investments would pay off in the future through the construction of houses. As one of the interviewees explained, ‘…investment of time in development is at your own risk, you hope there will be construction projects - that is the approach.' In addition to the firms already mentioned, a supplier of insulation material made from sheep's wool and a supplier of cabling for houses also joined the innovation project.

At the end of 2003, the renewable house concept was launched at a meeting, followed by presentations across the country. The launch event and presentations were attended by social housing corporations, property developers and municipalities. In the years after the launch event, more firms joined the innovation project. These included property developers, a construction firm, an engineering firm, an innovation consultancy firm and various suppliers of construction materials and components (including wooden walls, wooden doors and windows, insulation material made from flax, and gypsum fibreboard made from recycled gypsum and paper fibres). The ways in which these firms became involved in the innovation project varied. Some were invited to join by one of the already participating firms. For example, by the partner in the architecture firm: 'At a certain moment I was invited by Anderson, he is one of the initiators.' Otherwise a firm might become aware of the innovation project, and subsequently contact one of the participating firms. This occurred, for example, after having attended the launch event: 'I did not knew Anderson, we met him over there, and that is where the enthusiasm came from.'

To formalize cooperation between the various firms, a cooperative was set up in 2005. The firms that participated in the innovation project were members of the cooperative. The board of the cooperative consisted of the partner in the architecture firm, the owner of the environmental engineering firm and an owner of the innovation consultancy firm. From that moment on, the cooperative functioned as the organization in which all development and commercialization activities were embedded. The development activities included further refining the renewable house concept during the construction of individual houses. Further, additional development activities were started to investigate the possibilities of using the renewable house concept in the construction of high-rise buildings. The commercialization activities included developing various marketing tools, such as a website, brochures, presentations, a film about the construction of two houses and an annual magazine. Other commercialization activities included the development of a list of potential clients and giving presentations. The development and commercialization activities were funded in two ways. Some of them were funded directly by individual members. In these situations, a firm would spend its own resources on a specific development or commercialization activity. Other development and commercialization activities were funded by the cooperative. The money that the cooperative spent on development and commercialization activities was raised by an annual membership fee from its members plus a fixed percentage of the turnover that members achieved through the construction of renewable houses for individual clients.

By 2008, when we conducted the interviews, a few clients had adopted the renewable house concept. Construction of the first house had been completed in 2005, after which several other houses had been constructed. However, as described by the interviewees, the rate of adoption had been lower than initially expected: ‘Such radical innovations need a lot of time, it is a fact that it is going slowly’ and ‘A couple of years ago, we all thought it would go faster’. During a recent quarterly meeting, it had been suggested that additional commercialization activities should be established to speed up the rate of adoption. However, due to the lower-than-expected rate of adoption, the cooperative’s income had also been lower than anticipated. As a consequence, the cooperative’s ability to fund additional commercialization activities was limited. This would not have been a problem had the cooperative’s members been willing to fund the additional activities directly, but their willingness to invest additional resources on top of their annual membership fee was low. As a result, the ability to start additional commercialization activities remained limited. At the time that we were conducting the case study, the innovation project was running on limited resources. (At the time of writing this article, the number of construction projects in which the renewable house concept had been adopted was still low.)

3.4.2 The EFW project

In 2000, the EFW project was initiated by a technology development firm and two other companies. Since the technology development firm’s start-up in the 1980s, it had gained extensive knowledge on how to repair and prevent rot and decay in wooden window frames. Based on this knowledge, the firm had already developed various products such as a system for repairing wood rot in wooden window frames, a system for protecting parts of a wooden window frame from weather and a window frame that used a new way to connect the wooden parts together. The products were distributed and sold using a network of licensees made up of various maintenance contractors and window manufacturers. In 2000, several trends inspired the technology development firm to develop a new type of environmentally friendly window that would better fit with evolving customer needs. A manager of the technology development firm, together with the director of a maintenance contracting firm and a director of a window manufacturing firm, created a plan to develop the new type of window. (Later in the article these individuals will be identified as the champions for this new environmentally friendly window.) The idea was to develop a high-quality wooden window frame that would be environmentally friendly and require little maintenance. Further, the idea was to offer certainty and single-point responsibility with regard to low overall purchase cost and maintenance. To realize the new product idea, the cooperation of other firms was needed. As one of the initiators explained: 'Then we said, if we are going to do this, then we really have to think in terms of the system, set up an integrated supply chain approach and get manufacturers of wooden windows involved, a supplier of wood, a supplier of glass etc.'. After several meetings, the initiators obtained commitment from seven suppliers: a supplier of glass; a supplier of wood; two suppliers of coatings; a supplier of fasteners, aluminium profiles and ventilation systems; a supplier of sills; and a supplier of sealants. Together, these seven suppliers covered nearly all the components and materials that would be needed to construct the environmentally friendly window. Once the suppliers had decided to invest resources in the innovation project, various development and commercialization activities were started. These included activities such as developing and testing the window, developing a quality guarantee system and developing a marketing strategy and related tools. Later, another window manufacturer joined the innovation project, bringing in experience with a new mounting system for windows.

In 2002, the new product was launched during a conference organized by the technology development firm. As one of the interviewees noted, 'We rented the whole place, invited all our clients, and really launched it.' There was a large attendance and several construction-related media outlets reported on the launch. In the next few years, further commercialization activities took place to stimulate adoption of the new product. These included all kinds of marketing activities, including the development of additional marketing tools, enlarging the distribution network by licensing other window manufacturers to produce and sell the product and the setting up of technical and sales courses for licensees.

In the early years following the launch, the new product was adopted by a few social housing corporations for use in the renovation of residential buildings. However, the rate of adoption was not as high as expected. Later, to speed up adoption, the technology development firm proposed to the suppliers that they invest additional resources in the commercialization of the new product. As one of the interviewees noted, 'I think, in 2005 and 2006, these discussions took place. How to proceed?' However, the lower-than-expected rate of adoption limited the suppliers' willingness to allocate additional resources to the innovation project. Eventually, the suppliers ceased to fill their initial role as sponsors of the innovation project. Nevertheless, and despite the lower-than-expected rate of adoption, the initiators of the innovation project held to their belief that the new product was a potential success, and continued to invest in its commercialization.

By 2008, when we conducted the interviews, the rate of adoption was increasing. The scale of individual orders from social housing corporations was increasing. In particular the window manufacturer and the maintenance contractor who had been involved in the innovation project from the very start were experiencing a considerable increase, as one of them put it: 'Now, the past half year, there is a huge increase…, it goes like a train.' Another interviewee commented, 'For 2008, he (the window manufacturer) expects a very nice increase. Compared to 2007, a threefold increase.' Furthermore, renovation by social housing corporations was no longer the only market segment taking up the product. Also, a property developer had adopted the new, environmentally friendly, window for the construction of new residential buildings. Despite this increase in the rate of adoption, the initial expectations with regard to market share, as formulated in 2000, had not yet been met as of 2008. However, the increasing rate of adoption had strengthened the initiators' confidence in the potential of the innovation. As one of them said, 'The perspective, that is what it is about, and it is one in which I believe. If you believe in something you go for it, don't you?' Another added, 'As a co-developer of the system, I see a great future for it.' (At the time of writing this article, the environmentally friendly window had been adopted on a larger scale and had been followed by a new generation of environmentally friendly windows.)

3.5 The model that emerged

In this section, we give attention to the willingness of firms to allocate resources to these two innovation projects, and the influence that champion behaviour might have had in this regard. In so doing, we make a distinction between the influence of champions' behaviour during the early stage of an innovation project, and then in the post-launch period. We end this section by presenting a model that reflects the cross-case pattern that emerged from the case study data.

3.5.1 During the early stage

As the descriptions of the two collaborative innovation projects show, both projects were initiated by directors and managers from more than one firm. Among these directors and managers there were several individuals who, based on the three core behaviours of champions (see Howell *et al.*, 2005), we classified as champions. In the RHC innovation project it was the partner in the architecture firm (referred to as Anderson): 'He really is the driving force…, if Anderson falls away, I think the whole thing will collapse.' In the EFW innovation project there were three individuals who particularly displayed champion behaviour. First, there was a manager of the technology development firm: 'Really, I just believe in it. I do not believe that people will still want other windows.' Second, a director of the window manufacturing firm (referred to as Jones): 'In the beginning it was Jones, he really was a driving force. He still is. Yes, absolutely. He is full of energy.' Third, the director of the maintenance contracting firm (referred to as Lewis): 'He really is a driving force, Lewis.'

It were these individuals, in both innovation projects, who had an important role in getting other firms involved. As one of the interviewees said about the involvement of other firms in the RHC innovation project: 'Anderson has been the person who got other organizations involved.' Similarly, the manager of the technology development firm said regarding the meetings with suppliers that led to their involvement in the ESW project: 'That is how we got those seven suppliers involved. We had these meetings together with Jones and Lewis.'

The case study data indicate that these individuals, by expressing their enthusiasm and confidence in the innovation's potential, affected other firms' willingness to become involved and allocate resources to the innovation project. One interviewee, for example, said the following about how his firm got involved in the RHC innovation project: 'Anderson is a man who can create enthusiasm among others. He got a lot of people enthusiastic about this project, including us.' and 'You have a meeting with Anderson. Then you become more and more enthusiastic. Then you develop a part of a floor.' Further, the case study data suggest that champions' effect on resource allocation is explained by the rate of adoption expected by the other firms. An interviewee from the EFW innovation project for example commented: '…the story is that they, I think, presented it convincingly. This has a good chance. The timing is right, so join now because you too can profit.' Another interviewee from the EFW innovation project said: 'There are expectations stated in the plan, we are going to reach a market share of 10%.' Overall, we theorize that, during the early stages of innovation projects, champions' expression of enthusiasm and confidence in the potential of the innovation may contribute to positive expectations among firms regarding the rate of adoption which, in turn, may contribute to firms' willingness to allocate resources to the innovation projects.

3.5.2 Some time after launch

In both innovation projects, the participating firms were asked to allocate additional resources about three to four years after launch. The idea was to use these additional resources to stimulate adoption of the innovations, for example by setting up additional marketing activities. However, in both innovation projects, the participating firms were unwilling to allocate substantial additional resources. The case study data indicate that dissatisfaction with the rate of adoption following the launch contributed to this lack of willingness. It was the mismatch between the expected rate of adoption (that was, at least in part, based on champion's expression of enthusiasm and confidence in the potential of the innovation during the early stage) and the observed rate of adoption that appeared to be leading to this dissatisfaction and unwillingness to invest. For example, an interviewee from the RHC innovation project said in relation to the lack of willingness to allocate substantial additional resources: 'At first you hear stories about 40 houses over here, 50 houses over there, but those 40, 50 houses are still not there.' and 'We all expected that we would first build two or three houses together, and then we would have a few reference projects, and then the rest would follow automatically. That is what everyone thought, but it turns out not to be the case… But to promote it, of course, that is the other side of the story, money is needed. And we, as members of the cooperative, are not very willing to invest money again, we have all already spent a lot of money.' Similarly, an interviewee from the EFW innovation project commented: 'At a certain moment, the discussion turned to - you have to sponsor again.' and 'Then it became serious, we were disappointed in the development, in particular with the speed and progress'.

Drawing on the above, we can extend our previous theorizing by suggesting that positive expectations of the rate of adoption among firms during the early stage of an innovation project, some time after launch may contribute to firms' dissatisfaction with the observed rate of adoption, and that this then potentially contributes to a lack of willingness to allocate substantial additional resources. To summarize, Figure 4 shows the complete model that emerged from the case study data. See next page. (As becomes apparent from the model, champion behaviour as exhibited after launch was not found to affect resource allocation.)

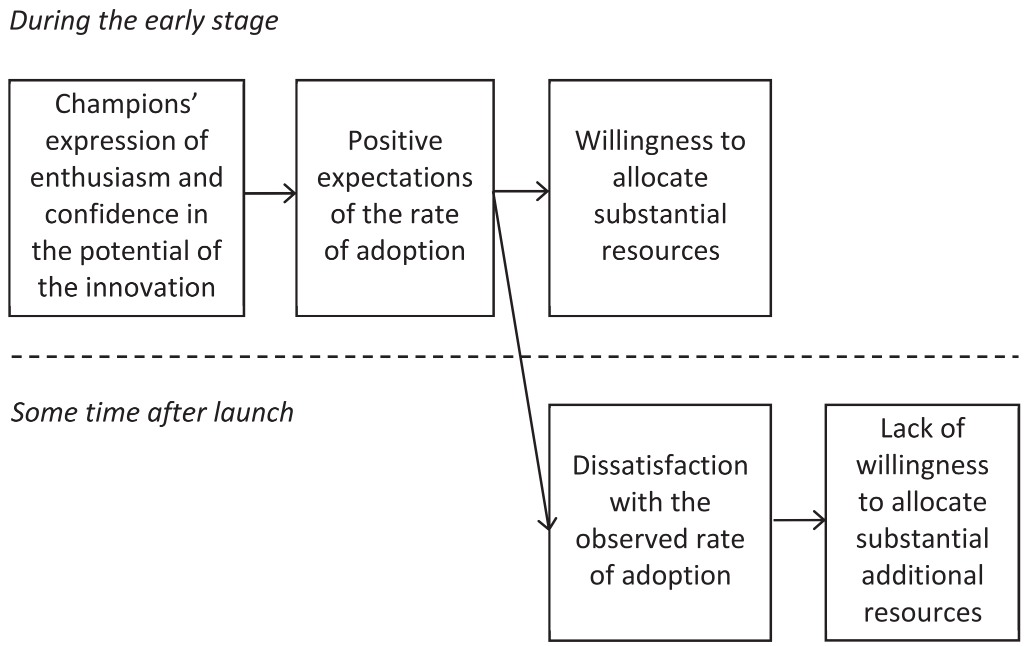

Figure 4. Model of how champions may have affected other firms' willingness to allocate resources

3.6 Contributions, limitations and future research

In this section, we highlight the contributions made by this study, suggest directions for future research and identify the main limitations. On a general level, the case study broadens the perspective on the effects that champions have in construction industry. The most studied effect in this field to date is that of champions on the innovativeness of construction projects (Tatum, 1984; Nam *et al.*, 1991; Nam and Tatum, 1997a; Barlow, 2000; Bossink, 2004b; Dulaimi *et al.*, 2005; Gambatese and Hallowell, 2011a). Only recently have construction management researchers begun to examine other effects. Here, we can refer to research on the effects of champions on the extent to which construction innovations diffuse (Gambatese and Hallowell, 2011b), on the social outcome of Percent for Art projects (McCabe *et al.*, 2011) and on the performance of technology development projects (Caerteling *et al.*, 2009). By illustrating how champions may affect the willingness of other firms to allocate resources to a collaborative innovation project, this study adds a new dimension to the growing research on the influence of champions in the construction industry.

Further, the insights provided by the case study into how champions may affect resource allocation, enrich the results from earlier studies. Here we refer to the studies by Chakrabarti (1974), Markham *et al*. (1991) and Markham (2000). These studies indicate that the presence of champions increases the likelihood of resource allocation during the development stage of collaborative innovation projects. Relatively little is, however, known about how champions' presence exactly affects resource allocation (Markham, 1998; Schlapp *et al.*, 2015). The present study provides three propositions that further explore this question. The first proposition is that the mechanism that explains the effect is the mediating role of firms' expectations of the rate of adoption. The second proposition is that it is not so much the champions' presence as such, but rather their expressions of enthusiasm and confidence in the potential of an innovation (which is one of the three prototypical behaviours of champions (Howell *et al.*, 2005)) that affect resource allocation. And the third proposition is that champion behaviour as exhibited during the development stage indirectly creates a barrier to the allocation of additional resources when, during the commercialization stage, the observed rate of adoption turns out to be lower than expected. Overall, by developing these three propositions the present study provides a step towards a deeper understanding of how champions affect resource allocation.

At least two directions for future research can be identified. First, future research may shed light on the validity of the three propositions provided by the case study. Second, the cases we studied were both a similar form of inter-firm collaboration in the manner that they went beyond an individual construction project. It might be interesting to also investigate decisions to engage in other forms of inter-firm collaboration that go beyond individual construction projects. Such research could provide valuable insights since it has been argued that inter-firm collaborations that go beyond individual construction projects enhance learning and innovation in the construction industry (Dubois and Gadde, 2002).

