DOCTORAL THESIS

ON ENHANCING JOINT RISK MANAGEMENT THROUGHOUT A PROJECT'S LIFECYCLE

EMPIRICAL STUDIES OF SWEDISH CONSTRUCTION PROJECTS

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Luleå, December 2013

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Preface

Before I started my PhD studies in 2006 I was barely aware of the complexity of this assignment. Knowledge is often intangible and “the more you learn, the more you realise how little you know” (as Socrates said, according to Plato) is a pretty accurate description of how I often felt along the route. The research process is not straightforward and full of struggle, making you sometimes feel completely lost and frustrated. At the same time, it is hardly possible to find another task that is so rewarding in terms of learning and self-development. Satisfaction when it is finally completed is great!

I would like to express my gratitude to all people who helped and encouraged me in the research process and writing the thesis.

First of all, my supervisor Associate Professor Per Erik Eriksson is gratefully acknowledged for supporting and guiding me through the process with patience and dedication. I am really thankful for your interest in our research and fruitful discussions. During these years, you have been a really good example and a source of inspiration for me.

I extend heartfelt thanks to Professor Thomas Olofsson, my co-supervisor and Head of the Construction Engineering Group. Thank you for creating a friendly and enjoyable atmosphere and for your positive attitude. It was a pleasure to be welcomed by, work with and share many wonderful moments with all of my great colleagues in the Research Group and the Division of Structural and Construction Engineering.

I would also like to thank Professor Will Hughes of the University of Reading for providing an opportunity to join his research group for two months and for

the support he offered me during the visit. It was a rewarding and enjoyable experience.

I also owe many thanks to industry practitioners who showed interest in my work and generously shared information with me. Thanks particularly to the members of the reference group – Kajsa Simu, Henrik Szentes and Ulf Olsson – for your inputs to the project and interesting discussions about the construction industry. It was very valuable to have connections to the 'reality'! All the participants in case study projects are acknowledged for welcoming me into their organizations, providing me with all the necessary information, and answering all my questions during the interviews. Your input was crucially important for the studies.

Susanne Engström, thanks for your excellent ability to examine work and give valuable feedback. Your comments helped me to significantly improve the quality of this thesis.

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Last (but very far from least) I would like to acknowledge all my friends around the world and family. My dearest Kristina Laurell and Anna-Karin Lénshof, your support and smiles meant so much to me! Thanks to my mom for always encouraging my education, and for all the help provided during the last months of writing this thesis when life was so chaotic. Thank you, Evgeny, for always being there for me, for your love and support. Victor and Martin, you are even more important output of these years. Thank you for being such a great source of joy in my life!

Luleå, December 2013

Ekaterina Osipova

Abstract

Due to their complexity, construction projects involve significant risks that must be managed in order to meet the main project objectives in terms of cost, time and quality. While some risks can be foreseen at the beginning of a project and allocated among the project actors, other risks are difficult to predict. Moreover, even identified risks may change in scope and require different types of response. In order to manage such risks successfully, collaborative efforts among project actors are needed. This thesis focuses on collaborative management of risks in construction projects – joint risk management (JRM) – which is claimed to provide several advantages in comparison to separate risk management by each project actor. An overall aim is to increase the understanding of how JRM can be enhanced throughout a project's lifecycle.

The underlying studies this thesis is based upon constitute a multiple case study of nine construction projects, a questionnaire survey and a longitudinal case study of three construction projects. Empirical data were collected through interviews, observations of JRM workshops and document studies. The empirical findings show that cooperative procurement procedures, organic management systems and appropriate strategies for addressing agency-related problems enhance JRM in construction projects. Thus they require thorough consideration when organizations intend to implement JRM.

This thesis provides several contributions to risk management theory. Firstly, the author extends the definition of JRM by including its core components together with associated activities and underlying factors. The extended definition better reflects, and increases understanding of, the nature of JRM. Secondly, the research contributes to discussion of serious drawbacks related to

traditional procurement practices by identifying and studying procurement variables (project delivery method, form of payment and use of collaboration or partnering arrangements) that have a major influence on risk management. In addition, the results of questionnaire survey suggest that cooperative procurement procedures in general and collaborative activities in particular are positively related to the use of JRM. Finally, by framing the empirical results in an organizational theory context this research identifies two sets of factors that strongly influence the implementation and effectiveness of JRM, related to management system (organic vs. mechanistic), and strategy for responding to agency-related problems. By applying theory on mechanistic and organic organization to RM, the study pinpoints the importance of managing tensions between control and flexibility when implementing JRM. The author suggests that JRM requires a combination of formal tools (aimed at controlling identified risks) and flexible strategies (aimed at responding to unforeseen events). By investigating how strategies to handle agency-related problems can foster collaborative relationships and JRM, this research contributes to RM literature where few studies have discussed JRM from the perspective of the principal – agent relationships.

Keywords: Risk management, joint risk management, uncertainty, project management, procurement, relational contracting, collaboration, construction, questionnaire survey, case study, Sweden

Abstract in Swedish

I och med ökad storlek och komplexitet på byggprojekten har förmågan att hantera risker blivit en central del för att förebygga oönskade konsekvenser i projekten och uppfylla de viktigaste projektmålen, dvs. tid, kostnad och kvalité. Även om vissa risker kan förutses i början av ett projekt och fördelas mellan projektaktörer, är andra risker svåra att förutse. Dessutom kan de identifierade riskernas omfattning förändras och kräva ändrade åtgärder. En succesiv hantering av sådana förändringar kräver ett samarbete mellan projektaktörer, i form av gemensam riskhantering (JRM), som har flera fördelar i jämförelse med riskhantering utfört av varje enskild aktör. Syftet med forskningsprojektet är att öka förståelsen för hur gemensam riskhantering bör bedrivas på ett systematiskt sätt under hela byggprojekttiden och vilka faktorer som påverkar dess framgång.

Empiriskt är resultaten baserade på en multipel fallstudie av nio byggprojekt, en enkätstudie samt en longitudinell fallstudie av tre byggprojekt. Datainsamlingen har skett via intervjuer, observationer av riskhanteringsworkshops och dokumentstudier. Resultaten visar att samverkansinriktade upphandlingsmetoder, ledningssystem som är organiska snarare än mekanistiska samt lämpliga strategier för att hantera agentproblem främjar JRM i byggprojekt. Dessa faktorer kräver därför ett noggrant övervägande när organisationer avser att genomföra JRM.

Denna forskning bidrar till både riskhanteringsteori och -praktik. För det första, genom att identifiera kärnelement tillsammans med tillhörande aktiviteter och underliggande faktorer, utvecklar författaren definitionen av JRM. Den utvidgade definitionen speglar bättre vad JRM är och ökar därför förståelsen för JRM-processen. För det andra, genom att identifiera och studera

upphandlingsvariabler som har en stor påverkan på riskhantering (dvs. kontraktsform, betalningsform och samarbetsavtal) bidrar forskningen till diskussion om nackdelar med traditionella upphandlingsmetoder. Dessutom visar resultaten från enkätstudie att samarbetsinriktade upphandlingsmetoder och gemensamma aktiviteter främjar användningen av JRM. Slutligen, genom att applicera organisationsteorier till empiriska resultaten, identifierar forskaren att ledningssystem (organisk kontra mekanistisk) och strategier för att hantera agentrelaterade problem har stark påverkan på genomförandet och effektiviteten av JRM. Genom att tillämpa teorin om mekanistisk och organisk organisation på riskhantering, preciserar studien vikten av att hantera spänningarna mellan kontroll och flexibilitet vid genomförandet av JRM. Författaren föreslår att JRM kräver en kombination av formella verktyg (i syfte att kontrollera identifierade risker) och flexibla strategier (i syfte att hantera oförutsedda förändringar). Genom att undersöka hur strategier för att hantera agentrelaterade problem kan främja samarbetsrelationer och JRM, bidrar denna forskning till riskhanteringslitteratur där få studier har diskuterat JRM utifrån agentrelationer.

Nyckelord: Riskhantering, gemensam riskhantering, osäkerhet, projektledning, upphandling, samarbete, byggprojekt, enkät, fallstudie, Sverige

Appended papers

Paper I. Osipova, E. and Eriksson P. E., (2011). How procurement options influence risk management in construction projects, *Construction Management and Economics,* Vol. 29 No. 11, pp. 1149–1158.

Paper II. Osipova, E. and Eriksson P. E., (2009). Joint risk management as a driver of project performance improvement, *Proceedings of the 5th Nordic Conference on Construction Economics and Organization*. Reykjavik: University of Reykjavik, Vol. 2, pp. 109-116.

Paper III. Osipova, E. and Eriksson, P. E., (2011). The effects of cooperative procurement procedures on joint risk management in Swedish construction projects, *International Journal of Project Organisation and Management,* Vol. 3 No. 3/4, pp. 209-226.

Paper IV. Osipova, E. and Eriksson, P. E., (2013). Balancing control and flexibility in joint risk management: Lessons learned from two construction projects, *International Journal of Project Management,* Vol. 31 No. 3, pp. 391-399.

Paper V. Osipova E. Establishing cooperative relationships and joint risk management in construction projects – An agency theory perspective. (Submitted to Journal of Management in Engineering in December 2013)

List of figures and tables

Abbreviations

AB (Allmänna bestämmelser) – General Conditions of Contract for Building, Civil Engineering and Installation Work

ABT (Allmänna bestämmelser för totalentreprenader) – General Conditions of Contract for Building, Civil Engineering and Installation Work performed on a package deal basis

ARCOM – Association of Researchers in Construction Management

BKK (Byggandets Kontraktskommitté) – Building Contracts Committee

DBB – Design-bid-build

DB – Design-build

GC – General contract

IEC – International Electrotechnical Commission

JRM – Joint risk management

LOU (Lagen om offentlig upphandling) – the Public Procurement Act

LTU (Luleå tekniska universitet) – Luleå University of Technology

PBL (Plan- och bygglagen) – the Swedish Planning and Building Act

PM – Project management

PMI – Project Management Institute

PMBOK – Project Management Body of Knowledge

RC – Relational contracting

RM – Risk management

SBI (Sveriges Byggindustrier) – the Swedish Construction Federation

Table of Contents

1 INTRODUCTION

This chapter provides the background information for the studies this thesis is based upon, introduces the research problem and aim, and outlines the structure of the thesis. First, the nature of the projects and the role of risk management are presented. The terms 'uncertainty' and 'risk' are introduced, the risk management process is briefly described and problems associated with risk allocation and relationships among project actors are presented. Criticisms of current risk management practices are then discussed, the research problem is formulated, and the research aim and questions are specified. Finally, the structure of the thesis is described.

1.1 Background

Today much construction work is carried out in the form of complex projects, thus project management (PM) is highly important (Maylor et al., 2008). The main goal of PM is to apply knowledge, skills, tools and techniques to project activities in order to meet the project objectives (Project Management Institute, 2013). However, there are many examples of construction projects failing to meet their objectives in terms of time, cost and/or quality. According to Turner (1992), "a project is an endeavour in which human, material and financial resources are organised in a novel way; to undertake a unique scope of work of given specification, within constraints of cost and time, so as to achieve unitary, beneficial change, through the delivery of quantified and qualitative objectives".

This definition suggests that all projects have a number of common characteristics: they are unique, have predefined performance goals (including time constraints), involve many interdependent participants and their

implementation is complex. Technical and organizational complexities, limitations of resources and the dynamic nature of the projects give rise to uncertainty (changes in elements over time that are difficult to predict and control). Hence, uncertainty is inherent in projects. Uncertainty may significantly affect chances of meeting project objectives, and thus must be properly managed. Risk management (RM) is an integral part of PM aiming at the identification, assessment and responses to potential uncertain events that may negatively or positively affect the delivery of project objectives (Project Management Institute, 2013). The main task of RM is to support organizations' efforts to make appropriate decisions in order to minimize consequences of negative events and maximize opportunities (Hillson, 2009).