As a final comment, we should point out that this study is not without its limitations. The main concern is, as with all case studies, the extent to which the interpretations of the case study data are valid. Therefore, the findings of this study must be viewed with caution.

3.7 Conclusion

For the development of new building products and systems, bridges need to be built: not just between firms in the construction industry, but also between the present and the potentially profitable future. This is a challenge that lies at the heart of collaborative innovation projects, and is particularly relevant given the fragmented and loosely coupled nature of the construction industry. The case study presented in this article illustrates how champions might have an important role in building these bridges.

CHAPTER 4

Chapter 4 - Exploring the value of narrative-based decision theory in understanding the decision to allocate resources to an innovation project (study III)

This chapter has been published in Management Decision [4]

4.1 Introduction

What is actually happening inside a manager's mind when deciding whether to continue investment in a R&D project? And would having more insight into the cognitive process that takes place when people make such a decision help to better understand people's R&D progress decisions? It is these questions that inspired us to explore the value of a novel theory of how people make decisions, narrative-based decision theory (Beach, 2009a; Beach, 2009b; Beach, 2010), in understanding people's R&D progress decisions. In this article, we do so by interpreting a finding of existing empirical research, the finding that instruction in the sunk cost principle seems to mitigate the sunk cost effect in R&D progress decision-making (Harrison and Shanteau, 1993; Tan and Yates, 1995), in terms of narrative-based decision theory. Our rationale for interpreting a finding of existing empirical research in terms of narrative-based decision theory, is that for narrative-based decision theory to be of explanatory value, the theory should be able to help explain findings of empirical research on R&D progress decisions. The first reason why we have chosen the finding just mentioned, is that the effect of sunk costs on the outcome of R&D progress decisions has been examined extensively, and remains a subject of vigorous debate (Butler, 2010; McAfee *et al.*, 2010). The second reason is that by choosing a moderating effect, instead of a regular effect, narrative-based decision theory is confronted with a more complex exercise. The third reason is that existing empirical work already provides an explanation for how instruction in the sunk cost principle may mitigate the effect of sunk costs (Larrick *et al.*, 1990). This gives

[4] Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2013) Exploring the value of a novel decision-making theory in understanding R&D progress decisions. *Management Decision*, 51(1), 184-199.

us the opportunity to explore more deeply whether narrative-based decision theory may be able to advance our understanding beyond what is already known, since the theory must then, besides interpreting the finding in its own terms, also account for an already existing explanation of the empirical finding.

In this article we present the result of our exploration. Our approach is as follows. First, we infer how people, according to narrative-based decision theory, choose between alternative courses of action. Subsequently we introduce the empirical finding of our interest. Then, by integrating the theory's view of how people choose between alternative courses of action, and a current explanation of how instruction in the sunk cost principle prevents the sunk cost effect from occurring, we offer a more detailed explanation. Based on this result, we end by calling for further investigations into the theory's value in understanding people's R&D progress decisions, and other management decisions.

4.2 The NBDT view

In this section we introduce narrative-based decision theory's view of how people decide whether to continue investment in a research and development project. Narrative-based decision theory (Beach, 2009a; Beach, 2009b; Beach, 2010)[5] is a recent theory from the field of naturalistic decision-making. A central goal in the field of naturalistic decision-making (NDM) research is to understand how people actually make decisions in real-world settings (Klein, 1993; Kahneman and Klein, 2009). In this field, a number of models of decision-making have been proposed. In a first review of NBM models, Lipshitz (1993) showed that there was considerable affinity between the then existing models. However, he also noted that the models only provided a partial answer to the question of how people actually decide in real-world settings. In a later review, the challenge to develop more comprehensive models and theories was repeated (Lipshitz *et al.*, 2001). The aim in developing narrative-based decision theory has been to address this issue and to provide a general psychological theory on decision-making. The result has been a theory that describes

[5] In the 2009 publications, the theory was referred to as Narrative-Based Decision Theory. However, in the book published in 2010, the theory was extended with a new view on the relationship between narrative and paradigmatic thought. The overall theory was named the Theory of Narrative Thought.

how people make a wide range of decisions, ranging from intuitive or unconscious decisions to the complex decisions that keep people awake at night. The theory can be regarded as a fairly straightforward elaboration of image theory (Beach and Mitchell, 1987; Beach, 1990), one of the earlier NDM models that has served as a theoretical basis for many laboratory experiments (for an overview see, Beach and Connolly, 2005; Beach, 2009b), and also for theory papers about decisions such as those to voluntarily leave an organization (Lee and Mitchell, 1994) or to retire early (Feldman, 1994). An important difference between image theory and its successor, narrative-based decision theory, is that the latter has been heavily influenced by the concept of narrative thought (Bruner, 1991), and also draws on concepts from other decision-making models.

Narrative-based decision theory's view of decision-making is built on the notion that decision-makers' current narratives play a key role in decision-making. Greatly simplified, decision-makers' current narratives are the stories they tell themselves (both consciously and unconsciously) about what happened in the past and what is happening in the present. It is a rich mixture of memories and cognitive images that enable a person to forecast what will happen in the future. According to narrative-based decision theory, decision-making is "the act of evaluating the desirability of the forecasted future and, when it falls short of our values and preferences, choosing appropriate interventions to ensure that the actual future is more desirable than the forecasted future (Beach, 2009b: 6)".

In this paper, we use constructs from narrative-based decision theory to model the cognitive process that takes place when a person makes an R&D progress decision. Our approach begins with the notion that the decision we are focusing on can be regarded as a choice between two alternative courses of action: allocate additional resources to an R&D project, or abandon the R&D project[6]. Narrative-based decision theory models choosing between two alternative courses of action as a process consisting of: (1) forecasting what the future will look like for each contemplated action; (2) evaluating the discrepancy between the forecasts and the decision-maker's values and preferences; and (3) selecting

[6] In real-world settings, the process that leads to such a choice may vary, and the choice may include more than the two options mentioned above. However, for reasons of simplification, we confine ourselves in this article to the process of choosing between the two options that are also used in the Radar-Blank Plane experiments on the sunk cost effect in R&D progress decision-making.

the contemplated action that leads to the smallest discrepancy. Figure 5 presents the process model that we have derived from narrative-based decision theory.

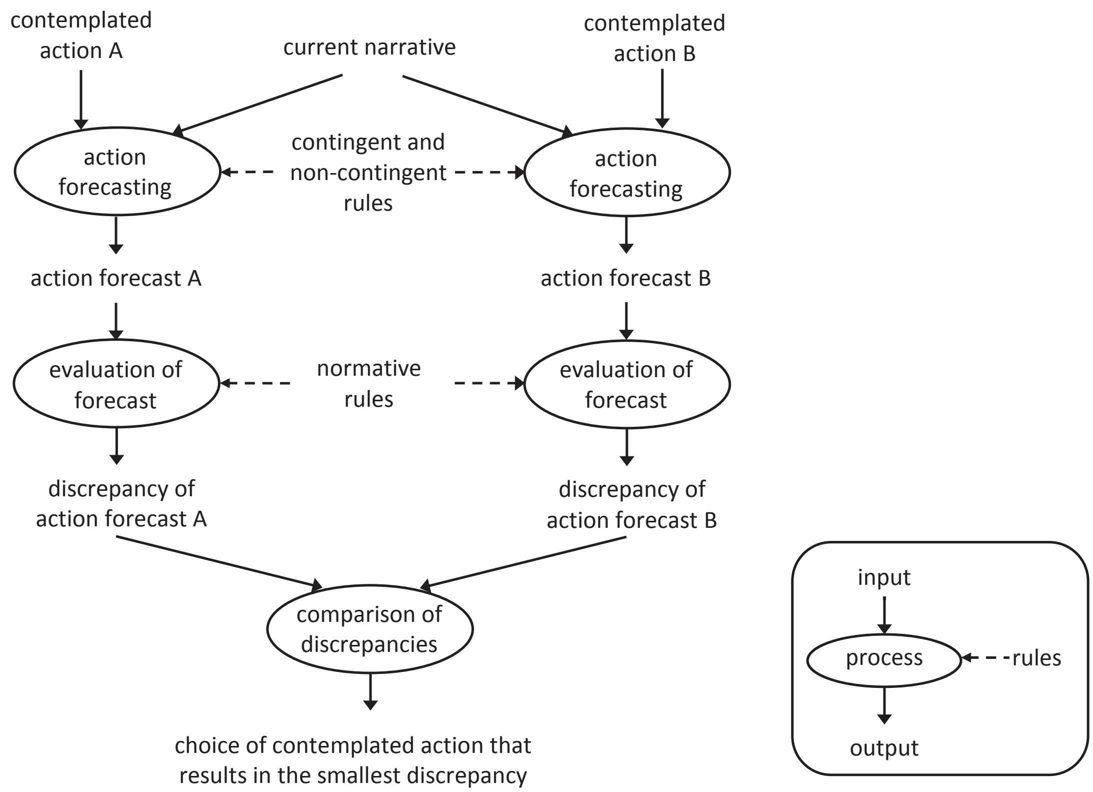

Figure 5. NBDT's view of choosing between two alternative courses of action (derived from Beach 2009b)

In the first part of the process, labeled action forecasting in Figure 5, the decision-maker's current narrative, contemplated actions, and contingent and non-contingent rules all play a central role. Simplified, the decision-maker's contingent rules tell the decision maker what to expect as a result of something he or she does, whereas the decision maker's non-contingent rules tell the decision maker what to expect as a result of actions by other people and nature. Action forecasting is achieved by applying the contingent and non-contingent rules to the current narrative while assuming that one of the contemplated actions is implemented. The result is a forecast, referred to as an action forecast, showing what the future might look like if a contemplated action is implemented.

In the second part of the process, labeled evaluation of forecast in Figure 5, the decision-maker's action forecasts and normative rules play a central role. Essentially, a decision-maker's normative rules tell the decision maker what is and what is not desirable. An action forecast is evaluated by applying the normative rules to it. The result is an assessment of the discrepancy between the action forecast and what the decision-maker's normative rules determine as desirable, referred to as the discrepancy of the action forecast. Thus, the result of the evaluation informs the decision-maker how desirable or otherwise the future offered by the action forecast is. The first two steps, action forecasting and forecast evaluation, are completed for both the contemplated actions (in our case "allocating additional resources to the R&D project" and "abandoning the R&D project").

In the third part of the process, labeled comparison of discrepancies in Figure 5, the discrepancies of the two action forecasts are compared. This comparison allows the decision-maker to select the contemplated action that is expected to lead to the smallest discrepancy or, in other words, the contemplated action that is expected to lead to a future that is least inconsistent with the decision-maker's normative rules. Thus, according to narrative-based decision theory, choosing between alternative courses of action does not entail a comparison of contemplated actions, or action forecasts, but rather a comparison of the discrepancies of action forecasts. Before proceeding to the next section, where we introduce the empirical finding to which we will apply the process model of Figure 5, we should stress that narrative-based decision theory is much richer and more detailed than our application of the theory may suggest.

4.3 A finding from the RBP experiments

Imagine you are observing the president of Ener-Helio Corporation, a solar cell manufacturer. During the past three years her company has spent several million dollars on a research and development project to develop a new type of solar cell. A week has passed since a large competitor announced it was developing a similar solar cell. There are clear signs that the competitor's solar cell will be superior to Ener-Helio's one. At this moment, the president is staring out the window. She is deciding whether she should allocate the next million to her company's R&D project, or abandon the project.

One of your thoughts as an observer could be that Ener-Helio's president is in a situation of escalating commitment. Escalating commitment situations have been characterized as ones in which a choice has to be made about whether to continue an endeavor having already invested, and receiving negative feedback suggesting that, at the very least, the goal is not yet attained, with uncertainty surrounding the likelihood of achieving it (Staw, 1976; Brockner, 1992). As the phrase implies, it is not uncommon for managers to escalate commitment in a situation like Ener-Helio's president is in (Schmidt and Calantone, 2002). Sharing this thought with the president could make her turn towards you and say: "Interesting point. Please continue. Why would someone like me, with a degree in electrical engineering, mistakenly allocate additional resources to an R&D project?"

For an answer to this question we turn to the results of three experiments in which participants were confronted with a decision task similar to the one described above (Arkes and Blumer, 1985). The experiments were part of Arkes and Blumer's research into the effect of sunk costs, i.e. past costs, on a decision-maker's willingness to continue an endeavor. The results of the three experiments showed that once an R&D project had incurred costs, participants were more willing to allocate resources than when the same R&D project had yet to incur any costs. These were remarkable findings since the sunk cost principle from microeconomics tells us that only the future revenues and costs that vary between alternative courses of action are relevant when making choices and that, therefore, sunk costs are irrelevant (Horngren *et al.*, 2006; Horngren *et al.*, 2007).

Since then, various researchers have re-used the scenario of Arkes and Blumer's experiment, also referred to as the Radar-Blank Plane scenario (Garland, 1990; Garland and Newport, 1991; Conlon and Garland, 1993; Harrison and Shanteau, 1993; Tan and Yates, 1995; Garland and Conlon, 1998; Arkes and Hutzel, 2000; Higgins *et al.*, 2001; Moon, 2001a; Moon, 2001b; Tan and Yates, 2002; Moon *et al.*, 2003; Van Dijk and Zeelenberg, 2003; Wong *et al.*, 2006; He and Mittal, 2007; Wong *et al.*, 2008; Harvey and Victoravich, 2009; Van Putten *et al.*, 2010). Over time, researchers have made small changes to the scenario but its essence remains. An example of the scenario is as follows:

> "You are the President of Aero-Flite Corporation, an airplane manufacturer. You have spent __ million dollars of the 10 million dollars budgeted for a research project to

develop a radar scrambling device that would render a plane undetectable by conventional radar (in effect a radar-blank plane). The project is __% complete. Another firm has begun marketing a similar device that takes up much less space and is much easier to operate than Aero-Flite's (Garland, 1990: 729)."

After having read the scenario, participants in a Radar-Blank Plane (RBP) experiment have to decide whether to allocate additional resources to the R&D project or abandon the R&D project. By manipulating the sunk cost information in the scenario, i.e. the amount of money already spent, researchers have been able to examine the relationship between sunk costs and the participants' decisions. Similarly, other pieces of information have also been associated with the outcome of the participants' decisions. For example, information about project completion (Conlon and Garland, 1993), competitor's performance (Conlon and Garland, 1993), responsibility (Wong *et al.*, 2006), and decision risk (He and Mittal, 2007). Further, by measuring participants' personality traits researchers have shown that, besides differences in the information provided, also differences in personality traits are associated with the decisions made by participants. Here we refer to differences in duty, which is the extent to which a person adheres to ethical principles and moral obligations, and differences in achievement striving, which is the extent to which a person has high aspiration levels and works hard to achieve his or her goals (Moon, 2001b).

Overall, when it comes to the magnitude of the sunk cost effect, i.e. the effect size, the results from the Radar-Blank Plane experiments present a mixed picture. When looking at those studies that do not confound sunk costs with project completion (see Conlon and Garland, 1993), it becomes clear that the observed effect sizes, in terms of Pearson's r, differ across experiments (Conlon and Garland, 1993; Tan and Yates, 1995; Garland and Conlon, 1998; Moon, 2001a; Van Dijk and Zeelenberg, 2003). Appendix B provides an overview of the observed effect sizes in the Radar-Blank Plane experiments referred to. It shows that the observed effect sizes are both positive and negative, and range from small to large. While the list of experiments in Appendix B might not be exhaustive, and we are unable to report exact values for some of the experiments listed, the overview of observed effect sizes confronts us with a question: What explains the difference between the effect sizes across experiments?

One plausible explanation is that the relationship between sunk costs and the outcome of R&D progress decisions is moderated by other variables. An example of such a moderator variable is decision-makers' educational background or, more precisely, prior instruction in the sunk cost principle (Harrison and Shanteau, 1993; Tan and Yates, 1995). In a first study by Harrison and Shanteau (1993) cost accounting students who had received instruction in the sunk cost principle were, in the presence of sunk costs, somewhat less likely to allocate additional resources to the radar-blank plane project than introductory psychology students who had not received such instruction (r = .19; $\chi^2(1, N = 87) = 2.98$, p = .08)[7]. In a second study, in which the scenario also included an attractive alternative use of the funds, the effect size was however nearly zero (r = .02; $\chi^2(1, N = 85) = 0.03$, p = .87). In two later studies, Tan and Yates examined the moderating effect of instruction in the sunk cost principle more thoroughly (Tan and Yates, 1995). Besides varying participants' educational background, they also manipulated the sunk cost information in the scenario. In a first study, the effect of sunk costs on the decisions of students with a management accounting background was considerably weaker than the effect of sunk costs on the decisions of students without a management accounting background (r = .08; $\chi^2(1, N = 41) = 0.29$, p = .59, versus r = .59; $\chi^2(1, N = 50) = 17.53$, $p < .001$). In a second study, in which the scenario also included estimates of expected future revenues and costs (indicating a net return of five million dollar), the difference between the effect sizes was however quite small (r = .13; $\chi^2(1, N = 48) = 0.76$, p = .38, versus r = .16; $\chi^2(1, N = 50) = 1.29$, p = .26).

According to the four experiments of Harrison and Shanteau (1993) and Tan and Yates (1995), one explanation as to why Ener-Helio's president might escalate her commitment is that she could fall victim of a sunk cost fallacy due to a lack of instruction in the sunk cost principle. In the following pages, it is this finding of existing empirical work on R&D progress decisions, diagrammed in Figure 6, that we will explore through the lens of the process model shown in Figure 5.

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[7] Since our primary focus is on the substantive significance, we first report the effect size (measured by Pearson's r), and then report on the statistical significance (measured by χ^2 or F, and p). To calculate effect sizes we have followed instructions from Field and Wright (2006).

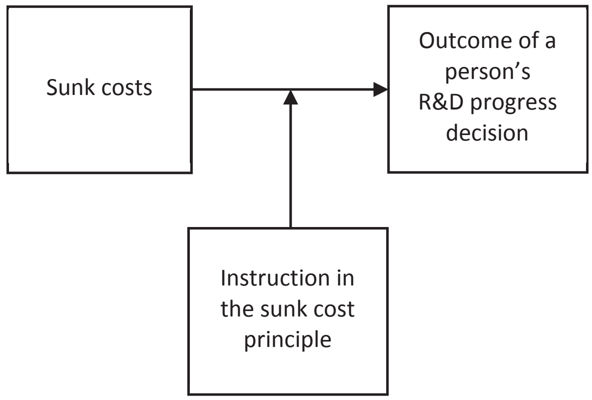

Figure 6. The empirical finding that is explored through the lens of Figure 5

4.4 Expanding on the underlying mechanism

Drawing on the process model of how people choose between two alternative courses of action, we develop, in this section, a more detailed explanation of how instruction in the sunk cost principle may prevent the sunk cost effect from occurring. We do this in two steps. First, we explain how, in terms of the process model, sunk costs may affect the outcome of a person's R&D progress decision. Subsequently, we combine this explanation with an earlier explanation as to how instruction in the sunk cost principle may prevent the sunk cost effect from occurring. The result is a clarification and extension of the earlier explanation (shown in Figure 7).

Before we can use the process model from Figure 5 to show how the sunk cost effect may occur in R&D progress decisions, we first need to locate sunk costs in the process model. These are to be found in the decision-maker's current narrative. As noted earlier, the current narrative is the story decision-makers tell themselves about what happened in the past and what is happening in the present. Thus, if a decision-maker knows that a lot of money has already been spent on a R&D project, this information is part of the decision-maker's current narrative on the R&D project. This is an important notion because, following the logic of the process model, the content of the current narrative affects the content of the action forecasts which, in turn, affects the discrepancies of the action forecasts which then, in turn, affect the decision-maker's choice between the two alternative courses of action (see Figure 5). Now, having located sunk costs in the process model, we can infer how sunk costs, as a feature of a decision-maker's current narrative, may lead a decision-maker to opt for allocating additional resources to an R&D project (and choosing not to abandon the R&D project). Following the logic of the process model, sunk costs cause a decision-maker to choose to allocate additional resources to an R&D project if those sunk costs, as a feature of the decision-maker's current narrative, create a difference between the decision maker's action forecasts such that the "abandon the project" action forecast is more discrepant than the "allocate additional resources" action forecast.

The above reasoning suggests two ways through which the sunk cost effect may be prevented, and that, following the logic of the process model, are relevant in understanding how instruction in the sunk cost principle may exert a moderating influence. First, such instruction may prevent the sunk costs, as a feature of the decision maker's narrative, leading to a difference between the decision-maker's action forecasts. Second, this instruction may prevent the action forecast for the "abandon project" action being more discrepant than the action forecast for the "allocate additional resources" action. Continuing with the logic of the process model and narrative-based decision theory's conception of contingent, non-contingent, and normative rules, in the first path of moderation instruction prevents the use of a contingent or non-contingent rule that creates the difference between the two action forecasts, whereas in the second path of moderation instruction prevents the use of a normative rule that makes the "abandon project" action forecast more discrepant than the "allocate additional resources" action forecast. It is through these two paths that the process model suggests that instruction in the sunk cost principle may exert its moderating influence on the sunk cost effect in R&D progress decisions. This line of reasoning fits with narrative-based decision theory's view on the origins of a decision-maker's contingent, non-contingent, and normative rules since, according to the theory, such rules can be acquired through experience or instruction.

The question that now arises is which rules are prevented from operating in the two paths of moderation? For an answer to this question, we turn to an earlier explanation as to how instruction in the sunk cost principle may prevent the sunk cost effect from occurring (Larrick *et al.*, 1990), and integrate it with the above reasoning. The results of the experiments by Larrick *et al.* (1990) suggest that the answer lies in the "don't waste" explanation of the sunk cost effect. The "don't waste" explanation of the sunk cost effect is a well-known explanation of the sunk cost effect (for reviews of explanations see: Staw, 1981; Brockner, 1992; Arkes and Ayton, 1999; Friedman *et al.*, 2007; McAfee *et al.*, 2010). According to the "don't waste" explanation of the sunk cost effect, decision-makers are affected by sunk costs because they overgeneralize a normative rule known as the "don't waste" rule (Arkes and Blumer, 1985; Arkes and Ayton, 1999). The "don't waste" rule states that wasting resources is undesirable. It is argued that decision-makers who are affected by sunk costs extend the "don't waste" rule from resources not yet spent (to which it should refer) to include resources already spent and, in so doing, create a new, economically unsound, normative rule that leads to the sunk cost effect: a rule that states that wasting resources already spent is undesirable. One of the experiments by Larrick *et al.* (1990: 367-368) showed that participants who had been instructed in the sunk cost principle were considerably less likely to think that the desire not to waste resources already spent is an economically sound normative rule. This suggests that instruction in the sunk cost principle may prevent the sunk cost effect from occurring by preventing decision makers from using a normative rule that states that a waste of already-spent resources is not desirable. It is here that Figure 5 helps provide a more complete explanation. In terms of the process model, the second path of moderation would look as follows:

> 2nd path of moderation: Instruction in the sunk cost principle moderates the sunk cost effect in R&D progress decision-making, by preventing decision-makers from using a normative rule that states that a waste of already-spent resources is not desirable, *which in turn, avoids an increase in the discrepancy of the decision makers' "abandon R&D project" action forecast.* (The italic part is what we can add to Larrick *et al*.'s explanation by looking through the lens of Figure 5.)

However, as noted earlier, instruction in the sunk cost principle may, according to the logic of the process model, also exert a moderating influence by preventing the use of a contingent or non-contingent rule. More precisely, a contingent or non-contingent rule that includes sunk costs, and that, when used, creates a difference between the decision maker's action forecasts such that the "abandon the project" action forecast is more discrepant than the "allocate additional resources" action forecast. Following the logic of the "don't waste" explanation for the sunk cost effect, the difference between the decision maker's two action forecasts would be a difference in terms of wasted resources. More specifically, the "abandon project" action forecast would show the resources already spent as a waste, whereas the "allocate additional resources" action forecast would not. This brings us to the view that if instruction in the sunk cost principle would lead a decision-maker to believe that abandoning an R&D project cannot result in a waste of resources already spent, then neither of the possible action forecasts will show the resources already spent as a waste. A quotation from a management accounting textbook that discusses the sunk cost principle supports this reasoning. Just after stating that sunk costs are irrelevant to the decision-making process, the textbook states: "All past cost are down the drain. Nothing can change what has already happened (Horngren *et al.*, 2007: 264)." The idea being that you cannot waste what you no longer have. This quotation might make a reader of the textbook realize that wasting resources already spent is a contradiction in terms, and therefore impossible. Drawing on the above, the first path of moderation would look as follows:

> 1st Path of Moderation: Instruction in the sunk cost principle moderates the sunk cost effect in R&D progress decision-making, *by preventing decision makers from using a contingent rule that states that abandoning an R&D project will result in a waste of resources already spent, which in turn, avoids the decision makers'"abandon project" action forecast incorporating a waste of resources already spent*. (The italic part is the alternative explanation that we can provide by looking through the lens of Figure 5.)

As an overview, Figure 7 shows both paths of moderation through which instruction in the sunk cost principle may moderate the sunk cost effect in R&D progress decision-making.

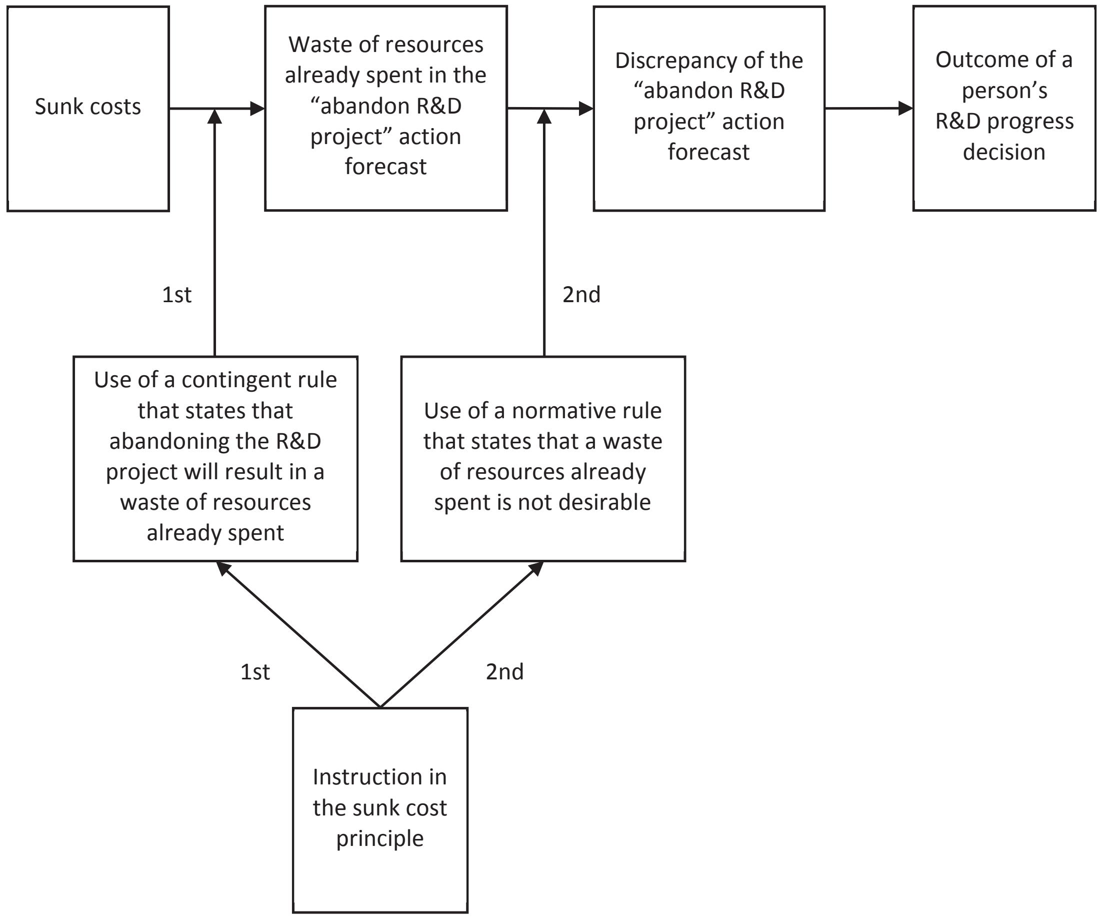

Figure 7. A clarification and extension of Larrick *et al.*'s explanation for the finding (numbers correspond to the paths of moderation)

4.5 Discussion and conclusion

In this article, we have explored the ability of a new theory of decision-making, narrative-based decision theory (Beach, 2009b; Beach, 2009a; Beach, 2010), to help explain the outcome of R&D progress decisions. We did so by interpreting a finding of existing empirical work, the finding that instruction in the sunk cost principle may mitigate the effect of sunk costs on R&D progress decisions (Harrison and Shanteau, 1993; Tan and Yates, 1995), in terms of narrative-based decision theory. First, by drawing on narrative-based decision theory, we derived a model of the cognitive process that takes place when a person makes an R&D progress decision. Subsequently, by integrating the process model and Larrick *et al.*'s explanation (1990) as to how instruction in the sunk cost principle may prevent the sunk cost effect from occurring, we developed a more detailed explanation of how instruction in the sunk cost principle may moderate the effect of sunk costs in R&D progress decision-making. In so doing, we shed light on two paths of moderation through which instruction in the sunk cost principle may moderate the sunk cost effect in R&D progress decision-making. More specifically, our approach has not only resulted in a more complete description of the path of moderation in which the normative rule studied by Larrick *et al.* (1990) is prevented from being used, but also resulted in an alternative path of moderation in which a contingent rule, that may be of equal importance in the creation of the sunk cost effect, is prevented from being used.

The contribution of our article stems from our use of a novel process model of how people choose between two alternative courses, a model that can be derived from narrative-based decision theory. The article demonstrates that the process model can help explain how, in the case of R&D progress decisions, a predictor variable - sunk costs - and an accompanying moderator variable - instruction in the sunk cost principle - may exert an influence. Thereby, the article raises the question whether narrative-based decision theory may also be able to help elucidate the causal mechanisms underlying other relationships observed in research on R&D progress decisions. One could for example explore whether narrative-based decision theory, as a theoretical lens, can also bring clarity to how other predictor variables are related to the outcome of R&D progress decisions; or how the relationships between such predictor variables and the outcome of R&D progress decisions are affected by moderator variables. Such an investigation could, like ours did, start with the question whether the predictor or moderator variable might be affecting decision-makers' current narratives, contemplated actions, contingent or non-contingent rules, or normative rules. Overall, based on the result of our exploration, we call for further investigations into narrative-based decision theory's value in understanding R&D progress decisions and other management decisions.

Another, more practice-oriented, opportunity for future research would be to investigate whether narrative-based decision theory, as a theoretical lens, can help in improving the quality of R&D progress decisions. As a first step, one could for example try to help decision-makers make explicit their reasoning when considering whether to allocate additional resources to an R&D project. Following the logic of the process model from Figure 5, this would include portraying an decision-maker's action forecast for each contemplated action, the normative rules used, the contingent and non-contingent rules used, and the accompanying current narrative. A second step would then, for example, be to help improve the decision-maker's reasoning by asking questions about the portrait of the decision-maker's reasoning; questions that, following the logic of narrative-based decision theory, seem to be relevant for assessing the quality of choices between alternative courses of action. In this second step, already existing decision aids serve as source from which helpful questions may be derived (Kahneman and Tversky, 1977; Butler, 1985; Beach, 2009b; Kahneman *et al.*, 2011). Furthermore, besides trying to help decision makers by using narrative-based decision theory as a lens to detect helpful questions, one could investigate whether narrative-based decision theory can be used as a lens to improve existing computer-based decision support systems.

To conclude, by introducing narrative-based decision theory's view of how people choose between alternative courses of action to management researchers, and by subsequently exploring its value in understanding R&D progress decisions, we hope to contribute to a more in-depth understanding of R&D progress decisions and other management decisions. This, in turn, we hope will help those who make such decisions.