In 2013, KPMG conducted a global construction survey based on 165 face-to-face interviews with senior executives of leading engineering and construction companies around the world. Most of the respondents reported that some projects their companies had been involved in had underperformed and cited inadequacies in RM processes as one of the major causes of failures to meet performance targets. Despite significant investments in RM over the past decade, the failures call into question the effectiveness of PM in general and RM in particular. To counter such failures a stronger focus on people and relationships is advocated because RM relies on people as much as processes and tools (KPMG International, 2013). Moreover, respondents acknowledged that efficient RM is the main contributor to growth, in accordance with previous findings that there is a strong connection between RM and the success of projects (e.g. Raz and Michael, 2001).

1.1.1 Uncertainty, risk and risk management

Nearly a century ago, Knight (1921) highlighted the importance of distinguishing between the terms 'uncertainty' and 'risk'. He argues that the term 'risk' is often used as a substitute for unfavourable uncertainty, giving rise to misunderstanding. Knight suggests that the terms should be distinguished on the basis of measurability, holding that 'risk' refers to measurable uncertainty while 'uncertainty' is unmeasurable, i.e. certain probabilities cannot be assigned. Moreover, while many risks and uncertainties may have negative results others may be advantageous. However, this issue is still debated in the research literature as there is no consensus about what constitutes uncertainty (Perminova et al., 2008; Ward and Chapman, 2003). Most widely recognized project management frameworks, e.g. the global standard "A Guide to the Project Management Body of Knowledge", PMBOK (Project Management Institute, 2013), use the term 'risk' to define uncertain events. However, a

strong focus on the term ‘risk’, which is still mostly associated with threats, excludes uncertainties with potentially beneficial effects.

Various definitions of project risk have been presented (see, for example, Baloi and Price, 2003; Barber, 2005; Chapman and Ward, 2002; Flanagan and Norman, 1993; Jaafari, 2001; Project Management Institute, 2013; Smith et al., 2006). Several of these definitions have a common feature: they define risk in terms of uncertain events and their impact on chances of meeting a project’s objectives. Some definitions, e.g. IEC (2001), use the terms ‘probability’ and ‘consequence’ and define risk as a combination of the probability of an event occurring and its consequences for project objectives. As this thesis discusses risks in the project context, a formal definition from PMBOK is used: “project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality” (Project Management Institute, 2013).

The overall goal of RM is to minimize the negative consequences of an uncertain event and maximize the positive opportunities it may provide. Three steps, *risk identification, risk assessment and risk response* form the core of the RM process.

Risk identification is aimed at determining potential risks i.e. forecasting events that may affect the project. PMBOK suggests that as many project stakeholders as possible should participate in the identification process. However, in construction projects, numerous different actors rarely participate in the identification process (Rahman and Kumaraswamy, 2004). Instead, every actor usually carries out their own risk identification.

Risk assessment is the second step in the formal process. The goal is to prioritise risks for management. The research literature offers numerous models, based on both qualitative and quantitative methods, for assessing project risks.

Risk response, the third step, is directed at finding optimal ways to deal with risks. According to the Project Management Institute (2013) there are four main risk response strategies: risk avoidance (dealing with risks by changing project plans or finding methods to eliminate them); risk reduction (reducing probabilities and/or consequences of a risk event); risk transfer (shifting responsibility for handling risks to another party, either inside or outside the project); and risk retention within the project. How remaining risks are allocated among the project actors is defined by the contracts.

1.1.2 Contractual relationships and problems of risk allocation

Organizing construction projects is a complex process, involving temporary associations of many contractually-related participants who belong to different organizations, may have little familiarity and weak relationships with the project manager (Lundin and Söderholm, 1995). This raises uncertainty in the project organization and problems of opportunistic behavior. The more participants that are involved, the more complex the task of PM becomes.

The participants in construction projects include clients, contractors, sub-contractors, manufacturers and suppliers, architects, engineers, consultants, local authorities, funding organizations and end-users. In this thesis three main groups of construction project actors are discussed: clients, contractors and consultants. According to PBL (2010), a client is a party that carries out or assigns others to carry out construction, demolition or land work. There are two main groups of construction clients: public and private. Privately owned companies usually undertake projects to make a profit (exceptions are various non-profit organizations, which undertake projects for diverse motives, often social or environmental). The public sector includes the central government and local authorities, which undertake projects to provide a public service and/or benefits for their citizens (or powerful interest groups). A contractor is an organization that provides a service for the client, i.e. executes construction works. Contractor organizations have widely varying degrees of complexity and provide diverse services – from ground works to electrical installations and telecommunications. The role of consultants is to assist clients and contractors by providing design, engineering services or other business-related services. As many interdependent actors are involved in any large project, relationships among them strongly influence the implementation, and success, of projects.

It has been argued that traditional contracts do not foster cooperative relationships, but rather relationships based on self-interest, opportunism and adversarial behavior (Gil, 2009; Kadefors, 2004). Conflicts and disputes are therefore common especially when unforeseen events occur in a project (de Man and Roijakkers, 2009). Moreover, traditional procurement procedures based on standardized contract conditions are often seen as major barriers to collaboration (Kadefors and Badenfelt, 2009). In such contracts there is more focus on price and short-term results than on collaboration and long-term relationships (Eriksson and Laan, 2007). However, standardized contract conditions are widely used because the industry is familiar with them and it avoids transaction cost of redrafting (Cox and Thompson, 1997).

Risks are allocated among the project actors through construction contracts, i.e. written agreements that specify the liabilities and responsibilities of each party. Risk allocation influences the behavior of project actors and thus may profoundly affect the project performance in terms of the total cost (Zack, 1996). Therefore, appropriate risk allocation is important, but it is associated with several significant problems. Notably, the project actors often have conflicting perceptions about who should be allocated specific risks (Loosemore and McCarthy, 2008). Usually, contractors bear most risks (Wang and Chou, 2003) and price them by adding a contingency to their bid price (Andi, 2006). However, contractors often do not evaluate risks properly because of the lack of relevant information at the beginning of the project and lack of time to prepare bids thoroughly (Ward et al., 1991). This problem may result in incorrect calculations of contingency funds. Over-estimation may be a significant contributor to project overspend (Zaghloul and Hartman, 2003), while under-estimation may result in higher than anticipated costs (with consequent reductions in profit or even losses) for the contractor during the project implementation (Laryea and Hughes, 2008). In the latter situation contractors may pass risks further down the supply chain, resulting in shifts of responsibility for substantial amounts of risks to the actors with the least power and control in the project (Hanna et al., 2013).

Another problem associated with risk allocation is that some risks are not identifiable and manageable at the outset of a project and some may change during its implementation (Hartman et al., 1997). Besides, even identified risks are “uncertain” because likelihoods of their occurrence are rarely known with certainty (Hillson, 2009). To summarize, appropriate allocation of project risks is important but difficult to achieve, partly due to time pressures during contract preparation and partly to the impossibility of accounting for many risks that may change or emerge during project implementation.

1.1.3 Towards collaboration and joint risk management

To overcome adversarial behavior and encourage client-contractor cooperation, various relational contracting (RC) strategies (e.g. partnering, alliancing and joint ventures) have been developed. An analysis of construction RC based on an extensive literature review of existing definitions, is presented by Yeung et al. (2012). The authors identify five essential elements of RC: commitment, trust, cooperation and communication, common goals and objectives, and win-win philosophy. One of the listed RC strategies, partnering, is widely used in the construction industry. Positive experiences of partnering projects in the

USA, UK, Netherlands and Denmark have led to the adoption of partnering concepts in Sweden.

In attempts to advance understanding of RM, recent studies have focused on the importance of collaboration in project organization in order to manage risks effectively. Hartman et al. (1997) advocate dynamic RM (continuous identification and evaluation of risks throughout an entire project) for the proactive and joint management of risks that cannot be fairly allocated in a contract. They highlight the importance of project actors' beliefs in team efforts and willingness to achieve a win-win scenario. A survey they present also indicates that practitioners are generally in favour of collaborative RM rather than allocating risks to specific actors. Rahman and Kumaraswamy (2002b) describe a similar approach they call 'joint risk management (JRM)'. They define JRM as "a dynamic management of risks at the post-contract stage based on relational contracting principles". In this approach risks are managed in collaboration, focusing on what is best for the project rather than sub-optimising the situation for each specific actor. The results of a survey by the cited authors (Rahman and Kumaraswamy, 2002a) also show that industry practitioners generally have a positive attitude towards JRM, suggesting that most risk items listed in an applied questionnaire would be most appropriately handled by a JRM approach.

Although, the collaboration of many different actors in RM is important to obtain a comprehensive view and avoid a narrow, biased perspective of project risks, RM is often performed individually rather than jointly. So, identifying reasons why collaboration in RM is problematic is of particular interest as it may elucidate ways to achieve JRM.

1.2 Aim and research questions

Several problem areas discussed in the introduction have to be examined further to obtain better understanding of JRM. First, there is a lack of descriptive material on the nature of JRM: what JRM is, and how people actually carry out JRM. Second, previous research has identified a number of serious drawbacks related to procurement practices based on the lowest price award mechanism with a short-term focus. Although contracting strategies that facilitate collaboration in projects have been intensively researched the relationship between cooperative procurement and JRM has not been studied. Third, relationships between project's actors play important roles in collaboration in projects, but adversarial problems among contracting parties commonly arise and have to be addressed to implement effective JRM.

The overall aim of the studies underlying this thesis is to increase the understanding of how joint risk management (JRM) can be enhanced throughout a project's life cycle, thereby contributing to improvements in the RM process and (hence) performance in construction projects. The studies are summarized in this thesis and presented more fully in five appended papers. The specific questions addressed in each of the papers, focusing on the problem areas discussed above, are presented in Table 1.

Table 1. Research questions addressed in the appended papers

Research questions	**Appended papers**				
	I	**II**	**III**	**IV**	**V**
RQ 1. What are the key components of JRM?		✓			
RQ 2. Why collaboration in RM is problematic?	✓			✓	
RQ 3. How do the utilized procurement procedures influence JRM?	✓		✓		
RQ 4. How can collaborative relationships among the contracting parties that underpin JRM be established?				✓	✓

The questions were posed in order to increase understanding of qualitative aspects of JRM, and thus ways to enhance JRM throughout projects. Certain aspects of JRM have been addressed in a number of quantitative investigations (e.g. Doloi, 2009; Rahman, 2003; Tang et al., 2007), which have provided valuable information on relationships between JRM and some underlying factors. However, quantitative analyses cannot provide deep understanding about how people collaborate in JRM. Blomquist et al. (2010) suggest that investigations aiming to obtain a deeper understanding of how project actors use available tools, respond to changing conditions and create common views of specific tasks, are highly relevant for further development of PM research. Therefore, there is a need for qualitative investigation of JRM to enhance both academic knowledge and PM practices, which the studies presented in this thesis attempted to meet.

Earlier investigations have shown that lack of collaboration between key actors is a major barrier to effective RM, thus research that increases understanding of ways to foster collaboration throughout projects is crucial. Therefore, the studies incorporated perspectives of clients, contractors and consultants, all of whom are likely to benefit from knowledge of suitable approaches to enhance JRM. Clients can improve their RM process by adopting a JRM approach, while contractors and consultants can benefit from increased knowledge about what JRM is and how to participate in JRM activities, as requested by clients. Further, from a sustainability perspective, society as a whole could substantially benefit from optimization of RM in construction projects, since it could reduce wastes of time, money, material and human resources, while increasing the quality, durability and end-user satisfaction of buildings and infrastructure.