CHAPTER 5

Chapter 5 - Together on the path to construction innovation: Yet another example of escalation of commitment? (study IV)

This chapter has been published in Construction Management and Economics [8]

5.1 Introduction

When it comes to innovation, it has been suggested that the construction industry is characterized by a low rate of innovation; also described as "zephyrs of creative destruction" (Winch, 1998). Although there is disagreement about whether this perception is accurate (Winch, 2003; Reichstein *et al.*, 2005; Hooker and Achur, 2014), the amount of attention given to construction innovation by researchers (Goulding and Alshawi, 2012) seems to signal a desire for more construction innovation. A review of the literature on construction innovation by Blayse and Manley (2004) highlighted six main factors which either drive or hinder construction innovation (for other reviews see for example: Gambatese and Hallowell, 2011a; Kulatunga *et al.*, 2011). One factor is the relationships between firms in the industry. The results of various studies indicate what type of relationship is needed between firms; that is, relationships with some degree of continuing cooperation. For example, a study by Dubois and Gadde (2002: 629) indicated that tighter relationships between firms beyond individual construction projects could enhance the opportunities for innovation. Miozzo and Dewick's observations on the relationship between inter-firm collaboration and construction innovation commented: "In a complex systems industry, such as construction, firms must rely on the capabilities of other firms to produce innovations and this is facilitated by some degree of continuing cooperation between those concerned with the development of products, processes and designs (Miozzo and Dewick, 2004: 71)." A notion that is supported by studies by Rose and Manley (2012) and Veenswijk *et al.* (2010). Taken together, these studies indicate that collaborative relationships between firms beyond the scope of individual construction projects may foster innovation. The current study focuses

[8] Rutten, M. E. J., Dorée, A. G. & Halman, J. I. M. (2014) Together on the path to construction innovation: yet another example of escalation of commitment? *Construction Management and Economics*, 32(7-8), 653-657.

on collaborative innovation projects which represent a good example of this type of relationship between firms.

A collaborative innovation project is a project in which firms join forces to cooperate in the development and commercialization of a new building product, system, or service for a range of potential customers or clients (Blindenbach-Driessen *et al.*, 2010: 577). The aim is that the new building product, system or service will be adopted in many construction projects. As a result, the relationships between firms participating in a collaborative innovation project go beyond the scope of an individual construction project. Examples from the literature include the joint development and commercialization of a new modular housing system (Hofman *et al.*, 2009) and the joint development and commercialization of a new environmentally friendly window (Rutten *et al.*, 2009). For a collaborative innovation project to exist and to achieve success, firms must be willing to commit resources to the project. Therefore, given the desire for more construction innovation, is the decision to allocate resources to a collaborative innovation project a good decision, or not?

The so-called Radar-Blank Plane (RBP) experiments conducted by organisational behaviour researchers provide relevant results. These experiments suggest that, once a firm starts to participate in a collaborative innovation project it may escalate commitment (see for example: Arkes and Blumer, 1985; Conlon and Garland, 1993). A firm is said to escalate commitment when it, for reasons that are not economic, decides to allocate additional resources to continue the project (Staw, 1976; Schmidt and Calantone, 2002). It has been argued that escalation of commitment is a widespread phenomenon present in various contexts, and that "the mechanisms underlying escalating commitment may offer explanations of such diverse behaviors as shown by people who wait for an inordinately long time for a bus to take them someplace to which they could have walked just as easily, the couple who persist in a souring romantic relationship, the organization that sticks with a failing venture, and the nation that finds itself 'knee-deep in the big muddy' in an international conflict, such as the United States in Vietnam in the 1960s and 1970s (Brockner, 1992: 39)". Although escalation of commitment is a widespread phenomenon (Sleesman *et al.*, 2012), research indicates that the tendency to escalate commitment may vary between populations (Tan and Yates, 1995; Van Putten *et al.*, 2010). This raises the question of whether firms that jointly invest in the development and commercialization of a new building product, system, or service are likely to escalate commitment. If the answer is yes, then firms are wasting scarce resources as the resources available to firms to invest in the development and commercialization of new building products, systems and services are limited. In these scenarios, escalation of commitment would be an undesirable phenomenon.

The study reported here was conducted as part of a national research program on construction innovation in the Netherlands (PSIBouw). Building on the findings of the RBP experiments, the study aim was to examine whether Dutch firms that jointly invest in the development and commercialization of a new building product, system, or service are susceptible to two escalation effects: a). the effect of expected loss of sunk costs, and b). the effect of perceived project stage. The rationale being that if firms are susceptible to these escalation effects, they need to be warned about this. In the subsequent sections the theoretical background and hypotheses are introduced; the method used is described; the results are displayed; and potential explanations are offered for the results.

5.2 Theoretical background and hypotheses

The first RBP experiments were conducted in the 1980s (Arkes and Blumer, 1985) as part of research into the influence of sunk costs (i.e. resources already spent) on the escalation of commitment behaviour. The participants first had to read a scenario of an innovation project in which a radar-blank plane was being developed. An example of the scenario is as follows: "As the president of an airline company, you have invested 10 million dollars of the company's money into a research project. The purpose was to build a plane that would not be detected by conventional radar, in other words, a radar-blank plane. When the project is 90% completed, another firm begins marketing a plane that cannot be detected by radar. Also, it is apparent that their plane is much faster and far more economical than the plane your company is building (Arkes and Blumer, 1985: 129)." The participants then had to decide whether to abandon the innovation project, or to allocate additional resources to continue the innovation project. The results showed that, once an innovation project had incurred costs, the participants were more willing to continue investing in the project compared with a project that had not yet incurred any costs. These findings were remarkable since microeconomic theory posits that only the variation in future revenues and costs between alternative courses of action are relevant when making choices, i.e. that, effectively, sunk costs are deemed to be irrelevant (Horngren *et al.*, 2007).

Since then, researchers have continued to use the RBP scenarios to study various effects (Rutten *et al.*, 2013). The sunk cost effect has become the most studied. 21 RBP experiments on the effect of sunk costs have shown the following results. Twelve experiments found a significant positive relationship suggesting that sunk costs make it more likely that firms continue to invest in an innovation project (Arkes and Blumer, 1985; Garland, 1990; Garland and Newport, 1991; Arkes and Hutzel, 2000; Moon, 2001a; Moon, 2001b; Van Dijk and Zeelenberg, 2003; Westfall *et al.*, 2012). Three experiments were ambiguous and, depending on the type of participant or the measure of the dependent variable, either a positive significant relationship or no significant relationship was found (Conlon and Garland, 1993; Tan and Yates, 1995; Van Putten *et al.*, 2010). Five experiments found no significant relationship suggesting that sunk costs are not influential on whether firms continue to invest in an innovation project (Conlon and Garland, 1993; Tan and Yates, 1995; Garland and Conlon, 1998; Moon *et al.*, 2003; Westfall *et al.*, 2012). And one experiment found a significant negative relationship suggesting that sunk costs make it less likely that firms continue to invest in an innovation project (Garland and Conlon, 1998). Overall, the most common finding was that sunk costs were positively associated with the likelihood of continuing investment.

Various scholars have explained these positive associations by drawing on loss aversion theory (Arkes and Blumer, 1985; Garland and Newport, 1991). This theory states that people have a strong desire to avoid losses and are particularly averse to losses that are certain. It has been argued that this tendency underlies the sunk cost effect as decision-makers may think that to abandon an ongoing innovation project will result in "a certain loss of the amount already invested” (Arkes and Blumer, 1985: 132) and, as a result, it is more attractive to choose to continue investing in the innovation project. This line of reasoning is also referred to as a "sunk cost fallacy" in the literature (Arkes and Ayton, 1999). This research may be relevant for the population under study here (i.e. Dutch firms that jointly invest in the development and commercialization of a new building product, system, or service) as the firms in the population also could fall victim to the same fallacy.

Consequently, it can be hypothesized that:

> *Hypothesis 1*: The loss of sunk costs that a firm participating in a collaborative innovation project expects if it would abandon the collaborative innovation project is positively associated with the firm's likelihood of continuing their investment.

The second effect most studied in the RBP experiments is the project completion effect first reported by Conlon and Garland (1993). The term project completion refers to how close an innovation project is to completion. In general, innovation projects are really only completed when the newly developed product or service has become profitable in the market place. Conlon and Garland had noticed that, in previous RBP experiments, the level of sunk costs was mistakenly combined with the degree to which a project was completed. Therefore, they sought to separate out the variables by conducting two experiments. Both experiments showed a significant positive relationship between the degree to which a project was completed and the likelihood of continuing investment. This confirmed their expectation that a firm's desire to complete an innovation project actually does increase as project completion gets nearer (Conlon and Garland, 1993: 410). Since then, the project completion effect has been examined in eight other RBP experiments (Garland and Conlon, 1998; Moon, 2001a; Moon, 2001b; Moon *et al.*, 2003; He and Mittal, 2007; Harvey and Victoravich, 2009). The results of these experiments were similar to the results of the two experiments by Conlon and Garland. This means all 10 experiments have observed a significant positive relationship which strongly suggests that the closer an innovation project is to completion the greater the likelihood is that a firm will continue to invest in it. Once again, findings from the field of organisational behaviour may be relevant to firms that jointly invest in the development and commercialization of a new building product, system, or service. As such, one would expect, for example, that firms working with collaborative innovation projects already in the market introduction stage would be more likely to continue to invest in them as when compared with firms with projects that are still in the earlier development stage.

Consequently, it can be hypothesized that:

> *Hypothesis 2*: The stage of a collaborative innovation project, as perceived by a firm that participates, is positively associated with the firm's likelihood of continuing to invest.

5.3 Method

In order to test these two hypotheses, a survey was conducted among Dutch firms participating in collaborative innovation projects developing and commercializing new building products, systems, or services. By studying firms in real-world settings, rather than university students in laboratory settings (which is the case with most RBP experiments), a field study is added to a research stream otherwise dominated by laboratory studies. From a methodological perspective, this represents a form of triangulation (Colquitt, 2008).

5.3.1 Sample and data collection

The population of this study consists of Dutch firms that, in collaboration with other firms, invest in the development and commercialization of a new building product, system, or service. Since previous research indicates that also firms outside the construction industry (in its broadest sense) may participate in such collaborative innovation projects (Rutten *et al.*, 2008), the population can be regarded a subset of the construction industry – i.e. those firms from the Dutch construction industry that are participating in a collaborative innovation project – augmented with firms from other sectors. A two-stage sampling procedure was used to select firms. First, we contacted organisations in the Netherlands familiar with collaborative innovation projects developing and commercializing new building products, systems, or services, and the firms involved. This included two construction industry associations and three semi-governmental organisations promoting innovation. This led to the identification of 32 collaborative innovation projects eligible for the study. (Eligibility criteria for inclusion were: a). the collaborative innovation project is aimed at the development and commercialization of a new building product, system or service, b).the collaborative innovation project is ongoing, and c). three or more firms invest resources in the collaborative innovation project.) For 25 of these collaborative innovation projects, involving in total 154 firms, we received the names and email addresses of the individuals who on behalf of the firms participated in the collaborative innovation projects. The number of firms in a collaborative innovation project ranged from 3 to 10.

The survey was constructed using online survey software (Unipark EFS Survey). Before the main survey was conducted, a small pilot study was conducted in order to test the adequacy of the survey instrument. In this pilot study three construction industry professionals involved in collaborative innovation projects and three construction management researchers were invited to complete the survey. After completion of the survey, individual interviews were conducted about the survey instrument. This included assessing whether questions had been understood as intended. Based on these interviews small changes were made to the survey instrument. Further, the pilot study showed that the online survey software was functioning well. After the pilot study, the main survey was conducted. An invitation email with a link to the survey was sent to each firm between April 2009 and March 2010. Non-responders were sent a reminder after two weeks and a second reminder after four weeks. Of the 154 firms, 122 responded to the survey which represents a response rate of 79%. 15 firms were excluded as they did not complete the survey. Four other firms were excluded as, in fact, they had not invested in a collaborative innovation project. Thus, the final sample included 103 firms (participating in 25 collaborative innovation projects).

5.3.2 Variables

Single-item measures were used to assess likelihood of continuing investment, expected loss of sunk costs, and perceived project stage. The decision to use single-item measures was based on the results of research on the robustness of single-item measures (Wanous *et al.*, 1997; Nagy, 2002; Bergkvist and Rossiter, 2007), which indicates that single-item measures are acceptable for measurement purposes when the construct can be classified as a concrete attribute of a concrete singular object; as is the case for the constructs in this study.

Likelihood of continuing investment (dependent variable)

The likelihood that a firm continues to invest was measured by asking the question: "How likely it is that your firm continues to invest in the collaborative innovation project?" A 7-point semantic differential scale was used, ranging from 1, very unlikely, to 7, very likely.

Expected loss of sunk costs (independent variable)

The loss of sunk costs that a firm expects if it would abandon the collaborative innovation project was measured by asking: "If your firm would decide to quit now, would that lead to a great or small loss of investments for your firm?" A 7-point semantic differential scale was used, ranging from 1, very small, to 7, very great.

Perceived project stage (independent variable)

The stage of the collaborative innovation project as perceived by a firm was measured by asking: "In what stage is the collaborative innovation project?" Responses were coded 0, for exploratory or development stage, and 1, for market introduction or market growth stage.

Control variables

Two more variables were included since, based on previous research (Conlon and Garland, 1993; Moon, 2001a), it was thought that they may have a causal effect on the dependent variable and could be correlated with at least one of the independent variables. This makes them important variables to be controlled for (Allison, 1999). These were: the 'perceived enthusiasm among potential customers or clients'; and, the 'length of participation'.

The former control variable was measured by asking respondents to indicate their level of agreement with the following statement, "Potential customers or clients are enthusiastic about the new product, system, or service." A 6-point Likert scale[9] was used

[9] A 6-point Likert scale was used as previous research (Weems and Omwuegbuzie, 2001) suggests that the middle category of a 7-point Likert scale, 'neither disagree or agree', is often overselected by respondents partly because the middle category is also interpreted as 'no opinion'. Since semantic differential scales do not ask respondents to rate their agreement with a statement, we did not use 6-point semantic differential scales for measuring 'likelihood of continuing investment' and 'expected loss of sunk costs'.

with the response categories 1 ‘strongly disagree’, 2 ‘disagree’, 3 ‘somewhat disagree’, 4 ‘somewhat agree’, 5 ‘agree’, and 6 ‘strongly agree’.

The latter control variable was measured by asking, "Since when is your firm involved in the collaborative innovation project? Please select quarter and year," and subtracting the respondent's answer from the quarter and year in which the respondent completed the survey.

5.3.3 Method of analysis

The analysis is based on the notion that the data have a two level nested structure. In multilevel research, data that have a two level nested structure are viewed as a two-stage sample (Hox, 2002). Examples of two level nested structures are pupils within schools, people within households, individuals within organizations. Pupils, people and individuals are called the lower-level units. Schools, households and organizations are called the higher-level units. In this study, firms are nested within collaborative innovation projects; firms being the lower-level units, collaborative innovation projects the higher-level units. We adopted hierarchical linear modeling (HLM; Raudenbush and Bryk, 2002) to investigate the hypotheses as have other studies involving nested data (Hitt *et al.*, 2007). HLM has an important benefit in examining nested data when compared with analysis using ordinary least squares regression (OLS). In nested data observations are not independent. However, OLS assumes that observations are independent. Violation of this assumption leads to underestimation of the standard errors of regression coefficients and this increases the risk of type I errors. A type I error occurs when "we believe that there is a genuine effect in the population when, in fact, there isn't (Field, 2005: 31)." HLM, on the other hand, takes into account the nested structure of data. It reduces the risk of type I errors by partitioning the residual variance into a 'between-group' component and a 'within-group' component. In this study the groups correspond to the collaborative innovation projects. (For a short introduction to multilevel modeling see Rasbash (2006).)

5.4 Results

Table 7 presents the descriptive statistics of the dependent variable, independent variables, and control variables used in this study. The mean of 5.17 for 'likelihood of continuing investment' implies that on average firms were somewhat likely to likely to continue to invest in the collaborative innovation project. With regard to the independent variables Table 7 shows that, on average, firms expected their loss of investments to be neither small nor large if they would abandon the collaborative innovation project (mean of 3.95). Further, the mean of 0.42 for 'perceived project stage' implies that 58% of the firms perceived their collaborative innovation project to be in the exploratory or development stage, and 42% of the firms in the market introduction or market growth stage.

Table 7. Means, standard deviations, and correlations

Variable	Mean	s.d.	1	2	3	4
1 Likelihood of continuing investment	5.17	1.45				
2 Expected loss of sunk costs	3.95	1.78	-.19†			
3 Perceived project stage	0.42	0.50	.20*	-.11		
4 Perceived enthusiasm among potential customers or clients	4.59	0.86	.19†	.22*	.01	
5 Length of participation	2.25	2.51	.14	.03	.38**	-.18†

Firms' n = 103, collaborative innovation projects' n = 25.