1.3 Structure of the thesis

This thesis consists of an introductory part and five appended papers (Figure 1). The first, introductory, part has five chapters. Chapter 1 presents background information, introduces identified problems and gaps in existing research, and describes both the aim and questions addressed in the underlying research. In Chapter 2 related work on RM, project collaboration and JRM is presented and the two main theories utilized in the research (the theory of mechanistic and organic organizations, and agency theory) are introduced, discussed and related to the research aim. Chapter 3 describes the research methods applied, including the research process, and three studies performed – a licentiate study, a questionnaire survey and a longitudinal case study. In addition it presents the applied data collection and analysis methods, and discusses trustworthiness of the research. Chapter 4 summarizes the results of the studies and gives an overview of the appended papers. In Chapter 5 the most significant findings are presented and their implications (theoretical and practical) are discussed. Finally, limitations of the studies and recommendations for future research are presented. In addition, there are five appendices to the first part of the thesis, which include a questionnaire survey, interview guides, glossary, and list of additional publications by the author.

The second part of the thesis consists of the five appended papers that address focal aspects of JRM, as encapsulated in the questions listed in Table 1. The first paper focuses on RM processes in different procurement options and discusses how the project delivery method, form of payment, and use of collaboration or partnering arrangements affect RM. The second paper explores the concept of JRM, based on findings from previous research and focusing on

two groups of factors that are important for effective JRM. The third paper presents the results of a questionnaire survey of construction clients and discusses effects of cooperative procurement procedures on JRM. The fourth paper synergistically considers RM literature and organizational theory on mechanistic and organic management systems, and discusses the importance of managing tensions between control and flexibility when implementing JRM. The fifth paper focuses on principal-agent problems and how they were addressed in two construction projects in order to establish collaborative relationships and enhance JRM.

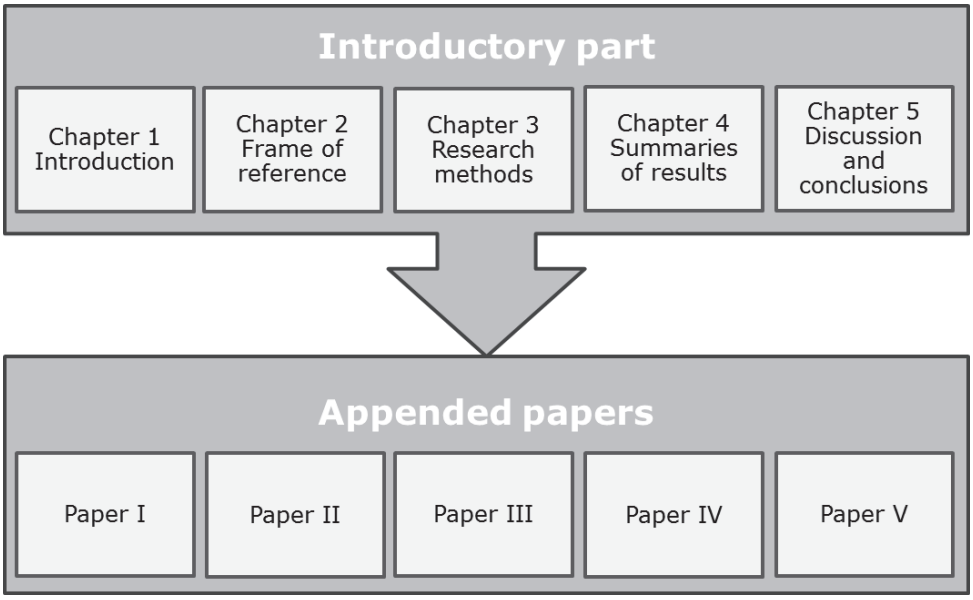

Figure 1. Structure of the thesis

1.4 Delimitations

The presented research examines roles of relationships among key actors in projects, and more specifically their roles in handling 'risks', i.e. uncertain events that may affect the delivery of project objectives and need to be identified, assessed and responded to if they arise. 'Project risk', i.e. the effect of uncertainty on a project as a whole is beyond the scope of this research.

As the PMBOK Guide and similar standards are widely used by the industry, practitioners are more comfortable with the terminology they provide than possible alternatives. Therefore, the term 'risk management' (RM) is used

throughout the thesis and the term ‘risk’ includes both potential threats and potential opportunities.

The research focuses on three main groups of actors: clients, contractors and consultants, because these actors were included in JRM teams considered in the studies and participated in the observed JRM workshops (as described and discussed below). Sub-contractors and suppliers were not involved in JRM workshops and are, therefore, excluded.

Finally, this research was conducted in Sweden and the studied procurement options are limited to those that are widely used in Sweden: general contracting, design-build, and collaboration through partnering.

2 FRAME OF REFERENCE

This chapter consists of two parts. First, related work on RM, project collaboration and JRM is discussed. Then the applied theories are introduced: the theory of organic and mechanistic organization, used to explain how control and flexibility affect implementation of JRM, and agency theory, used to develop an understanding of how the collaborative relationships that underpin JRM can be fostered.

2.1 Related work

As project RM and collaborative relationships are the overarching concerns of this research, an overview of related work on RM processes and collaboration in construction is presented below.

2.1.1 The risk management process

Several models that formally divide the RM process into various stages have been presented, applied and discussed in prior literature. The international standard "Project risk management – Application guidelines" (IEC, 2001) offers a model with four steps: risk identification, risk assessment, risk treatment, and risk review and monitoring. The PMBOK (Project Management Institute, 2013) model is similar in some respects but divides risk assessment into two processes: qualitative and quantitative risk analysis. Chapman and Ward (2003) have presented a framework called SHAMPU (Shape, Harness, and Manage Project Uncertainty) with nine steps, according to which practitioners should: define the project, focus the process, identify the issues, structure the issues, clarify ownership of responsibilities, estimate variability, evaluate implications, harness the plans, and manage implementation. Del

Cano and De la Cruz (2002) propose an integrated methodology for implementing RM in large, complex construction projects, divided into four process phases: initiation, balancing, maintenance and learning. Each phase consists of several stages, each of which involves several activities. Despite the variety of models, *risk identification, assessment and response* form the core of project RM, as discussed in the Chapter 1. Therefore, a model consisting of these three stages was used in the studies this thesis is based upon (Figure 2).

Figure 2. The risk management process

Risk identification, the first step in the process, is aimed at determining potential risks, i.e. forecasting events that may affect the project. A number of tools and techniques have been developed for identifying such risks, including brainstorming, the Delphi technique, structured interviews, expert judgment, questionnaires, checklists, application of historical data and/or previous experience, testing and modelling, and evaluation of other projects (Project Management Institute, 2013). Empirical studies of RM indicate that checklists and brainstorming are the most widely used techniques in risk identification and show that individual judgments of the project participants are often most heavily relied upon in risk identification (Akintoye and MacLeod, 1997; Lyons and Skitmore, 2004; Uher and Toakley, 1999).

During the risk identification process potential risks are generally grouped. There are several approaches for classifying project risks (Baloi and Price, 2003; Jaafari, 2001; Leung et al., 1998; Li et al., 2005; Tah and Carr, 2000; Zhi, 1995), but generally risks in construction projects can be divided into three groups:

1. Internal or controllable risks (e.g. risks related to design, construction, management and relationships);

2. External or uncontrollable risks (e.g. financial, economic, political, legal and environmental risks);

3. Force majeure risks (e.g. risks of earthquakes, floods, fires).

Despite the recommendation of PMBOK to include as many project stakeholders as possible in the identification process, numerous different actors rarely participate (Rahman and Kumaraswamy, 2004). Instead, all the actors usually carry out their own risk identification.

Risk assessment is the second step in the formal process. The goal is to prioritise risks for management, using various quantitative or qualitative methods. The former are based on mathematical techniques and generate numerical assessments of probabilities and consequences, while the latter are based on subjective judgments.

The research literature offers numerous models for assessing project risks. For example, Tah and Carr (2000) present a formal model for qualitative risk assessment based on fuzzy estimates of risk components, and use cause-and-effect diagrams to illustrate relationships between sources of risks, risks and their consequences. Zeng et al. (2007) also propose a risk assessment methodology based on fuzzy reasoning techniques aimed at dealing with risks in complex projects. In their model, expert knowledge, engineering judgements and historical data are used in a consistent manner to structure and prioritize various risks. A fuzzy system is also used by Motawa et al. (2006) to evaluate the risk of change in construction projects. Another approach, proposed by Öztas and Ökmen (2005) and called JRAP (Judgemental Risk Analysis Process), is a pessimistic risk analysis methodology that is reportedly effective for managing construction project risks in uncertain conditions. Poh and Tah (2006) have developed an integrated model that takes into account both duration and cost risks and can be used for modelling impacts of risks that may affect a project. In addition, Dikmen and Birgonul (2006) propose a methodology for assessing both risks and opportunities in international projects.

The risk assessment techniques that are most widely used in construction projects have also been investigated by various authors. Baker et al. (1998) found that construction companies in the UK use both qualitative and

quantitative techniques. They also found that analyses based on experience (personal and corporate) and/or engineering judgement are the most successful qualitative techniques, and that applied quantitative techniques include break-even analysis, expected monetary value and scenario analysis. Several authors report conflicting results on the use of quantitative techniques. Two studies of RM practice in the UK construction industry have found that the practitioners rely mostly on professional judgment, intuition and experience (Akintoye and MacLeod, 1997; Wood and Ellis, 2003). A questionnaire survey by Tang et al. (2007) found that qualitative techniques are also most commonly in the Chinese construction industry, while quantitative methods are rarely used. Similarly, Simu (2006) found that Swedish contractors mostly use professional experience and gut-feeling in risk assessment. Kähkönen (2007) argues that the quantitative methods used in RM have advantages over the qualitative methods, but their use is limited due to difficulties that practitioners face. He also discusses the elements that contribute to development of workable solutions for quantitative risk assessment.

Risk response, the third step, is directed at finding ways of dealing with risks. There are four main risk response strategies: risk avoidance, reduction, transfer and retention (IEC, 2001; Project Management Institute, 2013; Smith et al., 2006). Risk avoidance deals with risks by changing project plans or finding methods to eliminate the risks. Risk reduction aims at reducing the probability and/or consequences of a risk event. Project risks that remain after risk avoidance and reduction may be transferred from the principal to another party, who may be either directly involved in the project or an external agent. Risk retention or acceptance indicates that responsibility for risks remains with the principals or their partners. Two options are available when retaining risks: development of a contingency plan in case a risk occurs, or taking no action until a risk is triggered. Several studies have identified risk reduction as the most frequently used technique within the construction industry (Baker et al., 1999; Lyons and Skitmore, 2004; Tang et al., 2007). However, results of a questionnaire survey (Akintoye and MacLeod, 1997) indicate that risk transfer is the most widely preferred strategy among UK practitioners.

A number of empirical studies, conducted in various countries to identify current RM practices (e.g. Akintoye and MacLeod 1997, Lyons and Skitmore 2004, Simu 2006, Osipova, 2008, Tang et al. 2007, Wood and Ellis 2003, Zou et al. 2007), report many similar findings. The results indicate the lack of a systematic approach to RM, particularly in early project phases, where it arguably has the greatest potential impact. Use of RM techniques is moderate and the main techniques (checklists and brainstorming) are subjective.

Moreover, quantitative RM models are argued to be complicated and difficult to use. The communication of risks between key actors is generally inadequate, at least partly because in current procurement practices the lowest bid price is more important than thorough analysis of potential risks for winning contracts. In addition, the actors often have their own management systems and do not use a joint database for RM documents. Further, despite the clear advantages of collaboration, each actor often focuses on his own part of the project and management of associated risks.

To summarise, RM is currently performed subjectively rather than analytically, individually rather than jointly and occasionally rather than continuously, although effective RM clearly requires a systematic approach based on efficient collaboration between the project actors.

2.1.2 Collaboration in construction projects

Adversarial and opportunistic behavior commonly occur in construction projects, resulting in a focus on short-term relationships, rather than long-term cooperation, and impairing economic results (Cox and Thompson, 1997; Zaghloul and Hartman, 2003). Hence, strategies to enhance collaborative relationships among construction project actors have been extensively researched. Several studies have shown that practitioners generally favour collaborative relationships and believe that they lead to improvements in product quality, accompanied by reductions in costs, risks and disputes (e.g. Akintoye and Main, 2007; Black et al., 2000). In addition, Drexler and Larsson (2000) show that relationships are much more stable in projects based on collaborative partnering than in other types of projects.

For several decades researchers have called for flexibility and a stronger focus on collaborative relationships in contracts (Macneil, 1974). However, traditional construction contracts still comprise a major barrier to such relationships (Kadefors and Badenfelt, 2009). As Gil (2009) notes, “contracts do not deliver projects, but drive behavior”. Hence, to encourage client-contractor cooperation relational contracting (RC) strategies have been developed and include partnering, alliancing and joint ventures. An extensive literature review of existing definitions of RC is presented by Yeung et al. (2012). These authors identify five core elements of RC: commitment, trust, cooperation and communication, common goals and objectives, and win-win philosophy. Other elements that may be present in some (but not all) forms of RC include: formal contracts, agreed problem resolution and continuous

improvement procedures, facilitated workshops, equity, a joint declaration statement, and real gain share/pain sharing.

In recent years collaboration through partnering has been widely applied by construction industries in many countries (Bayliss et al., 2004; Karlsen et al., 2008) Partnering, which can be defined as a form of project governance, is based on cooperative procurement procedures and facilitates a stronger focus on cooperation than on competition throughout projects (Eriksson, 2010), is widely used in the construction industry. In some countries, e.g. the UK, partnering arrangements are formally embedded in contracts. In contrast, in Sweden an additional collaboration or partnering agreement is usually used as a supplement to the main contract, but the use of partnering is still generally rare (Eriksson and Nilsson, 2008). Partnering is not a well-defined methodology for organizing projects, but rather a concept that requires a fundamental shift in thinking and culture (Alderman and Ivory, 2007). Thus, to obtain the benefits of partnering both clients and contractors must have high professionalism and knowledge of the project (Bresnen, 2007).

The most extensive research on collaboration in RM has been conducted in Hong Kong and presented in several papers by Rahman and Kumaraswamy (2002a; 2002b; 2004; 2005). Their surveys of construction industry practitioners revealed significant differences amongst actors in perceptions about how risks should be allocated in projects. However, they generally agreed that collaborative management was the optimal approach for handling most listed risks (particularly unforeseen events and risks that change during project implementation), showing that practitioners generally favour JRM. Further, their studies identified factors that should be considered when forming a project team for JRM. These include: technical capabilities, similarity of previous work experience, adequate resources, price, quality of performance, creativity/innovation and commitment to collaboration, joint problem-solving and continuous improvement. In order to create a successful collaborative environment, mutual trust, open communication among the actors, understanding of each other’s objectives and clear, equitable allocation of foreseeable risks were identified as the most important factors. The research also highlighted the importance of early involvement of subcontractors and main suppliers to ensure broad competence for effective risk identification and assessment. A project team involving clients, contractors and consultants should thus be formed before the final contract is awarded. This facilitates formulation of effective project briefing and (hence) deepens understanding of the project’s objectives by the actors.

The previous research on JRM provided information on relationships between JRM and some underlying factors that provided valuable foundations for the studies presented in this thesis. However, the previous research did not provide deep understanding about how people collaborate in JRM and factors that affect their collaboration. These are dimensions that were explored in the presented qualitative investigations in attempts to advance knowledge about the nature and practice of JRM.

2.2 Applied theories

This thesis is based on four studies that are described in Chapter 3 and fully presented in the appended papers. The objectives of each study and the research questions guided the selection of theoretical frameworks. The starting point was that the importance of both collaboration and relationships among project actors has been extensively discussed in the research literature, but the reasons why collaborative RM is problematic and difficult to achieve have been studied much less intensively.

2.2.1 Mechanistic and organic organization

To identify and explain obstacles to JRM, mechanistic and organic organization theory is applied. An underlying assumption is that RM, as a key part of PM, may be affected by these two conflicting organizational approaches and an appropriate balance between them is required. The theory was useful for analyzing how control (a mechanistic approach) and flexibility (an organic approach) have to be balanced to enhance the possibility of effective JRM.

One of the foundations of organizational theory is work by Burns and Stalker (1961), who observed, followed and interviewed personnel of 20 firms in order to characterize how the firms were managed. Based on their findings, they proposed two contrasting management systems: mechanistic and organic. A mechanistic system, characterized by a high level of control, specialized differentiation, hierarchical structures and strong reliance on individual knowledge and skills, is considered to be appropriate in stable environments. However, when there is a high level of uncertainty, a more flexible approach is needed. An organic system, characterized by a network structure, broad commitment and informative communication, is therefore more appropriate when conditions are likely to change substantially. The two approaches are conflicting and characterized by distinctly different management philosophies (see Table 2).

Table 2. Characteristics of mechanistic and organic organizations (adapted from Burns and Stalker, 1961)

Mechanistic	**Organic**
Specialized differentiation of functional tasks	Specialized knowledge and experience contribute to group efforts
Each individual task has an abstract nature (distinct from efforts of the whole organization)	Individual tasks (set by the whole environment) have a "realistic" nature
Precise definitions of rights and obligations are attached to each functional role	Acceptance of responsibility (problems cannot be defined as being someone else's responsibility)
Hierarchical and vertical structure of control, authority and communication	A network and lateral structure of control, authority and communication
Location of knowledge at the top of the hierarchy	Knowledge can be located anywhere in the network
Working behavior is governed by instructions and decisions issued by superiors	Information and advice are regarded as superior to instructions and decisions
Individual knowledge is highly esteemed	Shared, common knowledge is highly esteemed

Based on Burns and Stalker's theory, numerous researchers have studied how mechanistic and organic approaches affect PM. Many have confirmed that the main characteristic of mechanistic organizations is use of control, while organic organizations are associated with a high degree of flexibility. Aaker and Mascarenhas (1984) defined control as an approach that aims to mitigate all undesirable changes, while a key aim of a flexible strategy is to foster the ability to respond appropriately to uncertain and rapid environmental changes that might affect the organization's performance.

Koppenjan et al. (2011) defined two PM approaches based on the level of control and flexibility. A predict-and-control approach has a strong focus on planning and control, aiming at eliminating uncertainty and complexity. In

contrast, a prepare-and-commit approach aims to establish and maintain constant and shared management of uncertainty and complexity, and is characterized by close cooperation between the project actors, in order to achieve flexibility. In a study of project-based organizations in different countries, Keegan and Turner (2002) found that firms used mechanistic control-oriented approaches, regardless of the nature of the project, and this stifled flexibility and innovation. In contrast, Brown and Eisenhardt (1997) argued that pure approaches i.e. purely mechanistic or purely organic, are seldom used by organizations. Instead, the two approaches often need to be (and are) combined. Their comparative study of six firms showed that a successful strategy incorporates both structured elements (to avoid chaos) and unstructured elements (so that the firm can respond quickly to changes). In particular they found that combining clear responsibilities and priorities with extensive communication and freedom is found to be a successful strategy in continuously changing environments (Brown and Eisenhardt, 1997). Ahrens and Chapman (2004) confirmed these results and showed that control systems can simultaneously support flexibility. In a presented case study they found that a mechanistic management approach coexisted with a flexible approach through intensive discussion and analysis.

Bettis and Hitt (1995) discussed operations of organizations in changing environments, which they noted present high levels of uncertainty and low predictability. They highlighted two components of organizational strategic response capability: robustness (which provides immunity to uncontrollable changes), and flexibility (which is strongly related to the ability to react rapidly to changes. A study by Geraldi (2008) also focused on changing environments and multi-project organizations that have to manage the coexistence of order and chaos. According to Geraldi, project organizations that face a high level of uncertainty should strive for a high level of flexibility. Otherwise, the project organization gets into ‘bureaucratization of chaos’ i.e. the addition of rules, constraints and strict instructions that do not reflect reality.

2.2.2 Agency theory

Relationships in projects play important roles for successful implementation of JRM. However, adversarial problems among contracting parties commonly arise and must be addressed in order to implement effective JRM. Agency theory offers a useful framework for identifying issues that may significantly impact relationships and elucidating their effects. Key aspects include identification of ways in which project actors can formulate compatible objectives and cope with the problem of differences in risk attitudes, and how

they can deal with issues of information asymmetry, outcome uncertainty and complexity. Therefore, agency theory is used to address research questions related to approaches for fostering the collaborative relationships among contracting parties that are essential for effective JRM.

Agency theory originated in the 1960s and 1970s. It is based on two main assumptions about contracting parties. First, they may have different goals which may result in a goal conflict (Jensen and Meckling, 1976). Second, the principal and agent may have different attitudes to risk, which can lead to risk-sharing problems (Fama, 1980). In addition to these major assumptions about different goals and risk attitudes, the principal-agent relationships is influenced by outcome uncertainty, variations in outcome measurability and task programmability, information asymmetry, and length of the relationship (Figure 3).

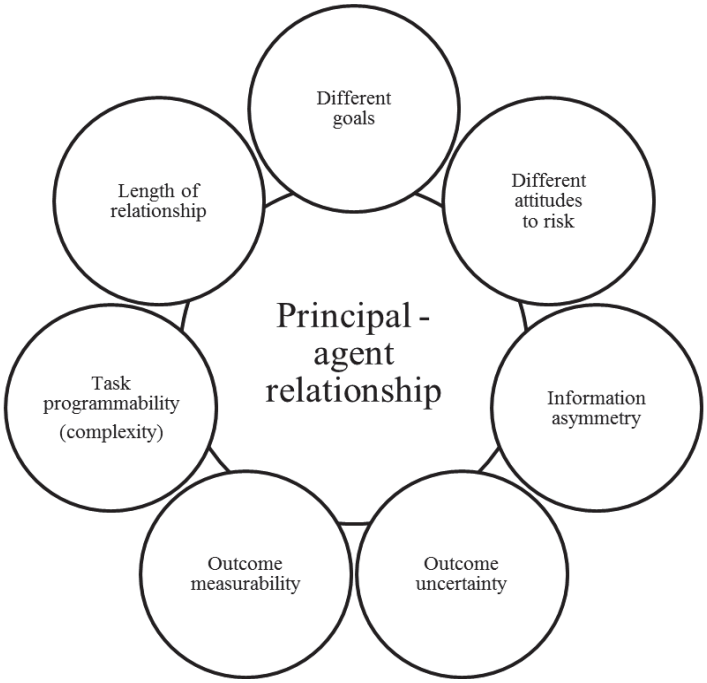

Figure 3. Agency-related problems (adapted from Eisenhardt, 1989)

When the principal and agent have different goals, the differences may result in a goal conflict that causes the agent to act in its own interest rather than the principal's interest (Eisenhardt, 1989). The construction industry is perceived as being highly goal-conflicted because many stakeholders with different goals

are involved in a project (Toor and Ogunlana, 2010). Thus, goal alignment is important in order to meet time, cost and quality specifications.

The problem of risk-sharing arises when the principal and agent prefer different actions due to differences in their attitudes to risk (Eisenhardt, 1989), i.e. their willingness to take risks based on the expected trade-off between risk and reward (Ward et al., 1991). Because of the differences in willingness to take risks, risk transfer is one of the most commonly used RM strategies in the construction industry (Akintoye and Main, 2007). However, significant disagreements among construction practitioners were found about where risks should be allocated within supply chains. A questionnaire survey of 89 Australian practitioners found that the responsibilities and liabilities of subcontractors aroused the strongest disagreement (Loosemore and McCarthy, 2008).