† $p < .10$

* $p < .05$

** $p < .01$

Two-tailed tests.

In addition to what is shown in Table 7, the survey found that 88% of the firms in the sample employ less than 250 employees and that the sample consists of a variety of firms: architectural and engineering firms (15%); construction firms (33%); suppliers (21%); and, other types (31%). The group referred to as 'other types' consisted of consultancy firms, property developers, social housing corporations, governmental organizations, facility management services providers, and a logistic services provider. The survey also found that 79% of the respondents rated his or her influence on their firm's decision to continue investment as either large, or very large (in response to the question: “How much influence do you have on your firm’s decision to continue investment?”). This means that, on average, a respondent’s perception of the likelihood that its firm continues to invest in the collaborative innovation project may be regarded as an acceptable indicator of the actual likelihood that the firm continues to invest. This provides confidence in the construct validity of the dependent variable ‘likelihood of continuing investment’.

In running the HLM model and in order to calculate the intraclass correlation coefficient (ICC), first a "null" model was run in which no independent or control variables were entered. The null model resulted in an ICC of 0.14, indicating that 14% of the variance in a firms' likelihood of continuing investment is due to differences between collaborative innovation projects. In contrast 86% of the variance in the likelihood of a firm continuing investment is due to differences between firms. Second, the independent and control variables were added to the HLM model. Adding the independent and control variables shows that these variables explain 11% of the variance in the likelihood of a firm continuing to invest (R^2 = .11). Table 8 presents the results of the HLM model.

The tests of the two hypotheses gave the following results. Hypothesis 1 predicted that the expected loss of sunk costs when abandoning the collaborative innovation project will be positively associated with a firms' likelihood of continuing investment. The results in Table 8 do not support this hypothesis. On the contrary, the results show a statistically significant negative relationship which the coefficient of -0.196 being significant at the .05 level. This is a complete contradiction of Hypothesis 1.

Hypothesis 2 predicted that the perceived stage of the collaborative innovation project will be positively associated with firms' likelihood of continuing investment. The results do not support this hypothesis either. The coefficient for perceived project stage is positive (0.338) but this is not statistically significant since the *p*-value is greater than .05.

Table 8. Results of hierarchical linear modeling for likelihood of continuing investment

Variable	Predicted effect	Coefficient	s.e.	*p*	R^2
Null model					
Intercept		5.175***	0.175	<.001	
Random-intercept model					
Intercept		5.024***	0.185	<.001	.11
Expected loss of sunk costs	H1 (+)	-0.196*	0.079	.016	
Perceived project stage	H2 (+)	0.338	0.302	.266	
Perceived enthusiasm among potential customers or clients		0.452**	0.167	.008	
Length of participation		0.087	0.060	.155	

Firms' n = 103, collaborative innovation projects' n = 25.

Expected loss of sunk costs, perceived enthusiasm among potential customers, and length of participation have been centered around the grand mean.

* $p < .05$

** $p < .01$

*** $p < .001$

Two-tailed tests.

5.5 Discussion

The present study set out to investigate the behaviour of firms participating in collaborative innovation projects. The aim was to test whether firms are likely to escalate their commitment in such projects given two possible influencing factors. First, the thought that abandoning the project will lead to a large loss of sunk costs. Second, the notion that the project is at an advanced stage. The results of this study suggest not. In this section potential explanations are discussed for the why the results of this study differ from the results that were expected based on the RBP experiments. The explanations provided are related to an important difference between the current study and the RBP experiments; whereas the respondents of this study are professionals involved in real-word innovation projects, the respondents of most RBP experiments are university students confronted with a scenario of a fictitious innovation project. We here discuss explanations that are related to this difference between the present study and the RBP experiments. It should be noted, however, that alternative explanations may exist.

The results indicate that firms that expect a large loss of sunk costs, if they would abandon a collaborative innovation project, are less likely to continue to invest than firms expecting a small loss of sunk costs. This is a remarkable finding since, based on loss aversion theory and the results of the RBP experiments, one would expect the opposite. The question is how to explain the negative relationship found? Contrary to most RBP experiments one showed a negative sunk cost effect. The researchers involved argued that the negative effect might be explained by the participants' relatively high "sensitivity to expenditures" (Garland and Conlon, 1998: 2035). The idea here is that a heightened sensitivity to expenditures can lead people to behave more cautiously when deciding whether or not to invest further resources. This might be a characteristic of the negative relationship that was found. In the sample, 88% of the firms had less than 250 employees and, thus, the sample is dominated by small and medium-sized firms (SMEs). This is not surprising since the construction industry is well-known for its high percentage of SMEs (Dainty *et al.*, 2005). It has been argued also that, in order to understand the innovation dynamics in the construction industry, one needs to take account of the dynamics of how SMEs innovate (Sexton and Barrett, 2003a; Sexton and Barrett, 2003b) when the resources available to them "to innovate in parallel with normal business" are very scarce (Barrett and Sexton, 2006: 331). Therefore, the negative relationship found in this study might not be so surprising. SMEs that expect a large loss of sunk costs, if they would abandon a collaborative innovation project, are likely to have been spending a relatively large share of the scarce resources they have available to innovate. This may heighten their sensitivity to spending resources, thereby activating the desire to preserve resources, and make them more cautious to continue investment when compared with firms that have spent fewer resources. A mechanism that is probably less likely to occur in a lab experiment in which participants spend imaginary money.

This line of reasoning prompts a further question. In which of the two situations might firms' investment decisions be flawed - when they have spent a small amount or a large amount of resources? Since we controlled for the perceived enthusiasm of potential customers and clients, firm's likelihood of continuing to invest seems, from an economic point of view, to be either irrationally high in the first situation, or irrationally low in the second situation. Two potential decision errors that firms might want to be aware of when considering whether to continue to invest.

Furthermore, the results suggest that firms that consider a collaborative innovation project to be at an advanced stage are not more likely to continue to invest when compared with firms that consider such projects to be at a less advanced stage. The project-based nature of the construction industry may explain why we did not find the same positive relationship as that found in the RBP experiments. Whereas the RBP experiments involved student participants, the survey engaged with "professional experts at doing projects" who, as a collaborative innovation project progresses, might be less inclined to substitute the project's goal with the desire to complete what was started. This explanation is supported by a study on the endowment effect (List, 2003). This is an escalation effect found in other contexts which states that owning a good increases its value to the owner. List's study showed that professional experience can eliminate the endowment effect. Overall, the results suggest that it would not be necessary to warn firms involved in collaborative innovation projects against a project stage effect.

5.5.1 Narrative-based decision theory

Narrative-based decision-making theory may provide a deeper understanding of why the results of this study differ from the results that were expected based on the RBP experiments. Narrative-based decision theory is a novel theory of how people make decisions (Beach, 2009a; Beach, 2010). Compared to earlier decision theories such as prospect theory (Kahneman and Tversky, 1979), narrative-based decision theory is based on the assumption that decision-makers minimize discrepancy instead of maximize value. Furthermore, narrative-based decision theory posits that decision-makers' normative rules are central to understanding the decisions they make. Simplified, a decision-maker's normative rules tell the decision-maker what is desirable. These rules are used to choose a course of action that is expected to lead to a future that is least inconsistent with the decision-maker's normative rules. Or, in other words, the course of action that is expected to lead to the smallest discrepancy. Whereas the RBP experiments involved student participants in laboratory settings, the survey engaged with firms in real-world settings spending real money. As a result, the normative rules that participants used when asked about the likelihood of continuing investment may have differed between this study and most RBP experiments. The explanation that was given in the previous section for the negative relationship between expected loss of sunk cost and likelihood of continuing investment, for example, suggests that the normative rule that states that it is desirable to preserve scarce resources is probably not used as much by student participants in laboratory settings (since they spend imaginary money), as it is by firms that have spent a lot of resources on a real-world innovation project. Further, the explanation that was provided for the absence of a relationship between perceived project stage and likelihood of continuing investment, suggests that the normative rule that states that it is desirable to complete what was started is probably not used as much by construction industry professionals in real-life settings, as it is by student participants in laboratory settings. It other words, it is respondents' use of different normative rules that may underlie the differences in the results of this study and the results that were expected based on the RBP experiments.

5.6 Conclusion

The Radar-Blank Plane experiments conducted by organisational behaviour researchers suggest that when firms come together and collaborate in developing and commercializing a new building product, system or service, they are likely to escalate commitment. This would be an undesirable phenomenon, particularly because the resources which firms have available for innovation are often limited. In this respect the current study brings good news for Dutch firms that, in collaboration with other firms, invest in the development and commercialization of a new building product, system, or service. The results of this study suggest that they are not likely to escalate commitment, either when they expect a large loss of sunk costs if they would abandon an collaborative innovation project, or when they realize that the collaborative innovation project has reached an advanced stage. Moreover, the study suggests that Dutch firms that expect a large loss of sunk costs, are less, not more, likely to continue to invest than firms that expect a small loss of sunk costs. This, in fact, represents a de-escalation effect instead of an escalation effect.

The extent to which the results of this study apply to firms in other countries that jointly invest in the development and commercialization of a new building product, system, or service, remains a question for future research. However, as this study involved firms in real-world innovation projects, rather than students in laboratory settings as is the case with most RBP experiments, the results of this study may turn out to be more indicative of the behavior of firms in other countries than the RBP experiments. A second direction for future research is to examine whether other escalation effects found in the RBP experiments exist in the population under study. Such research could help determine to what extent the findings of the RBP experiments are indicative of what happens in real-world innovation projects. A third direction for future research is the identification of moderator variables. Does, for example, firm size or firm type moderate the effects studied? Or in other words, are there any differences between large firms and SMEs with regard to the effects studied? Or between construction firms and suppliers? Such research may contribute to a more detailed understanding of escalation of commitment in collaborative innovation projects. Another direction for future research is to further examine potential explanations for the study results. Here we refer to the explanations offered in this paper, as well as to alternative explanations. Such an examination could, for example, start with exploring the study results through interviews or a focus group with a sample of the population.

The main limitation of this study, as is the case with many studies on firms (Short *et al.*, 2002), is the use of a convenience sampling procedure. Convenience sampling involves selecting subjects from a population on the basis of accessibility or availability. Compared to random sampling procedures, i.e. sampling procedures in which each member of the population has an equal or known chance of being selected, convenience sampling is less likely to lead to a sample that is representative of the population. However, a random sampling procedure was not an option in this study since such a procedure would require a list of all Dutch firms that, in collaboration with other firms, invest in the development and commercialization of a new building product, system, or service (a list that does not exist). Though we tried to create a representative sample by searching for firms participating in collaborative innovation projects in different ways (i.e. by contacting multiple industry associations and governmental organizations), it is uncertain how well the sample represents the population. For example, the degree to which the sample is representative with regard to the proportions of different types of firms is uncertain. Overall, the uncertainty surrounding the representativeness of the sample poses a threat to the empirical generalizability of the results. Consequently, the findings of this study need to be interpreted with caution.

We can conclude with some practical implications of the study and, in particular, the implications of the de-escalation effect found. The de-escalation effect suggests that a firms' willingness to continue to invest may be either irrationally high when little has been spent, or irrationally low when a lot has been spent. In other words, the results seem to offer the following advice to firms: "Co-developing and commercializing a new building product, system or service? Take care not to continue just because you have spent a little, or to quit just because you have spent a lot."

CHAPTER 6

Chapter 6 - Main contributions and implications

In this final chapter the main contributions and implications of the research in the thesis are summarized. The first section summarizes, for the convenience of the reader, the rationale for the thesis, the research objectives, the central research questions and the methods used. In addition, the first section explores the topicality of the research. Subsequently, in the second section, a summary is provided of the main contributions. Further, in the third and fourth section of this chapter, the implications for future research and practice are discussed. The chapter ends with a final reflection on the research presented in this thesis.

6.1 Research overview

As described in the first chapter of this thesis, the construction sector is characterized by high levels of fragmentation. The many different firms being the fragments, the sector being the whole. Previous research indicates that the construction sector's fragmented nature makes that collaborative innovation projects are an important path to construction innovation (Latham, 1994; Egan, 1998; Dulaimi *et al.*, 2002; Toole *et al.*, 2013). Previous research, however, also indicates that another characteristic of the construction sector, i.e. it's loosely coupled nature, acts as a barrier to the creation and continuation of collaborative innovation projects (Dubois and Gadde, 2002; Dorée and Holmen, 2004; Holmen *et al.*, 2005; Ingemansson Havenvid *et al.*, 2016). Since the conditions for collaborative innovation projects to arise and advance are not favorable in the construction sector, it is important to study and understand collaborative innovation projects. It is this notion that led to the research reported in this thesis.

6.1.1. Topicality of the research

The circumstances that prompted the research in this thesis are still present today. Today's construction sector is, just like a decade ago, a fragmented sector. That is, the sector's value chain still consists of many different firms. Which is not a surprise since the fragmentation is in part a result of a phenomenon that has characterized the evolution of many industries;

i.e. economic specialization. Consequently, this thesis addresses a subject that is as topical as ever. Moreover, the topicality of the thesis subject is reflected both in current practice and in current scientific literature.

The topicality of the research in this thesis is reflected in the current practice of the Dutch construction sector in the following way. In the past years, firms and governmental organisations have joined forces in various communities that aim to enhance innovation through collaboration. A community that was initiated during the period that the research in this thesis was conducted, is Pioneering. Pioneering is a community in the region of Twente, consisting of local governments, firms and knowledge institutes, that aims to foster construction innovation through collaboration (Pioneering, 2016). Pioneering started in 2009, and is still active as a community today. In 2014, a similar community started in the region of Brabant, i.e. the Spark community. Like Pioneering, Spark aims to accelerate innovation in the construction sector by stimulating collaboration between firms (Spark, 2016). Recently, in 2016, another community was launched that has similar goals as the Pioneering and Spark communities. That is Bouwcampus. By bringing together a range of various organisations from the Dutch construction sector, also Bouwcampus aims to foster the development of innovations that address the current challenges faced by the Dutch construction sector (Bouwcampus, 2016). Together, the existence of these communities illustrate that the subject of this thesis, collaboration for innovation, is high on the agenda of the Dutch construction sector.

The topicality of the subject of this thesis is also reflected in the scientific literature. Collaboration for innovation as a research subject, is a research subject that is as topical today as it was ten years ago. This is, for example, illustrated by the number of articles in this field that have been published over the past years in three well-known construction management journals: Construction Management and Economics (CME), Journal of Construction Engineering and Management (JCEM), Construction Innovation (CI). See Table 9. The numbers in Table 9 indicate that there has been a constant interest of construction management researchers in the subject of collaboration and innovation over time. Further, examples of recent studies that focus, in particular, on innovation through forms of collaboration that go beyond the scope of an individual construction project, are the studies by Ingemansson Havenvid *et al.* (2016) and Hofman *et al.* (in press). These studies illustrate that construction sector's fragmented and loosely coupled nature continues to inspire researchers to study and enhance the understanding of collaborative innovation.

Table 9. Research on collaboration and innovation published in construction management journals in the past decade

Years of publication	**Number of articles***		
	CME	**JCEM**	**CI**
2006-2007	61	35	13
2008-2009	64	29	8
2010-2011	62	45	20
2012-2013	79	46	14
2014-2015	68	29	32

*: Number of articles containing the words 'collaboration or cooperation and innovation' anywhere in the article ('or' and 'and' here refer to boolean operators).

6.1.2. Objectives, research questions and methods

The thesis aims to contribute to the understanding of collaborative innovation projects in the construction sector. The four studies presented in chapter 2 to 5 each contribute to this understanding. That is, by contributing to the understanding of (A) the role of systems integrators and champions in collaborative innovation projects, and (B) the decisions of firms to invest resources in collaborative innovation projects. The remainder of this section provides an overview of the central research questions of the four studies presented in the previous chapters, and the methods that were used to address the research questions. See Table 10 for a summary.

Table 10. The four studies

Study (*)	Central research question	Method
Study I (A)	What is the role of systems integrators in collaborative innovation in the construction sector?	Literature review
Study II (A&B)	How do champions influence firms' decisions to invest resources in a collaborative innovation project?	Case study
Study III (B)	How may narrative-based decision theory aid in understanding firms' decisions to invest resources in a collaborative innovation project?	Literature review
Study IV (B)	Are firms participating in a collaborative innovation project likely to escalate commitment when they expect a large loss of sunk costs if they would abandon the project? Or when the collaborative innovation project has reached an advanced stage of progress?	Survey

*: The research objective to which a study contributes is given between brackets.

Due to the different type of research questions, different methods were used. Literature reviews were conducted to answer the research questions of study I and study III. The literature review of study I integrated literature from five fields of research: literature on systems integrators in complex product systems industries, literature on construction innovation, literature on new product development, literature on strategic networks and alliances, and literature research on open innovation. The literature review of study III integrated literature from three fields of research: literature on narrative-based decision theory, literature on the Radar-Blank Plane experiments, and literature on the sunk cost effect.

To answer the research question of study II a case study of two collaborative innovation projects was conducted within the Dutch construction industry. Both innovation projects involved new product development and commercialization activities by groups of firms. Among the directors and managers of these firms there were several individuals who acted as champions of the collaborative innovation projects. In total, interviews were conducted with 21 people (average duration of 90 minutes). All interviews were recorded and transcribed. Besides conducting interviews, various documents were collected such as internal memos, minutes, e-mails, brochures, newsletters, newspaper articles, magazine articles, product specifications and a product handbook. Furthermore, an internet search was performed to retrieve additional information. In total, 69 documents were collected containing information about the two collaborative innovation projects.

To answer the research question of study IV a survey was conducted among firms participating in collaborative innovation projects within the Dutch construction sector[10]. A two-stage sampling procedure was used to select firms. First, various organizations in the Netherlands were contacted that were familiar with collaborative innovation projects developing and commercializing new building products, systems, or services. For 25 collaborative innovation projects, involving in total 154 firms, the names and email addresses were collected of the individuals who on behalf of the firms participated in the collaborative innovation projects. Before the main survey was conducted, a pilot survey was conducted in order to test the adequacy of the survey instrument. Of the 154 firms that were invited to participate in the main survey 122 firms responded; representing a response rate of 79%.

6.2 Summary of the main contributions

This section describes how the findings of the four studies contribute to the objective of the thesis. First, the findings are summarized that contribute to (A) the understanding of the role of systems integrators and champions in collaborative innovation projects. Subsequently, the findings are summarized that contribute to (B) the understanding of the decisions of firms to invest resources in collaborative innovation projects. The section concludes with a discussion of the overall contribution of the thesis.

[10] The data for this study were collected as part of a larger survey. See Appendix C for an overview of the complete survey instrument.

6.2.1 Contributions to the understanding of the role of systems integrators and champions in collaborative innovation projects

The findings of study I and II contribute to (A) the understanding of systems integrators' and champions' role in collaborative innovation projects. Study I does so by exploring the role of systems integrators. Study II does so by exploring the role of champions.

Study I builds on previous research on systems integrators. According to studies conducted in industries producing complex product systems, systems integrators have a central role in setting up and coordinating collaborative innovation projects. Drawing on this research and on the notion that also the construction sector is a sector producing complex product systems, Winch (1998) was the first to explore the role of systems integrators in collaborative innovation in the construction sector. Whereas Winch (1998) suggests that the term 'systems integrator' cannot be applied to firms in the construction sector in its original meaning, since design and production is split between two different types of firms (i.e. the principal architect or engineer and the principal contractor), Study I suggests that this view is inaccurate, or at least incomplete. It does so as follows. First, on the basis of a review of the literature on systems integrators in other industries producing complex product systems, Study I develops a set of criteria for classifying a firm as a systems integrator. These criteria are: (a) design and production of systems by integrating externally supplied components and services; (b) one-off or small-batch production; and (c) responsibility for the functioning of the system as a whole. Subsequently, Study I provides two examples of firms from the Dutch construction sector that meet these classification criteria and that have performed a similar role in collaborative innovation projects as has been observed with systems integrators in other industries. In so doing, Study I suggests, contrary to what seems to be argued by Winch (1998), that also in the construction sector systems integrators exist in the original meaning of the term and that perform a central role in setting up and coordinating collaborative innovation projects. Further, drawing on research in four different but related fields of literature, Study I provides an overview of factors that may affect the performance of collaborative innovation projects and that systems integrators might want to take into account when setting up and coordinating collaborative innovation projects.

Study II contributes to (A) the understanding of systems integrators' and champions' role in collaborative innovation projects. It does so by exploring how champions influence the allocation of resources to collaborative innovation projects. The insights provided by the case study enrich the results from earlier studies. Here we refer to the studies by Chakrabarti (1974), Markham *et al.* (1991), Markham (2000). These studies indicate that the presence of champions increases the likelihood of resource allocation during the development stage of collaborative innovation projects. Little is, however, known about how champions' presence exactly affects resource allocation (Markham, 1998; Schlapp *et al.*, 2015). By developing three propositions that address this issue, the case study provides a step towards a deeper understanding of how champions influence resource allocation. First, the case study suggests that the mechanism that explains the effect of champions on resource allocation might be the mediating role of firms' expectations of the rate of adoption. Second, the case study suggests that it is not so much the champions' presence as such, but rather their expressions of enthusiasm and confidence in the potential of an innovation (which is one of the three prototypical behaviours of champions) that might affect resource allocation. And third, the case study suggests that champion behaviour as exhibited during the development stage might indirectly create a barrier to the allocation of additional resources when, during the commercialization stage, the observed rate of adoption turns out to be lower than expected.

6.2.2 Contributions to the understanding of firms' decisions to invest resources in collaborative innovation projects

The findings of study II , III and IV contribute to (B) the understanding of the decisions of firms to invest resources in collaborative innovation projects. Study II does so by exploring how champions influence the decisions of firms to invest resources in a collaborative innovation project. The findings of study II, as described in the previous section, suggest that firms' expectations of the rate of adoption have a central role in their decisions about whether to invest resources in a collaborative innovation project. Further, study II suggests that champions' expressions of enthusiasm and confidence in the potential of an innovation might contribute to positive expectations among firms of the rate of adoption.

Study III also contributes to the understanding of the decisions of firms to invest resources in a collaborative innovation project. It does so by demonstrating the potential value of narrative-based decision theory (Beach, 2009a; Beach, 2010) in explaining such decisions. Following the logic of narrative-based decision theory, study III suggests that to thoroughly understand firms' decisions to invest resources, one needs to investigate two types of cognitive rules a decision-maker uses when making the decision. This includes both the normative rules and the contingent and non-contingent rules used by a decision-maker. Simplified, a decision-maker's normative rules tell the decision maker what is and what is not desirable. Further, the decision-maker's contingent rules tell the decision maker what to expect as a result of something he or she does, whereas the decision maker's non-contingent rules tell the decision maker what to expect as a result of actions by other people and nature. The investigation of the results of previous experimental research (Harrison and Shanteau, 1993; Tan and Yates, 1995) through the lens of narrative-based decision theory, as described step by step in chapter IV, illustrates that such an investigation can provide a deeper understanding. In so doing, study III demonstrates how narrative-based decision theory may help explain how firms' decisions about whether to invest resources are influenced. Overall, study III contributes to a deeper understanding of the decisions of firms to invest resources in a collaborative innovation project.

Besides study II and III, study IV also contributes to the understanding of the decisions of firms to invest resources in a collaborative innovation project. It does so by examining whether firms that invest, in collaboration with other firms, in the development and commercialization of a new building product, system, or service are susceptible to escalation of commitment. Previous research on the decision to invest resources in an innovation project, i.e. the Radar-Blank Plane experiments conducted by organisational behaviour researchers, suggest that firms participating in a collaborative innovation project are likely to escalate commitment when they expect a large loss of sunk costs if they would abandon the collaborative innovation project (see for example: Moon, 2001a; Moon, 2001b; Van Dijk and Zeelenberg, 2003; Westfall *et al.*, 2012), or when they realize that the collaborative innovation project has reached an advanced stage (see for example: Moon *et* *al.*, 2003; He and Mittal, 2007; Harvey and Victoravich, 2009). The findings of study III, however, suggest that firms participating in a collaborative innovation project are not likely to escalate commitment, either when they expect a large loss of sunk costs if they would abandon an collaborative innovation project, or when they realize that the collaborative innovation project has reached an advanced stage. Moreover, study IV suggests that firms that expect a large loss of sunk costs, are less, not more, likely to continue to invest than firms that expect a small loss of sunk costs. This, in fact, represents a de-escalation effect instead of an escalation effect. Overall, the findings of study IV question the generalizability of the findings from the Radar-Blank Plane experiments to the real world of collaborative innovation projects.

6.2.3 Overall contribution

A concise summary of the principal findings of the research presented in this thesis is provided in Table 11. Overall, the thesis contributes to the understanding of collaborative innovation projects in the construction sector. In so doing, the thesis enriches the construction management literature that posits that long-term collaboration between firms, i.e. collaboration that goes beyond the scope of an individual construction project, is an important source of innovation in the construction sector (Dubois and Gadde, 2002; Dorée and Holmen, 2004; Miozzo and Dewick, 2004; Ingemansson Havenvid *et al.*, 2016). In this line of literature it is argued that the construction sector may benefit from long-term relationships between firms along the value chain, since such inter-firm relationships foster innovation. The present thesis, by contributing to the understanding of collaborative innovation projects in the construction sector, enriches this line of literature in various ways. First, it provides insight into the role that two key actors, systems integrators and champions, may have in the creation of long-term relationships between firms that are aimed at achieving collaborative innovation. Second, it contributes to the understanding of the decisions of firms to start or continue such long-term relationships by allocating resources to a collaborative innovation project. And, third, the research presented supports the notion that a collaborative innovation project, when leading to a collaborative innovation that is widely adopted in the market, has the potential to serve as the first step in

Table 11. Summary of the principal findings

Study (*)	Central research question	Principal finding
Study I (A)	What is the role of systems integrators in collaborative innovation in the construction sector?	By setting up and coordinating collaborative innovation projects, systems integrators in the construction sector perform a similar central role in collaborative innovation as has been observed in previous research in other complex product system industries.
Study II (A&B)	How do champions influence firms' decisions to invest resources in a collaborative innovation project?	By expressing enthusiasm and confidence in the potential of the innovation champions might influence firms' expectations of the rate of adoption, which in turn might influence firms' decisions to invest resources in a collaborative innovation project.
Study III (B)	How may narrative-based decision theory aid in understanding firms' decisions to invest resources in a collaborative innovation project?	Narrative-based decision theory may aid in understanding firms' decisions to invest resources in a collaborative innovation project by suggesting that, in order to understand such decisions, one needs to explore the normative and (non-) contingent rules firms use in such decision-making.
Study IV (B)	Are firms participating in a collaborative innovation project likely to escalate commitment when they expect a large loss of sunk costs if they would abandon the project? Or when the collaborative innovation project has reached an advanced stage of progress?	Firms participating in a collaborative innovation project are not likely to escalate commitment, either when they expect a large loss of sunk costs if they would abandon the project, or when they realize that the collaborative innovation project has reached an advanced stage of progress.

*: The research objective to which a study contributes is given between brackets. See section 6.1.2 for a description of the research objectives.

the creation of a long-term collaborative network of firms that jointly develop and deliver a building system or product to the market. In general, by contributing to the understanding of the investment of resources in collaborative innovation projects, this thesis contributes to the understanding of the creation and continuation of long-term relationships between firms that lead to collaborative innovation, and, is so doing, enriches the construction management literature just mentioned.

6.3 Directions for future research

In this section we provide several directions for future research that follow from the research reported in this thesis. First we discuss opportunities for future research that follow from the findings reported in this thesis that contribute to (A) the understanding of the role of systems integrators and champions in collaborative innovation projects. Subsequently, we discuss opportunities for future research that follow from the findings that contribute to (B) the understanding of the decisions of firms to invest resources in collaborative innovation projects.

The findings in this thesis lead to various new research questions about the role of systems integrators and champions. Whereas the findings suggests that in the construction sector systems integrators and champions may have an important role in creating and advancing collaborative innovation projects (study I and II), it leaves open the question of whether there are other actors that perform a similar role. Consequently, it remains unknown how large the share of systems integrators and champions is in the creation of collaborative innovation projects in the construction sector when compared to other actors. Another question that follows from study I and II is under what conditions a new system or product created by a group of firms collaborating in an innovation project, grows into a complete new product family developed and delivered by a network of firms that is led by a systems integrator. Another direction for future research is to investigate the influence of systems integrators and champions on the performance of collaborative innovation projects. The research presented in this thesis, for example, explored how champions influence the allocation of resources to collaborative innovation projects; which can be regarded as an aspect of process performance. But what about the influence of champions on development time, another important aspect of process performance? Or the influence of systems integrators on innovation success; measured by for example the rate of adoption, market share, or revenues? Future research may explore the influence of systems integrators and champion on such other aspects of performance.

Also the findings that contribute to the understanding of the decisions of firms to invest resources in collaborative innovation projects, open up new areas for investigation. Whereas the research presented in this thesis provides insight into some of the factors that may influence the decisions of firms to continue investment in a collaborative innovation project (see study II, III and IV), it leaves open the question of which of these factors and of other factors identified in previous research, influence such decisions the most. Future research could address this issue by focusing on the substantive significance of effects (i.e. effect sizes), besides the statistical significance of effects (i.e. *p* values).

Further, by questioning the generalizability of two prominent findings from the Radar-Blank Plane experiments to the real world of collaborative innovation projects in the construction sector (study IV), the research presented in this thesis raises the question in which contexts firms in the construction sector are and aren't susceptible to escalation of commitment. The suggestion in existing escalation literature that escalation of commitment is a widespread phenomenon present in many contexts, may lead one to assume that escalation of commitment is also a widespread phenomenon in collaborative innovation projects. However, study IV did not find any signs of escalation of commitment in collaborative innovation projects when examining the susceptibility of firms to two escalation effects. Future studies may provide more insight into the contexts in which firms in the construction sector are and aren't likely to escalate commitment.

6.4 Managerial implications

In this section we point to the main managerial implications that follow from the research reported in the previous chapters. First, we discuss managerial implications for firms that consider participation, or that participate, in a collaborative innovation project. Second, we discuss a managerial implication for subsidy programs and communities that aim to enhance innovation through collaboration in the construction sector. Table 12 provides a summary of the main managerial implications.

Table 12. Summary of the main managerial implications

Target audience	Managerial implication
Firms in the construction sector that consider to invest (additional) resources in a collaborative innovation project	A firm that is deciding whether to invest (additional) resources in a collaborative project, may lower the risk of making the wrong decision by carefully scrutinizing the firm's expectations and desires that guide its resource allocation decision before finalizing the decision. When doing so, a firm should pay specific attention to the firm's expectations of the rate of adoption, and assess the foundation on which these expectations rest.
Subsidy programs and communities that aim to enhance innovation through collaboration in the construction sector	Systems integrators and champions may serve as driving forces of collaborative innovation. Further, due to systems integrators' and champions' central position in collaborative innovation projects they might, compared to other firms and participants in such projects, have an above-average influence on the performance of collaborative innovation projects. Therefore, it may be beneficial to subsidy programs and communities that aim to enhance innovation through collaboration to build relationships with systems integrators and champions.

Since the resources that firms invest in innovation are scarce, it is important to reduce the risk of decision errors. The studies presented in this thesis provide several managerial implications that may help firms to reduce the risk of making erroneous decisions. Decisions about whether to allocate resources to a collaborative innovation project can be erroneous in various ways. The results of study II for example suggest that, during the development stage of collaborative innovation projects, firms' expectations of the rate of adoption might be substantially influenced by champions' expectations of the rate of adoption. This represents a risk since champions tend to be too optimistic in predicting future rates of adoption (Schilling, 2010). A firm that is about to decide whether it should invest resources in a collaborative innovation project, could therefore ask itself whether its expectations of the rate of adoption are heavily influenced by a champion who strongly believes in the potential of the innovation. And if so, whether it (i.e. the firm) would benefit from searching for information from other sources that can be used to assessed the viability of the collaborative innovation project, as suggested by Royer (2003).