Information asymmetry refers to differences in the abundance, and quality, of information available to different project actors, which make it difficult to ascertain if decisions taken by contractors are optimal for clients. Thus, extensive exchange of information is vital for fostering an effective project environment (Dagenais, 2007). According to agency theory, information has a cost and can be purchased. Before the principal and agent enter into a contract, the principal has to assess whether an agent has the required skills for performing the task (Bergen et al., 1992), and it has been argued that careful partner selection through cooperative procurement procedures helps to reduce risk and uncertainty (Pesämaa et al., 2009). However, in construction projects clients often choose the lowest bid and ignore other factors, which may hamper collaboration and lead to conflicts during project implementation.

Outcome uncertainty refers to the fact that project outcomes only partly depend on the behavior of the actors (Eisenhardt, 1989) as numerous external factors, such as changes in legislation, economic conditions or environmental states, may affect them too. Bettis and Hitt (1995) examined organizations operating in changing environments and found that forecasts may be accurate for a very short time due to high uncertainty and low predictability. Several researchers have suggested that project managers should use a combination of control and flexible approaches to manage outcome uncertainty (Geraldi, 2008; Koppenjan et al., 2011).

Output measurability refers to the variability in the ease of measuring (and managing) different types of outcome (Eisenhardt, 1989). It is particularly difficult for tasks that take a long time to finish or require joint effort by

multiple project actors. However, many output parameters can be measured by using appropriate variables to obtain accurate, reliable assessments of project actors' performance (Das and Teng, 2001). Target price is an example of such a parameter: if the final cost is lower than the target price, a performance-related bonus may be paid to the contractor(s). In construction projects, output parameters are usually measured in the final inspection. However, a potential flaw in this procedure is that a contractor may complete allocated tasks within time and budgetary constraints, but in a manner that severely hampers other contractors or sub-contractors, thereby impairing project performance. This further highlights the need for a flexible, cooperative approach.

Task programmability, or complexity, refers to the ability to define the behavior of agents in advance. For example, complex and problematic projects require more managerial efforts than easy or typical projects. Complexity has been studied extensively because it has multiple dimensions (e.g. organizational, technological and environmental dimensions) and is regarded as a key contextual element of project management (Maylor et al., 2008).

Increases in the length of relationships are argued to decrease information asymmetry (Eisenhardt, 1989), and, thus enhance collaboration. Construction industry is project-based, and therefore, temporary relationships are common creating potential for conflicts between the project actors (Lundin and Söderholm, 1995).

3 RESEARCH METHODS

This chapter presents the research methods used in the studies to achieve the aim and address the research questions. First, a brief discussion of the research process and the four studies underlying this thesis is provided, followed by the detailed description of the two empirical studies: a questionnaire survey, and a longitudinal case study. The data collection and analysis methods are then presented, and finally trustworthiness of the research is discussed.

3.1 Research process

This thesis is based on four studies undertaken by the author from 2006 to 2013, as summarized in Figure 4.

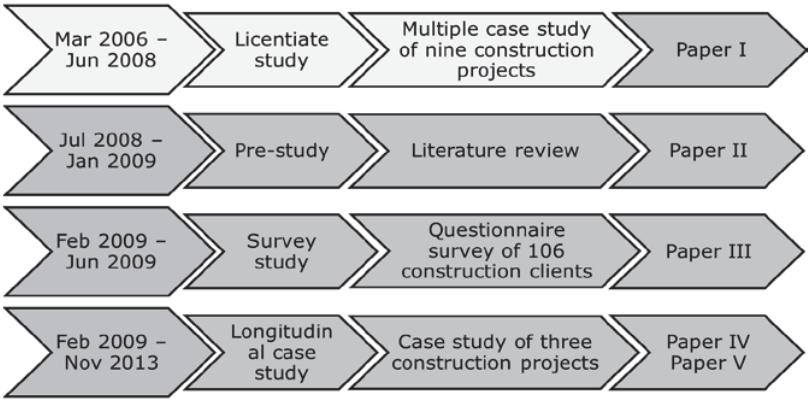

Figure 4. Research process

The doctoral work started in March 2006 with a *licentiate study* – a comparative study of RM practices in nine construction projects in which different procurement options were adopted. The point of departure for this study was the idea that the client's choice of procurement option is intrinsically linked to certain ranges of responsibilities and liabilities for the various actors, the degrees of their collaboration in the project and (thus) RM practices. The results highlighted three serious problems with current RM practices. Firstly, a lack of a systematic approach to RM was found, especially in the early phases of the projects, where it arguably has the greatest potential impact. Secondly, the communication of information about risks between the actors during the procurement phase was inadequate for delivering projects with certainty. This was at least partly because the lowest bid price was regarded as more important than thorough analysis of the potential risks. Thirdly, there was little evidence of collaborative RM: each actor focused on his own part of the project and management of associated risks, rather than overall risks.

The results of the licentiate study were presented in a licentiate thesis (Osipova, 2008) and Paper I (Osipova and Eriksson, 2011). For more detailed description of the methods used see Paper I. The findings of the licentiate study resulted in a proposal for further research with a main focus on collaborative (joint) RM. The stated objective in the initial research application was to develop a model that could be used to guide JRM and improve understanding of ways to optimize its application in successive stages of construction projects.

In a *pre-study* available literature on RM processes generally, and collaborative RM particularly, was thoroughly reviewed from July 2008 to January 2009. Nearly all examined publications describe tools, techniques or practices that are (or could be) applied in RM. However, they do not address a key issue: that RM is performed by people, thus relationships among them will significantly affect the implementation and effectiveness of RM, especially JRM. This finding shifted the focus of the project from developing another model to analysis of the factors that underpin collaborative relationships and effective JRM. Thus, a further review was conducted, in which research more specifically focused on JRM was inventoried and analysed (Paper II), then research questions were formulated and suitable research methods for addressing the research questions were chosen. At this stage a reference group (consisting of three industry practitioners closely involved in RM and two scientific advisors from Luleå University of Technology) was established to contribute to discussions about focal phenomena, provide insights into current practices and assist in the selection of appropriate case study projects.

In the next stage, the study was connected to another research project involving a large *questionnaire survey* investigating effects of procurement procedures on project outcomes. The survey was designed, distributed and the responses were collected by researchers at LTU's Department of Business Administration. One part of the survey focused particularly on collaboration and JRM. I started to participate in this research at the data analysis stage by investigating effects of cooperative procurement procedures on JRM. The results of the survey were presented at a conference (25th Annual ARCOM Conference) and then further developed and published in a journal (Paper III).

The fourth stage involved three *longitudinal case studies* during four years, 2009-2013, designed to investigate the nature of JRM and develop understanding of how JRM can be enhanced throughout a project. First, I followed two construction projects from 2009 until their completion in 2011. Then a third project was included in the investigation and followed from 2011 to 2013. I investigated RM practices, particularly JRM components, in all three projects. A question of particular interest was how collaborative relationships among project actors that enhance JRM were established and maintained. In addition, the effects of JRM on the projects' outcomes were studied. The results of the case studies were presented in Papers III, IV and V.

Multiple research methods were used in the studies, selected on the basis of three criteria: the types of research questions addressed, , extent of control or manipulation over behavioral events, and the strength of their focus on contemporary events (Yin, 2009). Two of the main research methods, questionnaire survey and case study, are discussed in the following sections.

3.2 Questionnaire survey

A questionnaire survey was initiated by the researcher's supervisor, P. E. Eriksson, and his colleagues as part of the larger investigation of procurement procedures' effects on project outcomes. The questions were not focused on a particular project but on the clients' procurement procedures in general (for a sample questionnaire, see Appendix 1). One section of the survey was devoted to collaborative activities and JRM, in order to assess how frequently JRM is used in Swedish construction projects and effects of cooperative procurement procedures on its occurrence. I gained access to data when completed questionnaires were returned and compiled in a database.

3.2.1 Data collection

The questionnaire survey targeted construction client organizations that are members of the Swedish Construction Clients Forum. Like the Swedish construction industry in general, this population consists of a broad spectrum of clients: regional, national and international industrial and property companies; municipal and regional authorities; providers of government services and official agencies (Table 3). Hence, it provides a suitably broad representation of Swedish construction clients.

Table 3. Descriptive statistics of the client organizations

Sample size	Clients' market size		Type of work procured		Type of client	
	Local / regional	National / international	New construction / rebuilding	Maintenance / refurbishment	Public	Private
106	72	34	95	11	64	42

From the population of 140 organizations, 106 usable questionnaires were received, resulting in a response rate of 76%. The respondents were procurement managers, project managers, or directors of the construction and facilities departments in these organizations.

Responses to the questions were rated on a seven-point Likert scale ranging from 1 = very seldom, to 7 = very often. In addition, three nominal control variables were included: the type of client (local/regional client vs. national/international client, and private vs. public client); the type of construction work procured (new construction/rebuild project vs. maintenance/refurbishment); and whether or not the client followed public procurement regulations. After the completed questionnaires had been collected by mail, the data were entered into the Statistical Package for Social Science (SPSS).

3.2.2 Data analysis

The point of departure for data analysis was an assumption that cooperative procurement is essential for effective JRM. Thus, six hypotheses were

formulated through the literature review, predicting that the six cooperative procurement procedures shown in Figure 5 have positive effects on the use of JRM.

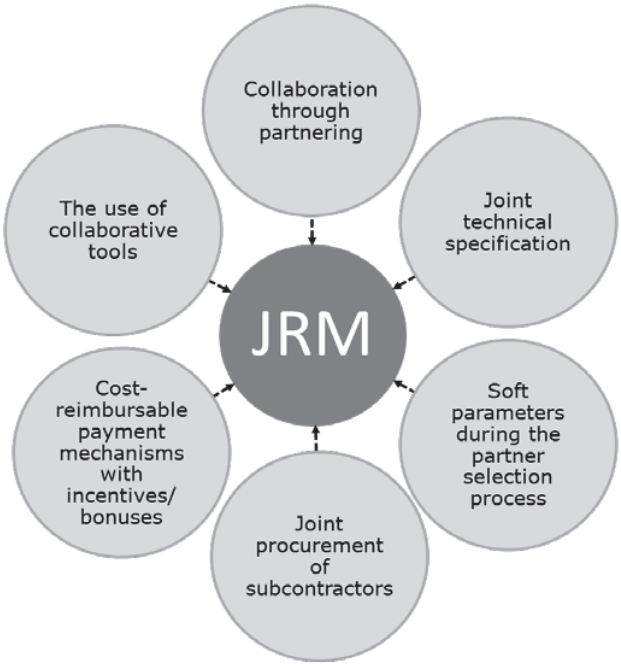

Figure 5. Cooperative procurement procedures hypothesised to be positively associated with the use of JRM

In order to test hypotheses, relationships between the dependent variable 'use of JRM' and the independent variables 'procurement procedures' were examined using two hierarchical regression models (Hair et al., 2010). The first solely tested effects of the control variables (i.e. type of client) on the use of JRM, while the six procurement procedures were added to the second to assess their effects. Both models were statistically significant, showing that the 'type of client' explained 10% of the variation (according to changes in R^2 correlation coefficients) in the use of JRM, while the use of cooperative procurement procedures explained almost 40 % of the variation. However, we would also specify how 'use of JRM' was defined and measured.

Further, effects of the individual cooperative procedures on the use of JRM was analysed using standardized regression coefficients. To ensure the absence of multi-collinearity problems that may have influenced the regressions VIF-

values were calculated (Hair et al., 2010). The VIF-values were considerably lower than the rule of thumb threshold of 5.0, indicating that correlations among the independent variables did not significantly bias the regression models.

In addition, One-way ANOVA was applied to identify the types of client that use JRM most actively, and the SPSS package was used to examine residuals and outliers to test the assumption that the data were normally distributed, as required for the applied regression analyses. Both the frequency distribution and probability plots of the standardized residuals indicate that the assumption of normal distribution was not violated.