Another but related managerial implication that focuses on the quality of firms' investment decisions, builds on a general insight that follows from study III. That is the insight that when deciding about whether to invest resources in a collaborative innovation project, decision-makers can fall victim to two general types of decision errors. The first type of decision error is about the accurateness of the expected future. The future that a decision-makers expects if he or she would choose a certain course of action. Inaccuracy here refers to an erroneous prediction of the future resulting from the use of wrong assumptions when predicting the future for a certain course of action. The implication described in the previous paragraph, about the influence of champions on firms' expectations of the future rate of adoption, aims at reducing this type of decision error. The second type of decision error is more fundamental and deals with the goals and desires that guide decisions. That is, a decision-maker may attach too much weight to a goal or desire that is actually unimportant, or even irrelevant. Or, the other way around, a decision-maker may fail to attach enough weight to a goal or desire that is actually very important. In terms of narrative-based decision theory, the second type of decision error is about using the wrong normative rules when assessing the desirability of the expected future. Study III and IV provided examples of this type of decision error in the context of collaborative innovation projects (for example, attaching too much weight to the desire to finish what was started). Overall, to lower the risk of falling victim to one of the two fallacies, a firm might benefit from carefully scrutinizing the firm's expectations and desires that guide a resource allocation decision before finalizing the decision. The same holds for lowering the risk of terminating the allocation of resources to a collaborative innovation project that is about to become a success. Based on the research in this thesis, we hypothesize that carefully scrutinizing expectations and desires when deciding whether to (continue to) invest resources in a collaborative innovation project, increases the likelihood that such decisions turn out to be good decisions.

The research in this thesis also provides a managerial implication for subsidy programs that aim to enhance innovation in the construction sector. An example from the Netherlands, although not exclusively oriented at the construction sector, is the governmental subsidy program called 'Innovatie Prestatie Contracten'. A subsidy program which started in 2007 and that from 2013 onwards is part of the governmental program 'MKB-innovatiestimulering Topsectoren'. The program aims to enhance innovation by small and medium size companies (SME's) by funding innovation projects within and between SME's. Since 2007 over 250 million euros of subsidy have been provided to SME's in the construction sector and other sectors. The research in this thesis may help such innovation-oriented programs in reaching their goals. It does so by suggesting that systems integrators and champions may play an important role in the networks that carry out such programs. Due to their central and influential role in collaborative innovation processes, systems integrators and champions may have more influence on the achievements of such programs, than other actors in the program's network. This would make systems integrators and champions potential important partners in achieving the goals of such programs. The same may hold for communities in the Dutch construction sector like Pioneering, Spark, and Bouwcampus that aim to foster innovation through collaboration (see also section 6.1.1.). Communities like these may also benefit from building valuable relationships with systems integrators and champions, since system integrators and champions may serve as driving forces of collaborative innovation.

6.5 Conclusion

The construction sector was, is, and will probably be a fragmented sector. The sector being the whole, the many different firms along the value chain being the fragments. Due to this fragmentation, collaborative innovation projects are, and will be, an important path to innovation in the construction sector. The rise of various programs that stimulate collaborative innovation in the Dutch construction sector, and that have been set up in the past decade exemplifies this notion. The present thesis embraced the importance of collaboration for innovation. The insights it provides contribute to a deeper understanding of collaborative innovation projects. Hopefully these insights may be helpful in overcoming the challenges that the sector faces as a whole and that require collaborative innovation.

Appendix A - PhD coursework

This appendix lists the PhD courses I attended.

PLS Path modeling

Course of the PLS School

Survey Analysis

Course of the Essex Summer School in Social Science Data Analysis of the University of Essex

17th European Doctoral Summer School on Technology Management

Summer school of the European Institute for Advanced Studies in Management (EIASM)

Methodology of Research and Design

Course of the Netherlands Organization for research in Business Economics and Management (NOBEM)

Case Study Research

Course of the SOM research school of the University of Groningen

Technical Writing and Editing

Course of the University of Twente

Systematically Searching for Information

Course of the University of Twente

Appendix B - Magnitude of the sunk cost effect in the RBP experiments

In this appendix an overview is provided of the magnitude of the sunk cost effect, i.e. the effect size, as observed in Radar-Blank Plane experiments. Table 13 provides a summary of the observed effect sizes, in terms of Pearson's *r*, for the contrast between no sunk costs condition and sunk cost conditions. Table 14 provides a summary of the observed effect sizes, in terms of Pearson's *r*, for the contrast between sunk costs conditions of ½ or 1 million and sunk costs conditions of more than 1 million. If the effect size was not reported in the original article, we extracted it from the original article if we were able to do so by using instructions provided by Field and Wright (2006) and Rosenthal and DiMatteo (2001). If the original article did not include sufficient data to extract effect sizes, we contacted the authors for the raw data.

Consistent with the sunk cost results of a recent meta-analysis of the determinants of escalation of commitment (Sleesman *et al.*, 2012), Table 13 and Table 14 show that the effect sizes as observed in Radar-Blank Plane experiments differ across experiments. This is in line with the notion that effect sizes should be heterogeneous across studies in the vast majority of cases (Field and Gillet, 2010).

Table 13. Magnitude of observed sunk cost effect in RBP experiments in terms of Pearson *r*; contrast between no sunk costs condition and sunk costs conditions

Radar-Blank Plane experiment	***N***	***r***
Experiment one from the Conlon and Garland (1993) paper		
- Contrast between no sunk costs condition and $ 1 million condition (i)	about 290	$-1 < r < 0$
- Contrast between no sunk costs condition and $ 5 million condition (i)	about 290	$0 < r < 1$
- Contrast between no sunk costs condition and $ 9 million condition (i)	about 290	$-1 < r < 0$
- Contrast between no sunk costs condition and $ 1 million condition (ii)	about 290	$-1 < r < 0$
- Contrast between no sunk costs condition and $ 5 million condition (ii)	about 290	$-1 < r < 0$
- Contrast between no sunk costs condition and $ 9 million condition (ii)	about 290	$0 < r < 1$
First two experiments from the Tan and Yates (1995) paper		
- Contrast between no sunk costs condition and $ 7 million condition (iii)	41	.08
- Contrast between no sunk costs condition and $ 7 million condition (iii)	50	.59
Second two experiments from the Tan and Yates (1995) paper		
- Contrast between no sunk costs condition and $ 7 million condition (iii)	48	.13
- Contrast between no sunk costs condition and $ 7 million condition (iii)	50	.16
Experiment from the Moon (2001a) paper		
- Contrast between no sunk costs condition and $ 1 million condition (i)	177	.01
- Contrast between no sunk costs condition and $ 5 million condition (i)	173	.04
- Contrast between no sunk costs condition and $ 9 million condition (i)	176	.20
Experiment one from the Van Dijk and Zeelenberg (2003) paper		
- Contrast between no sunk costs condition and Fl. 0.5 million condition (iv)	62	.35
- Contrast between no sunk costs condition and Fl. 1.5 million condition (iv)	62	.42
- Contrast between no sunk costs condition and ambiguous sunk costs condition (iv)	62	.04

Note: Only Radar-Blank Plane experiments that did not confound sunk costs with project completion are listed.

(i) dependent variable: likelihood of allocating the next 1 million from the budget to continue the project.

(ii) dependent variable: likelihood of allocating all the money remaining in the budget to complete the project.

(iii) dependent variable: allocation of 3 million to complete the project.

(iv) dependent variable: allocation of 1 million to launch the new product.

Table 14. Magnitude of observed sunk cost effect in RBP experiments in terms of Pearson *r*; contrast between sunk costs conditions "½ or 1 million" and sunk costs conditions "> 1 million"

Radar-Blank Plane experiment	***N***	***r***
Experiment one from the Conlon and Garland (1993) paper		
- Contrast between $ 1 million condition and $ 5 million condition (i)	about 291	0 < *r* < 1
- Contrast between $ 1 million condition and $ 9 million condition (i)	about 291	0 < *r* < 1
- Contrast between $ 1 million condition and $ 5 million condition (ii)	about 291	0 < *r* < 1
- Contrast between $ 1 million condition and $ 9 million condition (ii)	about 291	0 < *r* < 1
Experiment two from the Conlon and Garland (1993) paper		
- Contrast between $ 1 million condition and $ 9 million condition (i)	262	-1 < *r* < 0
Experiment two from the Garland and Conlon (1998) paper		
- Contrast between $ 1 million condition and $ 9 million condition (i)	69	-.45
Experiment three from the Garland and Conlon (1998) paper		
- Contrast between $ 1 million condition and $ 9 million condition (i)	32	.27
Experiment from the Moon (2001a) paper		
- Contrast between $ 1 million condition and $ 5 million condition (i)	164	.03
- Contrast between $ 1 million condition and $ 9 million condition (i)	167	.19
Experiment one from the Van Dijk and Zeelenberg (2003) paper		
- Contrast between Fl. 0.5 million condition and Fl. 1.5 million condition (iii)	62	.02

Note: Only Radar-Blank Plane experiments that did not confound sunk costs with project completion are listed.
(i) dependent variable: likelihood of allocating the next 1 million from the budget to continue the project.
(ii) dependent variable: likelihood of allocating all the money remaining in the budget to complete the project.
(iii) dependent variable: allocation of 1 million to launch the new product.

Appendix C - Survey instrument

The data for study IV were collected as part of a larger survey. Together, Table 15 and Table 16 provide an overview of all variables measured in the survey instrument.

Table 15. Variables of study IV included in the survey

Type of variable	Variable name
Dependent variable	Likelihood of continuing investment
Independent variable	Expected loss of sunk costs
	Perceived enthusiasm among potential customers or clients
	Perceived project stage
Control and other variables	Decision power
	Length of participation
	Firm type
	Firm size

Note: for a further description of the variables see chapter 5 (sections 5.3 and 5.4)

Table 16. Other variables included in the survey

Variable name	Description of the variable
Champion behaviour (perceived)	Perceived champion behaviour of other participants in the collaborative innovation project by the participant
Champion behaviour (personal)	Personal champion behaviour of the participant him- or herself
Collective efficacy	Personal belief in the collective capacity of the participants in the collaborative innovation project to execute behaviours necessary to produce specific performance attainments
Contract	The firm signed a contract stating that it participates in the collaborative innovation project
Goal importance	Relative importance to the firm of the following goals (each goal is a separate variable): turnover and profit goals, competitive advantage, learning, reputation
Goal expectation	Expectations that the firm will achieve the following goals (each goal is a separate variable): turnover and profit goals, competitive advantage, learning, reputation
Investment type	Type of investments made by the firm in the collaborative innovation project
Joint venture member	The firm is a member of a joint venture that has been created for the purpose of the collaborative innovation project
Likelihood of abandoning	Likelihood that the firm will abandon the collaborative innovation project
Perceived support	Extent to which the needs and interests of the firm are taken into account in the collaborative innovation project
Satisfaction	Satisfaction with the results achieved so far for the firm
Speed of return on investment	Extent to which the firm’s expectations about the speed of return on investments are met
Strategic relevance	Strategic relevance to the firm of the collaborative innovation project

Note: The data collected for these variables are not included in the thesis, but are available for future analysis.

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Summary

Today's construction projects involve a variety of firms specialized in a wide range of areas. When looking at the construction sector's value chain in its broadest sense, the general picture is that of a fragmented sector. This fragmentation does not only cause the production of a building to be a cooperative effort, but has also implications for innovation. Previous research indicates that collaboration beyond the scope of an individual construction project is an important path to innovation in the construction sector. Collaborative innovation projects represent an example of such collaboration between firms. A collaborative innovation project is a project in which firms join forces to cooperate in the development and commercialization of a new building component, system, or service for a range of potential clients. The aim being that the new building component, system, or service will be adopted in a series of future construction projects. The conditions for collaborative innovation projects to arise and advance are, however, unfavourable. This is due to another defining characteristic of the construction sector. That is, firms tend to assemble for the purpose of an individual construction project, and disperse when the construction project is finished. Consequently, scholars have characterized the relationships among firms outside construction projects as 'loose couplings', and the sector as a whole as a 'loosely coupled system'. Since collaborative innovation projects require firms to work together beyond the scope of an individual construction project, an essential feature of collaborative innovation projects – i.e. long-term collaboration – conflicts with the construction sector's loosely coupled nature.

Given these circumstances, it is important to study and understand how collaborative innovation projects arise and advance in the construction sector. There are at least two lines of previous research that provide relevant insights in this respect. The first line of research is that of key actors in bringing together firms and resources for innovation. In a fragmented and loosely coupled sector, the act of bringing together firms and resources in a collaborative innovation project is an uncommon but important act. It is therefore important to identify and understand the actors who do so. Previous research indicates that both systems integrators and champions might be such key actors. A second line of research that

provides relevant insights, is that of decision research conducted by organizational behaviour researchers. This line of research might be helpful in understanding the decisions of firms about whether to invest resources in a collaborative innovation project. Such understanding is important since, in a fragmented and loosely coupled sector, the decision to invest resources in a collaborative innovation project is an uncommon but important decision.

Four studies are presented in this thesis that build on the insights of the two lines of previous research. Together, the four studies contribute to a deeper understanding of collaborative innovation projects in the construction sector. Study I and II contribute to the understanding of the role of systems integrators and champions in collaborative innovation projects. Study II , III and IV contribute to the understanding of the decisions of firms to invest resources in collaborative innovation projects.

Study I explores the role of systems integrators in collaborative innovation in the construction sector. The term systems integrators refers to a class of firms. On the basis of a review of the literature on systems integrators in other industries, study I develops a set of criteria for classifying a firm as a systems integrator. These criteria are: (a) design and production of systems by integrating externally supplied components and services; (b) one-off or small-batch production; and (c) responsibility for the functioning of the system as a whole. By providing two examples of firms from the Dutch construction sector that meet these classification criteria, and that have performed a central role in setting up and consequently coordinating a collaborative innovation project, study I illustrates that there are systems integrators in the construction sector that performed a similar role in collaborative innovation as has been observed with systems integrators in other industries. That is, they set up and coordinated a collaborative innovation project. In addition, by drawing on literature from four different but related fields of research (construction innovation, new product development, strategic networks and alliances, open innovation) study I provides an overview of factors that may affect the performance of collaborative innovation projects, and that systems integrators might want to take into account when setting up and coordinating a collaborative innovation project.

Study II explores how champions influence the decisions of firms to invest resources in a collaborative innovation project. Champions have been defined as ‘individuals who make a decisive contribution to an innovation by actively and enthusiastically promoting its progress through critical stages'. Previous research indicates that the presence of a champion increases the likelihood of resource allocation during the development stage of collaborative innovation projects. Little is, however, known about how champions exactly affect firms' resource allocation decisions. On the basis of a case study of two collaborative innovation projects within the Dutch construction sector, study II develops three propositions that address this gap in literature. First, the case study suggests that the mechanism that explains champions' effect on resource allocation might be the mediating role of firms' expectations of the rate of adoption; which means that champions would affect firms' resource allocation decisions by affecting the rate of adoption firms expect. Second, the case study suggests that it is not so much champions' presence as such, but rather their expressions of enthusiasm and confidence in the potential of an innovation (one of the prototypical behaviours of champions) that might affect resource allocation. And third, the case study suggests that champions' expressions of enthusiasm and confidence in the potential of an innovation during the development stage of a collaborative innovation project might indirectly create a barrier to the allocation of additional resources when, during the commercialization stage, the observed rate of adoption turns out to be lower than the expected rate of adoption. Overall, study II provides a step towards a deeper understanding of how champions influence the decisions of firms to invest resources in a collaborative innovation project.

Study III explores the value of a new theory of how people make decisions, narrative-based decision theory, in understanding the decisions of firms to invest resources in a collaborative innovation project. It does so in particular by applying narrative-based decision theory to a finding of previous experimental research on the decision to allocate resources to an innovation project; i.e. the Radar-Blank Plane experiments conducted by organizational behaviour researchers. The findings of study III suggest that to thoroughly understand firms' decisions to invest resources in a collaborative innovation project, one needs to examine two types of cognitive rules decision-makers use when making such decisions. This includes both the normative rules and the contingent and non-contingent rules used by a decision-maker. As stated by narrative-based decision theory, a decision-maker's normative rules tell the decision maker what is and what is not desirable. The decision-maker's contingent and non-contingent rules tell the decision maker what to expect as a result of something he or she does, or as a result of actions by other people. Overall, by looking at a finding of the Radar-Blank Plane experiments through the lens of narrative-based decision theory, study III illustrates how narrative-based decision theory may help explain how a firm's decision to invest resources in a collaborative innovation project is influenced.

Study IV explores whether firms participating in a collaborative innovation project are likely to escalate commitment. A firm is said to escalate commitment when it, for economically unsound reasons, decides to invest additional resources to continue an innovation project. Previous research, the Radar-Blank Plane experiments, indicate that firms participating in a collaborative innovation project are likely to escalate commitment in the following situations. First, when a firm expects a large loss of sunk costs (i.e. resources already spent) if it would abandon the collaborative innovation project. And, second, when a collaborative innovation project has reached an advanced stage. However, on the basis of a survey among 103 firms participating in 25 collaborative innovation projects within the Dutch construction sector, study IV suggests that Dutch firms participating in a collaborative innovation project are not likely to fall victim to one of the two escalation effects. Moreover, study IV suggests that Dutch firms that expect a large loss of sunk costs, are less, not more, likely to continue to invest than firms that expect a small loss of sunk costs. This, in fact, represents a de-escalation effect instead of an escalation effect. Overall, the findings of study IV question the generalizability of the findings from the Radar-Blank Plane experiments, in which university students are confronted with a scenario of a fictitious innovation project, to the real world of collaborative innovation projects.

There are at least two important directions for future research that follow from study I, II, III and IV. The first direction for future research is that of the influence of systems integrators and champions on the performance of collaborative innovation projects. The research presented in this thesis, for example, explored the influence of champions on the allocation of resources to collaborative innovation projects; which can be regarded as an aspect of process performance. But what about the influence of champions on development time? Another important aspect of process performance. Or the influence of systems integrators on innovation success? Measured by for example the rate of adoption, market share, or revenues. Future research may explore the influence of systems integrators and champions on such other aspects of performance. The second direction for future research is that of firms' susceptibility to escalate commitment. The suggestion in existing literature that escalation of commitment is a widespread phenomenon present in many contexts, may lead one to assume that escalation of commitment is also a widespread phenomenon in collaborative innovation projects. By questioning the generalizability of two prominent findings from the Radar-Blank Plane experiments to the real world of collaborative innovation projects in the construction sector, the research presented in this thesis raises the question in which contexts firms in the construction sector are and aren't susceptible to escalation of commitment. Future studies may answer this question.

The construction sector was, is, and will probably be a fragmented sector. The sector being the whole, the many different firms along the value chain being the fragments. Due to this fragmentation, collaborative innovation projects are and will be an important path to innovation in the construction sector. The present thesis embraced the importance of collaboration for innovation. The insights it provides, contribute to a deeper understanding of collaborative innovation projects.

Nederlandse samenvatting

Samenwerken aan innovatie in de bouwsector: belangrijke actoren en investeringsbeslissingen

In bouwprojecten zijn een breed scala aan bedrijven betrokken die ieder hun eigen specialisme hebben. Kijkend naar de hele keten van de bouwsector ontvouwt zich een beeld van een sector die, zoals dat in de wetenschappelijke literatuur aangeduid wordt, gefragmenteerd is. Deze fragmentatie zorgt er niet alleen voor dat de totstandkoming van een bouwwerk een kwestie van samenwerking is, maar heeft ook gevolgen voor de totstandkoming van innovaties. Eerder onderzoek toont aan dat samenwerking tussen bedrijven die verder gaat dan een enkel bouwproject een bron kan zijn van innovaties. Gezamenlijke innovatieprojecten zijn een voorbeeld van dit soort samenwerking. Een gezamenlijk innovatieproject is een project waarin bedrijven samenwerken aan de gezamenlijke ontwikkeling en vermarkting van een nieuw bouwsysteem, -product, of dienst voor een groep van potentiële klanten of opdrachtgevers. Het doel van een innovatieproject is dat het nieuwe bouwsysteem, -product, of dienst geadopteerd wordt in toekomstige bouwprojecten. De omstandigheden voor het ontstaan en voortbestaan van gezamenlijke innovatieprojecten zijn echter niet gunstig. Dit hangt samen met een ander typisch kenmerk van de bouwsector. Te weten, bedrijven ontmoeten elkaar veelal in de context van een individueel bouwproject, en nemen weer afscheid van elkaar zodra het bouwproject gereed is. Dit kenmerk van de bouwsector heeft wetenschappers ertoe bewogen om de relaties tussen bedrijven over projecten heen als ‘loose couplings’ oftewel ‘losse verbindingen’ te typeren, en de bouwsector als geheel als een ‘loosely coupled system’. Omdat gezamenlijke innovatieprojecten bedrijven langduriger aan elkaar verbinden, dus niet alleen binnen de context van een enkel bouwproject, lijkt een essentieel kenmerk van gezamenlijke innovatieprojecten (lange termijn samenwerking) strijdig te zijn met de los verbonden aard van de bouwsector.

Gegeven deze omstandigheden is het van belang om te begrijpen hoe gezamenlijke innovatieprojecten ontstaan en voortbestaan in de bouwsector. Er zijn ten minste twee onderzoeksvelden die relevante inzichten aanreiken in dit kader. Het eerste onderzoeksveld betreft onderzoek over actoren die een voorname rol spelen in het samenbrengen van bedrijven en middelen voor innovatie. In een gefragmenteerde en los verbonden sector is het samenbrengen van bedrijven en middelen in een gezamenlijke innovatieproject geen alledaagse maar wel een belangrijke activiteit. Het is daarom van belang om actoren die dit doen, te identificeren en bestuderen. Eerder onderzoek suggereert dat systeemintegratoren en champions mogelijk dergelijke actoren zijn. Een tweede onderzoeksveld dat relevante inzichten biedt, betreft het onderzoek door organisatiegedragswetenschappers naar beslisgedrag. Dit onderzoeksveld kan bijdragen aan het begrip van beslissingen van bedrijven om middelen te investeren in een gezamenlijke innovatieproject. Het begrijpen van dit soort beslissingen is van belang omdat de beslissing om middelen te investeren in een gezamenlijk innovatieproject geen alledaagse maar wel een belangrijke beslissing is in een gefragmenteerde sector zoals de bouwsector.

De kern van dit proefschrift bestaat uit vier studies die voortbouwen op onderzoek uit de twee genoemde onderzoeksvelden. Tezamen dragen de vier studies bij aan een beter begrip van gezamenlijke innovatieprojecten in de bouwsector. Studie I en II doen dat door bij te dragen aan een beter begrip van de rol die systeemintegratoren en champions vervullen in gezamenlijke innovatieprojecten. Studie II, III en IV door bij te dragen aan een beter begrip van beslissingen van bedrijven om middelen te investeren in gezamenlijke innovatieprojecten.

Studie I verkent de rol van systeemintegratoren in gezamenlijke innovatieprojecten in de bouwsector. De term systeemintegrator verwijst naar een bepaald soort bedrijf. Op basis van een synthese van bestaande literatuur over systeemintegratoren reikt studie I een set van criteria aan voor het classificeren van een bedrijf als systeemintegrator. Deze criteria zijn: (a) ontwerpen en produceren van systemen door het integreren van extern geleverde componenten en diensten; (b) produceren van enkelstuks of kleine series; en (c) verantwoordelijkheid dragen voor het functioneren van het systeem als geheel. Door vervolgens twee voorbeelden aan te dragen van bedrijven uit de Nederlandse bouwsector die aan deze drie criteria voldoen, en die een centrale rol hebben vervuld in het opzetten en vervolgens coördineren van een gezamenlijk innovatieproject, illustreert studie I dat er in de bouwsector systeemintegratoren zijn die een vergelijkbare rol hebben vervuld in gezamenlijke innovatie als eerder is waargenomen door wetenschappers in andere sectoren. Deze rol betreft het opzetten en coördineren van een gezamenlijk innovatieproject.

Daarnaast, op basis van een verkenning van de literatuur van vier verschillende maar gerelateerde onderzoeksvelden (bouwinnovatie, productontwikkeling, strategische netwerken en allianties, open innovatie), reikt studie I een overzicht aan van factoren die het succes van gezamenlijke innovatieprojecten mogelijk beïnvloeden, en waar systeemintegratoren mogelijkerwijs rekening mee willen houden als ze een gezamenlijk innovatieproject opzetten en coördineren.

Studie II gaat over de vraag hoe champions de beslissingen van bedrijven beïnvloeden om middelen te investeren in gezamenlijke innovatieprojecten. De term champions verwijst naar 'individuen die een cruciale bijdrage leveren aan een innovatie door de voortgang actief en enthousiast te promoten in kritieke fases'. Eerder onderzoek suggereert dat de aanwezigheid van een champion het waarschijnlijker maakt dat bedrijven middelen investeren in een gezamenlijk innovatieproject gedurende de ontwikkelfase van het innovatieproject. Er is echter weinig bekend over hoe champions dergelijke investeringsbeslissingen precies beïnvloeden. Op basis van een casestudy van twee gezamenlijke innovatieprojecten in de Nederlandse bouwsector reikt studie III een drietal proposities aan die zich richten op deze leemte in de literatuur. Ten eerste, de casestudy suggereert dat champions de investeringsbeslissingen van bedrijven mogelijk beïnvloeden door de verwachtingen van deze bedrijven over de adoptiesnelheid van de innovatie te beïnvloeden. Ten tweede, de casestudy suggereert dat het niet zozeer de aanwezigheid van champions is die van invloed is, maar dat het vooral de uitingen door champions van enthousiasme en vertrouwen in de potentie van een innovatie zijn die de investeringsbeslissingen van bedrijven beïnvloeden. Tot slot suggereert de casestudy dat dergelijke uitingen van champions van enthousiasme en vertrouwen in de potentie van een innovatie gedurende de ontwikkelfase van een gezamenlijk innovatieproject indirect een drempel kunnen opwerpen voor verdere investeringen gedurende de commercialisatiefase indien dan blijkt dat de adoptiesnelheid lager is dan verwacht door bedrijven. Samenvattend kan studie II beschouwd worden als een stap richting een beter begrip van de wijze waarop champions de beslissingen beïnvloeden van bedrijven om middelen te investeren in een gezamenlijk innovatieproject.

Studie III verkent de waarde van een nieuwe theorie over hoe mensen beslissingen nemen, narrative-based decision theory, voor het begrijpen van beslissingen van bedrijven om middelen te investeren in een gezamenlijk innovatieproject. Dat doet studie III door narrative-based decision theory toe te passen op een bevinding van eerder onderzoek naar de beslissing om middelen te investeren in een innovatieproject; te weten de Radar-Blank Plane experimenten zoals uitgevoerd door organisatiegedragswetenschappers. De resultaten van studie III suggereren dat, om beslissingen van bedrijven om middelen te investeren in een gezamenlijk innovatieproject goed te begrijpen, men zich moet verdiepen in twee type ‘cognitive rules’ die beslissers gebruiken bij het maken van dergelijke beslissingen. Dit betreft enerzijds de ‘normative rules’ en anderzijds de ‘contingent’ en ‘non-contingent rules’ die beslissers gebruiken. De normative rules van een beslisser, aldus narrative-based decision theory, geven aan wat wel en niet wenselijk is. De contingent en non-contigent rules van een beslisser geven aan wat te verwachten als resultaat van iets dat de beslisser zelf doet, of als resultaat van iets dat anderen doen. Kortom, door een bevinding van de Radar-Blank Plane experimenten te plaatsen in het licht van narrative-based decision theory, illustreert studie III hoe narrative-based decision theory kan helpen te verklaren hoe beslissingen van bedrijven om middelen te investeren in een gezamenlijk innovatieproject beïnvloed worden.

Studie IV verkent of bedrijven die participeren in een gezamenlijke innovatieproject gevoelig zijn voor ‘escalation of commitment’. Escalation of commitment betreft het blijven investeren van middelen in een innovatieproject om redenen die vanuit economisch perspectief ongegrond zijn. Eerder onderzoek, de Radar-Blank Plane experimenten, suggereert dat bedrijven die participeren in een gezamenlijk innovatieproject gevoelig zijn voor escalation of commitment in de volgende twee situaties. Ten eerste, als een bedrijf een groot verlies van reeds geïnvesteerde middelen verwacht indien het bedrijf het gezamenlijke innovatieproject zou verlaten. En, ten tweede, indien het gezamenlijke innovatieproject in een vergevorderd stadium is. Echter, op basis van een enquête onder 103 bedrijven, die in totaal participeren in 25 gezamenlijke innovatieprojecten in de Nederlandse bouwsector, suggereert studie IV dat Nederlandse bedrijven die participeren in een gezamenlijk innovatieproject niet gevoelig zijn voor de twee genoemde escalatie effecten. Sterker nog, study IV suggereert dat bedrijven die een groot verlies van reeds geïnvesteerde middelen verwachten indien ze het gezamenlijke innovatieproject zouden verlaten minder, in plaats van meer, geneigd zijn om door te gaan met investeren. Dit is per saldo een de-escalatie effect (in plaats van een escalatie effect). Tezamen trekken de bevindingen van studie IV de generaliseerbaarheid van de bevindingen van de Radar-Blank Plane experimenten, waarin een scenario van een fictief innovatieproject wordt voorgelegd aan universiteitsstudenten, naar de praktijk van gezamenlijke innovatieprojecten in twijfel.

Er zijn ten minste twee voorname richtingen voor vervolgonderzoek die voortvloeien uit studie I, II, III en IV. De eerste richting voor vervolgonderzoek betreft de invloed van systeemintegratoren en champions op het proces en het innovatiesucces van gezamenlijke innovatieprojecten. Het onderzoek in dit proefschrift richt zich bijvoorbeeld op de invloed van champions op de hoeveelheid middelen die in een gezamenlijk innovatieproject worden geïnvesteerd; hetgeen beschouwd kan worden als een procesaspect. Maar hoe zit het met de invloed van champions op de doorlooptijd van de ontwikkelfase van een gezamenlijk innovatieproject? Een ander belangrijk aspect van het proces. Of de invloed van systeemintegratoren op het innovatiesucces van een gezamenlijk innovatieproject? Gemeten door bijvoorbeeld de adoptiesnelheid, het marktaandeel, of de financiële opbrengsten. Toekomstig onderzoek kan de invloed van systeemintegratoren en champions blootleggen op deze en andere procesaspecten en het innovatiesucces van gezamenlijke innovatieprojecten. De tweede richting voor vervolgonderzoek betreft de gevoeligheid van bedrijven in de bouwsector voor escalation of commitment. De bewering in de bestaande literatuur dat escalation of commitment een wijdverbreid fenomeen is dat zich voordoet in vele contexten, zou kunnen doen vermoeden dat escalation of commitment ook een wijdverbreid fenomeen is in gezamenlijke innovatieprojecten. Door de generaliseerbaarheid van twee prominente bevindingen van de Radar-Blank Plane experimenten naar de praktijk van gezamenlijke innovatieprojecten in de bouwsector in twijfel te trekken, doet dit proefschrift de vraag rijzen in welke contexten bedrijven in de bouwsector wel en niet gevoelig zijn voor escalation of commitment. Toekomstig onderzoek kan deze vraag beantwoorden.

De bouwsector was, is, en zal waarschijnlijk een gefragmenteerde sector blijven. De sector het geheel. De vele verschillende bedrijven in de hele keten de fragmenten. Door deze fragmentatie zijn en blijven gezamenlijke innovatieprojecten een belangrijke bron van innovatie in de bouwsector. Dit proefschrift omarmt het belang van samenwerking voor innovatie. De inzichten die het aanreikt, dragen bij aan een beter begrip van gezamenlijke innovatieprojecten.

Curriculum vitae

Maarten Rutten was born August 22, 1979 in Boxmeer. He attended the gymnasium at Bernardinus College in Heerlen where he graduated cum laude in 1997. In 1998, he obtained a propaedeutic diploma in psychology from Maastricht University, and in 2004, a MSc degree in architecture, building and planning from Eindhoven University of Technology. After his studies in Eindhoven, he started working as a consultant at Beco, a consultancy firm in the field of sustainability. Subsequently, from 2006 to 2012, he worked at University of Twente, department of Construction Management and Engineering. First as PhD student, and from 2009 as assistant professor. In 2012, he left University of Twente to join the School of Built Environment at Avans University of Applied Sciences, where he currently chairs the Commission on Education and Research, leads the BIM research team and teaches various courses. His research has been published in Construction Management and Economics, Management Decision, and Construction Innovation.

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