3.3 Longitudinal case study

JRM has only recently been applied in Sweden, thus it was deemed important to obtain a detailed view of its use in the country by investigating its application and effectiveness in ongoing projects. Two particular areas of interest were how JRM is implemented in projects and how various factors influence its implementation. A case study approach was selected to explore these issues for several reasons. Firstly, it has widely accepted suitability for addressing “how” and “why” questions (such as how collaborative activities are implemented and why JRM is adopted) and the influence of the social context (e.g. established relationships and utilized procurement procedures) on processes with human dimensions (Maxwell, 2005). Secondly, it provides opportunities to investigate processes in depth (Pratt, 2009; Yin, 2009) and collect qualitative data over sufficiently long periods of time for elucidating key aspects of focal activities or processes (Miles and Huberman, 1994).

3.3.1 Case selection

Several criteria were used for selecting case study projects. Firstly, the project manager had to intend to implement JRM (as JRM was the focus of the investigation). Secondly, the projects had to be in early stages to permit direct observations of JRM workshops, interview key personnel and review project documentation. Thirdly, access to potentially important information was regarded as crucial, i.e. the project managers had to be willing to share information and permit access to relevant data. The reference group connected to the study proposed a number of projects that met these criteria. A major strength of the approach is that people share information with researchers more readily when they are aware of the research aims.

Following this selection procedure, two construction projects were initially chosen and their managers were contacted to discuss the possibility of studying JRM processes within them. Both project managers agreed to participate in the study, approved participation of the researcher in RM workshops and provided access to the project documentation regarding collaborative arrangements and RM. At the same time, anonymity issues were discussed and all organizations expressed a desire to remain anonymous. When Project 1 was finished, the same project team proceeded to work on a new project (Project 3). A decision was taken to follow the new project in order to investigate effects of experiences from the first project and relationship history on working procedures in the new project. Thus, in total three construction projects were investigated over four years, as summarized in Table 4.

Table 4. Summary of the case study projects

Project pseudonym	**Construction time**	**Type of construction**	**Project delivery method**	**Payment mechanism**
Project 1 (PharmaLab)	2007-2009	Construction of laboratory facilities	GC and collaborative agreement	Fixed price Cost reimbursable Bonus
Project 2 (HydroPlant)	2008-2009	Reconstruction of a hydroelectric power station	GC and collaborative agreement	Fixed price Cost reimbursable Bonus
Project 3 (BioLab)	2010-2013	Construction of laboratory facilities	GC and collaborative agreement	Fixed price Cost reimbursable Bonus

Project 1, *PharmaLab*, entailed the construction of new pharmaceutical laboratory facilities consisting of two buildings. Construction started in 2007 and the facility was finished in December 2009. The client is a large public organization that regularly undertakes construction works and has long experience of the construction industry. The project was procured on a general contract basis with an additional collaborative agreement. During the bid evaluation the expertise of potential contractors and their collaborative abilities

were considered and the contract was awarded to one of the largest contractors in Sweden. A mix of fixed price and cost-reimbursement payment mechanisms with a performance-related bonus was chosen for the project.

Project 2, HydroPlant, entailed the first stage of reconstruction of a hydroelectric power station. The client is a large public organization that operates in the energy sector and is a regular purchaser of construction services. The project was procured on a general contract basis with fixed-price (bill of quantities) and cost-reimbursement payments and a performance-related bonus. During the bid evaluation, the lowest price bid was chosen and the contract was awarded to one of the major Swedish contractors.

Project 3, BioLab, started in 2010 and entailed the construction of the third building in the complex of laboratory facilities that was started in Project 1. The project was procured on a general contract basis with the same mixed payment mechanism as in Project I and an additional collaboration agreement. Although the client and general contractor were the same organizations as in Project 1, many other project actors were new.

3.3.2 Data collection

As multiple sources of evidence improve the quality of findings, analysis and conclusions (Yin, 2009), different kinds of evidence were utilized in the study: direct observations, interviews, and documents.

Direct observations

Alvesson (2011) suggests that gathering information from observations before interviews is good practice as it can provide valuable insights about questions to be asked during interviews. Accordingly, the researcher observed eight JRM workshops and two construction meetings. Before observing the workshops some preliminary information was collected about the organization and objectives of each project together with risk and contract documentation, through email communication (Projects 1 and 3) and a web-based project database (Project 2). The collected information was used to evaluate the project environment, i.e. participants' roles, the project's main phases and schedule, contract conditions, RM and collaborative activities. A qualitative approach was adopted during the observations, i.e. the researcher recorded events to obtain relatively incontestable descriptions for further analysis (Stake, 1995). The observations and field notes focused on the following four questions, adapted from Silverman (2006):

1. What are the participants trying to accomplish?

2. How exactly do they perform RM: how do they discuss risks, assess them and identify appropriate responses?

3. What is the participants' understanding of the observed events?

4. What assumptions do they make?

As a result, field notes from each workshop were produced describing activities performed by the participants and the researcher's remarks about them.

Interviews

Participants in each project were interviewed in two interview rounds (32 in total). The first round, during the project implementation phase, focused on the organization of the RM process in the respective projects. First, the respondents were asked to describe the project and their roles. This was followed by a short discussion about uncertainty, risk and RM, as it was important to obtain the respondents' perceptions about the main terms of the study to ensure that the researcher and respondents used the same language to describe certain phenomena before any detailed discussion of RM. Next, the interviewees were asked to describe how they addressed risks and how JRM workshops were organized in their project. Then, the procurement process, relationships among actors and collaboration in the project were discussed. In the second round, after the projects had finished, the interviews focused particularly on three issues: project outcomes, JRM, and collaboration. The interviewees were asked to describe how JRM was carried out and how it affected the project outcomes. They also described how they collaborated in the project and outlined advantages and disadvantages of the current project organization. Finally, the factors that influenced collaboration in general and JRM in particular were discussed in detail.

The interviews were semi-structured, in-depth, face-to-face, and each lasted approximately an hour. For interview guides see Appendices 2 and 3. The interviewees included representatives of the client (the overall project manager, a design manager and on-site staff), contractors (a project manager, a site manager and a construction engineer) and consultants (an architect and technical consultants). To increase reliability of the collected data in terms of transparency and future replication, all interviews were tape-recorded (Yin, 2009).

Document studies

RM documentation and collaboration agreements were studied continuously throughout the projects. The researcher had access to the web-database for Project 2, where all new documents were compiled and available for analysis, and the risk registers generated in Projects 1 and 3 were e-mailed to the researcher after each JRM workshop. Together with interview data, documentary materials were used to examine in detail the JRM process in each project and elucidate why JRM was successful in Projects 1 and 3 but problematic in Project 2, and how collaborative relationships were maintained.

3.3.3 Data analysis

The unit of analysis in the longitudinal case study was the JRM process. Each case was described using RM documentation and collaboration agreements, interview transcriptions and observation field notes. The data were analysed in two steps.

First, *within-case* analysis was performed to investigate the unique patterns of each case (Eisenhardt, 1989). The organisation of JRM in the projects was analysed using explanation building, which is valuable for not only explaining processes such as JRM but also for reflecting upon the underlying factors that affect their implementation (Yin, 2009). Thus, this technique was applied to explore each project's scope, sources of risk, utilized procurement procedures, collaborative activities and outcomes.

Following the explanation building, cross-case analysis was applied to examine similarities in and differences among the projects. During this analysis, the empirical findings were framed in two specific theoretical contexts. The theory of organic and mechanistic organization was applied to explain why JRM was successful in Project 1 but failed in Project 2. For this purpose, the data were organized in matrices with defined rows and columns (Miles and Huberman, 1994). The rows included organizational characteristics, while columns included how these characteristics were addressed in each case study. An illustrative matrix is provided in Table 5. In addition, to examine effects of relationships among the project actors on the JRM process the empirical findings were framed in the agency theory context, using a similar matrix approach for displaying and analysing the data. Here, the rows included the agency-related problems and columns contained data describing how the problems were addressed in the projects.

Table 5. Example of an analytical matrix

Organizational characteristics	**Project 1**	**Project 2**
Structure of control, authority and communication	Horizontal structure of control. The clients' representatives on-site have direct contact with subcontractors without going via the client's project manager.	Hierarchical structure of control. Client has a strong control function. All communication goes via the client's organisation.

3.4 Trustworthiness of the research

Three concepts are generally applied when assessing the trustworthiness of research: its validity, reliability and generalizability (Robson 2002). These terms respectively refer to the accuracy of the results, the likelihood of obtaining the same results if the same study was repeated following the same procedures, and the applicability of the results to other situations or populations.

Triangulation is a widely used strategy to assess the validity of qualitative research. It refers to the use of multiple data sources, methods, investigators and/or theories (data, methodological, observer and theory triangulation, respectively; Robson 2002). In the research underlying this thesis the first three of these types of triangulation were used, as follows. For data triangulation, information was obtained from direct observations, interviews, and document studies. For methodological triangulation, both a questionnaire survey and interviews were used. It is often argued that survey responses may be biased due to respondents misunderstanding or misinterpreting questions, or a desire to look better by answering "correctly". However, interviews are not free from bias either (Alvesson, 2011). This problem was addressed in the case study by interviewing representatives of all key project participants – clients, contractors, and consultants – in order to capture as full a spectrum of perspectives as possible. Moreover, selected interviewees included not only people with managerial roles, but also others who could provide valuable insights into the project organization. For observer triangulation, the reference group was included in discussions of the results and the researcher's scientific advisors contributed to writing the papers.

Reliability was ensured by detailed and systematic documentation of all steps of the research process. A database of all the reference literature was created using RefWorks. All empirical evidence, i.e. documents, interview transcriptions, field notes and analytical materials were compiled in a separate database for each case study project.

A frequently discussed problem associated with the used of qualitative methods is the *generalizability* of the results (Flyvbjerg, 2006; Stake, 1995; Yin, 2011). This is (ideally) ensured in quantitative research by applying statistically rigorous sampling procedures. However, data in qualitative research are usually derived from one or several cases selected on the basis of specified criteria (Silverman, 2006), which severely limits their statistical generalizability, but analytical, i.e. theory-connected generalization is possible (Miles and Huberman, 1994). A number of empirical findings in this study corroborate prior theory and empirical investigations, providing external validity for the research. It should also be noted that all the case study projects were Swedish construction projects. This is a limitation in terms of the generalizability of the findings. However, data were collected from diverse groups of actors and consistency in their views of JRM at least partially validates the identified patterns and general conclusions. Moreover, the use of several cases supports the external validity of the study (Yin, 2009).

4 SUMMARIES OF THE APPENDED PAPERS, KEY RESULTS AND CONTRIBUTIONS

This chapter summarizes the five appended papers, describing the background of each reported study, the main aim, methods employed, conclusions and their contributions to both academic knowledge and practical implementation of RM. The papers are ordered to reflect the logical flow of the studies and the key empirical findings rather than in chronological publication order.

4.1 Summary of Paper I

Title: How procurement options influence risk management in construction projects.

Authors: Ekaterina Osipova and Per Erik Eriksson

Publication status: Construction Management and Economics (2011), 29(11), pp. 1149–1158.

Background: Before proceeding with a project, a client has to choose an appropriate procurement option that facilitates effective project organization. Each procurement option is intrinsically linked to certain ranges of responsibilities and liabilities for the various actors, the degrees of their collaboration in the project and thus RM practices.

Knowledge gap: Few, if any, investigations have explicitly focused on procurement options' effects on RM from the multiple perspectives of clients, contractors and consultants.

Aim: To investigate how three major procurement variables (*project delivery method, form of payment, and use of collaboration or partnering arrangements*) influence RM.

Methods: An exploratory study (a questionnaire survey and document studies) and a series of interviews with clients, contractors and consultants involved in 11 construction projects.

Results: In every examined project, irrespective of the selected procurement option, RM was not carried out systematically in all of the phases and costs exceeded expectations for at least one or the actors. The lack of systematic RM was especially pronounced in early planning phases, when it is arguably most important, due to the limited participation of some actors. There was also generally little or no communication of risk-related information during the procurement phase. RM was most intensive during the production phase, thus, most responsibility for managing risks was implicitly (and sub-optimally) allocated to the contractor. In projects that allowed relatively high degrees of multiple actor participation throughout the project with opportunities for open dialogue and collaboration the RM process was more thorough and effective.

Conclusions: While project delivery methods formally define risk allocation, the use of incentives and partnering arrangements help establishment of a collaborative approach to RM. Two projects considered in this study in which joint objectives were set and collaborative activities were included provide examples of effective project organizations from a RM perspective. Collaboration between the actors during all project phases resulted in successful problem solving and cost savings for both the clients and contractors. A client is a party that owns the project, and should therefore both be an active participant in the RM process and demand active participation from the other actors. In particular, the architects and design managers should be involved more in RM because design is a very significant risk source. The highly restricted consideration of risks in early phases severely hampers systematic RM, as failure to identify, assess and formulate responses to risks in these stages may have serious repercussions in all subsequent phases.

Contributions: The findings increase understanding of practices that foster systematic RM, including use of appropriate procurement options in terms of the project delivery method, form of payment and collaborative or partnering arrangements.

4.2 Summary of Paper II

Title: Joint risk management as a driver of project performance improvement.

Authors: Ekaterina Osipova and Per Erik Eriksson

Publication status: Proceedings of the 5th Nordic Conference on Construction Economics and Organization (2009).

Background: Differences in project actors' perceptions of risk allocation lead to numerous conflicts during project implementation. Several studies have found enthusiasm among project actors for JRM, i.e. sharing responsibilities for risks rather than allocating them to specific actors. However, although JRM is widely believed to be the best option for dealing with unforeseen events, particularly in highly changeable environments, it is still rarely applied in Sweden. The limited use of collaborative practices in general, and JRM in particular, is a weakness in current practice that may seriously impair project performance.

Knowledge gap: Neither the potential utility of JRM nor optimal ways to implement it in the Swedish construction industry have been previously explored.

Aim: To acquire sufficiently deep understanding of JRM to enhance its implementation and (thus) project outputs.

Method: Literature review.

Results: Two groups of factors that support JRM were identified from the literature, one related to the procurement practices and the other related to relationships among project actors. The procurement-related factors are important to consider when choosing a procurement strategy. This group includes clear contracts, a total cost perspective in partner selection, focus on technical expertise and managerial competence in partner selection, incentives for risk-sharing/problem-solving, establishment of joint objectives, team-building activities in early stages and long-term agreements. The factors related to relationships among the actors have a "soft" nature and their value (in RM terms) is highly dependent on the nature of the integration of procurement-related factors in the project. They include: mutual trust, openness of project participants, effective communication, strong relationships and a desire to maintain them, exchange of information, dedicated teamwork,

commitment from senior management, a long-term perspective, commitment to quality and continuous improvement.

Conclusions: The acquired information about strategies to incorporate effective, systematic JRM throughout projects' lifecycle is potentially beneficial for both key project actors and RM analysts.

4.3 Summary of Paper III

Title: The effects of cooperative procurement procedures on joint risk management in construction projects.

Authors: Ekaterina Osipova and Per Erik Eriksson

Publication status: International Journal of Project Organisation and Management (2011), 3(3/4), pp. 209-226.

Background: Even conscious risk allocation does not guarantee that no conflicts will occur during implementation of a project. The identified risks may change and new risks may emerge, requiring joint efforts of the actors for effective management. Despite the clear advantages of collaborative RM, each actor often focuses on her/his own part of the project and management of associated risks. Through a literature review six hypotheses were developed, postulating that JRM is enhanced by the following cooperative procurement procedures: collaboration through partnering; joint technical specification by the client, contractors and consultants; cost-reimbursable payment mechanisms with incentives/bonuses; consideration of soft parameters during partner selection; joint procurement of subcontractors by the client and main contractor; and the use of collaborative tools.

Gap: Although a great deal of research has been carried out in Sweden and in other countries about cooperative relationships, there is a lack of investigations explicitly focusing on the nature and occurrence of JRM.

Aim: To investigate the frequency of the use of JRM in the Swedish construction industry and effects of the utilised procurement procedures on its occurrence.

Methods: Questionnaire survey of Swedish construction clients and case-studies.

Results: The use of JRM is limited in Sweden, but national clients use it more frequently than local clients, possibly because national/international clients identify and adopt management trends from other countries more quickly than local clients. Overall, cooperative procurement procedures are positively related to the use of JRM, but the only specific procedure that clearly and significantly enhance it are collaborative tools. Notably, the case study findings indicate that cooperative procurement procedures enhance the implementation of JRM.

Conclusions: The results highlight the importance of cooperative procurement procedures for the use of JRM. The cooperative procurement procedures used in the case-study project, i.e. collaborative agreement (similar to partnering), consideration of soft parameters during the partner selection process, incentive-based payment mechanism, and the extensive use of collaborative tools, facilitated the implementation of JRM. Involving a partnering facilitator to guide the joint activities of a project team is one way to increase collaboration and promote the use of JRM.

Contributions: A theoretical contribution of the paper is that JRM can be viewed as an important (but previously neglected) element of collaborative practices and activities. The results are expected to increase industry practitioners' awareness of the importance of cooperative procurement procedures, and thus assist construction clients in choosing appropriate procurement approaches for fostering a collaborative environment and JRM.

4.4 Summary of Paper IV

Title: Balancing control and flexibility in joint risk management: Lessons learned from two construction projects.

Authors: Ekaterina Osipova and Per Erik Eriksson

Publication status: International Journal of Project Management (2013), 31(3), pp. 391-399.

Background: Opportunistic behavior is an inherent phenomenon in projects because participants have different objectives and strive to optimize outcomes for their own organizations rather than the project (de Man and Roijakkers, 2009). To avoid the potentially adverse effects of such behavior, most project management techniques are control-oriented, based on hierarchical structures, centralized decision-making and strict divisions of work and responsibilities

(Lenfle and Loch, 2010). However, project organizations must also be flexible in order to respond appropriately to the unique uncertainties changes and challenges that arise in complex projects (Geraldi, 2008). Thus, both control and flexibility are essential for effective PM. As there is an inherent conflict between control and flexibility, achieving an optimal balance between them is one of the greatest challenges for a project organization (Raisch, 2008).

Knowledge gap: Although risks can profoundly affect the delivery of project objectives, effects of control-oriented and flexibility-oriented approaches on RM processes have not been investigated.

Aim: To investigate how mechanistic (control-oriented) and organic (flexibility-oriented) management systems influence the implementation of JRM.

Methods: Longitudinal case study (designated HydroPlant and PharmaLab). Data collection methods included observations, interviews and document studies.

Results: In the HydroPlant project a strongly control-oriented approach was adopted, despite significant uncertainties (and hence an inherent requirement for flexible, collaborative management). The client's focus on control and pre-established solutions resulted in very poor collaboration and inability to adapt to changing circumstances. The actors used risk registers to transfer risks to each other instead of handling them jointly. Moreover, unwillingness to accept each other's competence led to a lack of ability to find the most appropriate technical solutions. Consequently, the project was delayed by several months, there were significant cost overruns, and relationships within the project team were destroyed.

In the PharmaLab project there was much more focus on flexibility in order to cope with uncertainties and changes. For example, the client's on-site representatives had direct contact with subcontractors without involving the general contractor. They could also make decisions without going via the client's project manager. This cut decision-making times and increased flexibility, which fostered JRM. Significant changes demanded by the end-user required substantial additional work by the designers, consultants and general contractor. Nevertheless, the flexibility of the project actors and their collaborative attitude allowed tough deadlines to be met and joint management of the associated risk while adapting to the scope changes.

Conclusions: Under a control-oriented management system, responsibilities and liabilities for risks are mechanistically allocated to individual project actors, rather than being collaboratively shared. Thus, a strong focus on control hampers development of a collaborative project environment and does not create suitable conditions for JRM. JRM requires a combination of formal and collaborative processes, calling for a balance between control to manage identified risks and flexibility to cope with unforeseen events.

Contributions: By synergistically considering RM literature and organizational theory on mechanistic and organic management systems, the study pinpoints the importance of managing tensions between control and flexibility when implementing JRM.

4.5 Summary of Paper V

Title: Establishing collaborative relationships and joint risk management in construction projects – An agency theory perspective.

Author: Ekaterina Osipova

Publication status: Submitted for publication to Journal of Management in Engineering in December 2013.

Background: Through construction contracts, clients and contractors are involved in principal-agent relationships. These relationships are argued to be adversarial and characterised by two main features of contracting parties: different goals and different attitudes to risk. Agency-related problems contribute to the actors concentrating on risks associated with their own parts of projects instead of JRM.

Knowledge gap: Fewer studies have discussed JRM although risk-sharing is a key issue in principal-agent relationships, and agency-related problems must be effectively addressed to establish strong collaboration.

Aim: To investigate how project actors address problems associated with principal-agent relationships and thereby enhance collaboration and JRM.

Methods: Longitudinal case studies (designated PharmaLab and BioLab). Data collection methods included observations, interviews and document studies.

Results: Effective methods were adopted in both projects to solve the agency-related problems and establish strong cooperative relationships that enhanced JRM. The attitude of the project management played an important role in fostering collaboration and creating an environment where personnel felt confident about their roles. Relational workshops and JRM workshops were identified as the two most important practices or techniques for fostering a good collaborative environment and JRM. The project actors agreed that the "statement of common goals" facilitated solution of many problems during the project, and that promising to pursue the common goals encouraged them to strive to collaborate effectively. Differences in risk attitudes were managed through cooperative procurement procedures, cost-reimbursable payment mechanisms and the use of incentives. Due to the relationship history among the project actors and experience from the similar previous project, initial information asymmetry was lower in BioLab. A joint database for project documentation was used in both projects, which also decreased information asymmetry. Intensive communication through both formal and informal meetings provided important forums for discussions of problems (actual and potential) and possible solutions. The use of multiple output parameters (target price, joint cost management) resulted in reliable assessments of project actors' performance. The project actors generally agreed that there is a greater need to exploit all the available competence and knowledge, and thus for collaboration, to find optimal solutions in difficult and complex projects. Long-term focus (related to the length of relationship) underpins collaboration and may significantly decrease time required for establishing strong relationships.

Conclusion: The empirical findings show that strong collaboration is a multi-dimensional activity that is crucial for JRM. Effective JRM is highly dependent on other dimensions of collaboration (such as cooperative procurement, establishment of common goals and open communication) and should be implemented together with other factors.

Contribution: By identifying agency-related problems that have major impact on collaborative relationships in general and JRM in particular, this research contributes to RM literature where fewer studies have discussed JRM from the perspective of the principal – agent relationships. This research also increases understanding of how strategies to handle agency-related problems can foster cooperative relationships and JRM. In addition, this study increases awareness of the importance to establish collaboration further down the supply chain.

5 DISCUSSION AND CONCLUSIONS

This chapter (the last of the introductory part of the thesis) provides a concluding discussion of the main findings then discusses their theoretical and practical implications. Finally, limitations of the studies and recommendations for future research are presented.

5.1 Concluding discussion

We know there are risks in every project and they must be managed. Thus, various RM practices, tools and techniques have been developed and applied in projects, with varying degrees of success. It is widely believed that collaboration is important and that we have to work together to enjoy synergistic effects of cooperative RM and avoid individual participants acting purely in their own interest. However, differences in the interests and perceptions of the participants may severely hamper open discussion of risks. So, there is a clear need, addressed in this thesis, to identify ways to encourage people to talk openly about risks and actively collaborate in RM.

Most current RM tools and procedures are based on predicting risks and allocating them to specific project actors, but this approach is often inefficient for handling risks in the constantly changing environments of complex construction projects. In contrast, in JRM risks are managed collaboratively, by all actors focusing on what is best for the project rather than sub-optimising the situation for each specific actor. JRM is widely held to be an effective strategy for managing changing circumstances and unforeseen events, but despite its advantages it rarely seems to be used in practice, at least in the Swedish construction industry. Thus, the overall aim of the presented research was to increase understanding of how to enhance JRM throughout projects' lifecycles.

Previous research has provided few descriptions of the nature of JRM. Thus, a major aim of the studies this thesis is based upon was to extend existing definitions by considering core components of JRM as well as factors that affect its implementation. Three sets of factors have been examined as they seem to significantly influence the implementation of JRM and its effectiveness. These sets of factors are related to: procurement strategies, the mechanistic or organic nature of adopted management systems, and strategies for responding to agency-related problems.

5.1.1 Extending definitions of JRM

Rahman and Kumaraswamy (2002a) define JRM as "a dynamic management of risks at the post-contract stage based on relational contracting principles". This definition suggests that the essential elements of RC (commitment, trust, cooperation and communication, common goals, and win-win philosophy) are key foundations of JRM. However, the definition does not include the core components and activities of JRM and, thus, has limited utility for assessing whether a utilized RM approach is collaborative or not. The empirical findings presented in Papers IV and V, identified continuous JRM workshops, compilation of a joint risk database and a JRM facilitator as core components of JRM. The proposed definition is as follows.

JRM is a collaborative approach to risk identification, assessment and response based on continuous interaction among project actors to foster the sharing of expertise and understanding, thereby minimizing the negative consequences of uncertain events and maximizing opportunities they may provide.

Ideally, JRM process should include the following activities throughout a project's lifecycle. Firstly, *joint risk identification and assessment* in early phases is essential as it provides opportunities to establish shared understanding of project risks among project actors from the outset. Including all the key actors in the process also provides opportunities to exploit the full range of available expertise, which is essential for thorough risk identification and minimising bias during risk assessment. A difficulty that may arise here is that relationships among project actors may be weak initially, hindering establishment of the required commitment. Thus, it is also important to initiate team-building activities at early stages as they foster collaborative relationships. Secondly, *joint preparation of the risk registers and risk response plans* is essential to facilitate formulation of effective responses to risks from the overall perspective of the project rather than individual gains.

Participation of all the key actors is critical in this process as it reduces differences in perceptions about who should be allocated specific risks. Thirdly, as project risks are dynamic, *continuous updates of risk registers and response plans* are important for maintaining a current perspective and appropriately adjusting assessments and responses. Proactive, dynamic management of new and changing risks allows identification and assessment of risks that emerge during project implementation and their allocation to the most relevant and competent actors, based on joint discussion.

JRM workshops are core components of JRM, as they provide forums for joint discussions of risk identification, assessment and response that enhance understanding of the project, associated tasks and potential problems. Involving a facilitator to guide the JRM activities of a project team is one way to increase effectiveness of such workshops. Compilation of a joint risk database is essential to minimize information asymmetry and provide all project actors with necessary data about risks.

5.1.2 Factors that affect implementation of JRM

The empirical findings show that *cooperative procurement procedures, organic management systems and appropriate strategies for addressing agency-related problems* enhance JRM in construction projects. Thus they require thorough consideration when organizations intend to implement JRM, as discussed below.

One of the advantages of *cooperative procurement* is that it provides opportunities to involve the whole project team, and thus exploit the full members' competence from the very beginning of a project when it has the greatest potential impact. Involving contractors in early planning phases enhances risk identification and assessment, while including consultants provides opportunities for them to assess potential technical solutions jointly with the client and contractors, thereby improving solutions and reducing risks in the production phase. Careful consideration of contractors' ability to cooperate and other 'soft' parameters during the selection process increases prospects for both choosing the optimal main contractor and establishing a harmonious working environment. In contrast, partner selection based on the lowest bid impairs communication of risk during the procurement phase and thus may result in conflicts and disputes during project implementation. Communication of risks also depends on the payment mechanism. In projects procured through lump-sum contracts there is high financial pressure on contractors and disputes are common. Moreover, such contracts require

contractors to provide very detailed and specific technical documentation in their tenders, which often raises problems as there is insufficient time for thorough tender preparation. A further problem with fixed contracts is that they do not encourage clients to communicate risks well. In contrast, cost-reimbursable contracts with incentive arrangements focus less on financial aspects, allowing many problems to be solved during project implementation, liabilities to be equitably allocated, opportunities to be fairly distributed, and optimal solutions to be collaboratively identified. They also encourage all actors to minimize risks instead of shifting them to one another. Thus, they promote all the beneficial aspects of effective RM and thus reduce costs. For a more detailed discussion of the effects of cooperative procurement procedures on JRM, see Paper III.

Severe shortcomings of *mechanistic management systems* were identified. Most importantly, they result in a formal approach of predicting risks then rigidly formulating solutions and allocating them to specific project actors, which impairs collaboration and the ability to adapt to changing circumstances. Clearly, a more flexible approach is required to cope with dynamic, constantly changing risks, particularly in complex projects. *Organic management systems* can provide the required flexibility to cope with unforeseen risks, and the following elements appear to be particularly valuable for establishing effective JRM. The willingness of actors to develop common understanding about the project and share knowledge and experiences through continual dialogue and close collaboration is essential in order to exploit the full spectrum of their competence and expertise. Encouraging all the actors to see their tasks as parts of the overall project is also essential for fostering collaborative relationships and deep understanding of the project. Sharing responsibility through joint discussion of risk mitigation plans during JRM workshops is also valuable for developing consensus regarding the actors that have most competence and resources for managing specific risks. For a more detailed discussion of the effects of mechanistic and organic management systems on JRM, see Paper IV.

A collaborative approach to RM is based on openness and mutual understanding. Thus, it requires establishment of strong relationships among the project actors. *Agency-related problems*, such as differences in goals and attitudes to risk, information asymmetry and complexity issues, are inherent in contractual relationships and must be properly addressed. Goal alignment can be achieved through development of “a statement of common goals”, while differences in risk attitudes can be managed through cooperative procurement procedures, cost-reimbursable payment mechanisms and the use of incentives. Straight, honest communication is vital for minimizing information asymmetry

and may be underpinned by collaborative activities. Collaboration is particularly important in complex, difficult projects because of the opportunities it offers to identify optimal solutions by exploiting the full competence and knowledge of the team. For a more detailed discussion of the effects of agency-related problems on the implementation and effectiveness of JRM, see Paper V.

5.2 Theoretical implications

The presented studies provide several contributions to RM theory. First, they address knowledge gap regarding the lack of descriptive material on the nature of JRM: what JRM is, and how project actors actually carry out JRM. The author extends definition of JRM by including its core components together with associated activities and underlying factors. The extended definition better reflects, and increases understanding of, the nature of JRM and, therefore, can be used in future studies.

Previous research has identified a number of serious drawbacks related to procurement practices based on the lowest price award mechanism with a short-term focus. The presented research contributes to this discussion by identifying and studying procurement variables (project delivery method, form of payment and use of collaboration or partnering arrangements) that have a major influence on RM. In addition, the results of questionnaire survey suggest that cooperative procurement procedures in general and collaborative activities in particular are positively related to the use of JRM. Thus, JRM can be viewed as an important element of collaborative activities.

By framing the empirical results about RM in an organizational theory context this research identifies two sets of factors that strongly influence the implementation and effectiveness of JRM, related to management system (organic vs. mechanistic), and strategy for responding to agency-related problems. First, by applying theory on mechanistic and organic organization to RM, the study pinpoints the importance of managing tensions between control and flexibility when implementing JRM. The author suggests that JRM requires a combination of the formal tools (aimed at controlling identified risks) and flexible strategies (aimed at responding to unforeseen changes). Second, by investigating how strategies to handle agency-related problems can foster collaborative relationships and JRM, this research contributes to RM literature where few studies have discussed JRM from the perspective of the principal – agent relationships.

5.3 Practical implications

The studies also provide several contributions to JRM practices, including the following. They show that commitment of the project management is essential for successful JRM. In addition, sufficient time and effort must be spent to assure that JRM workshops are efficient, consistent and engage all the key project actors. They also show that collaborative arrangements are important for creating opportunities to involve the actors in RM throughout the construction project, and for aligning both their goals and attitudes. Therefore, they should be used as supplements to standardized contract conditions, particularly in complex projects with high uncertainty. In such cases correspondingly high degrees of collaboration are required to foster effective communication, information exchange, honest discussion of risks and joint problem-solving. Hence, all the characteristic features of collaborative relationships, such as open dialogue, trust and cooperation must be nurtured.

Furthermore, the early involvement of subcontractors (who usually carry out most construction work in projects) and including them in collaborative arrangements are important. This is because the early involvement helps to establish relationships based on joint problem-solving and improve understanding of project objectives, thereby increasing the effectiveness of JRM and reducing problems during project implementation. It is also important to include end-users in JRM teams and workshops to improve understanding of changes in their requirements that may demand significant changes during project implementation, allow them to follow the process more closely and plan changes in cooperation with the construction team.

Finally, the studies highlight a need for deeper understanding of collaborative relationships and JRM among the project actors, because clients often require projects to be carried out using collaborative arrangements, but contractors often lack adequate understanding of what this means and how they should behave in such projects.

5.4 Limitations and further research

There are several limitations of the presented studies. The only quantitative data obtained from the questionnaire survey concerned clients' opinions and JRM was not the focal issue addressed. Thus, the conclusions regarding JRM that can be validly drawn are limited. In the future work it would be interesting to design and conduct a rigorous survey and include larger samples and use multi-item scales to measure JRM. Further investigations of contractors',

subcontractors' and consultants' opinions are needed to improve understanding and obtain a more holistic view of JRM.

In the investigations of procurement options' effects on RM, only three options were considered: general fixed-price contracts, design-build fixed-price contracts and partnering with a cost-reimbursable payment mechanism. Clearly, effects of the numerous other permutations of procurement choices should be examined as they could provide different results. As procurement strategies are of vital importance for project collaboration, more attention to how to implement cooperative procurement and overcome problems related to traditional formal contracts should be paid in the future studies.

In the study of mechanistic and organic management systems' influence on implementation of JRM other contextual factors were excluded. However, the choice of management system may be influenced by many factors, such as the scope, complexity and inherent uncertainty of the project, procurement procedures and both the skills and attitudes of the management team. Therefore, effects of these other factors also require investigation, to determine optimal management procedures for effective JRM and avoid excessively rigid RM practices.

Principal-agent problems are related to the project actors involved in contractual relationships. Thus the focus of these studies was on the relationships between clients, contractors and consultants. Moreover, in the studied projects, sub-contractors and main suppliers were excluded from the JRM team. However, in order to fully obtain the benefits of JRM, thorough attention should be paid to roles of other actors further down supply chain who are not necessarily involved in contractual relationships with each other but still have to collaborate and establish strong relationships. Hence, future research into mechanisms that enhance involvement of as many actors as possible in JRM activities is relevant.

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Appendix 1. A sample questionnaire

1. Who does perform the technical specification of the product that the construction process involves?

	Very seldom						Very often
Client and/or consultant	☐	☐	☐	☐	☐	☐	☐
Main contractor	☐	☐	☐	☐	☐	☐	☐
Jointly by client, consultant and contractor	☐	☐	☐	☐	☐	☐	☐

2. How important are the following evaluation parameters when choosing a main contractor?

	Unimportant						Very important
Earlier experiences of the bidder	☐	☐	☐	☐	☐	☐	☐
Project organization and staffing	☐	☐	☐	☐	☐	☐	☐
Company size and financial stability	☐	☐	☐	☐	☐	☐	☐
Attitudes towards change	☐	☐	☐	☐	☐	☐	☐
References relating to similar projects	☐	☐	☐	☐	☐	☐	☐
Collaborative ability	☐	☐	☐	☐	☐	☐	☐
Technical competence	☐	☐	☐	☐	☐	☐	☐

3. Who does choose and procure subcontractors?

	Very seldom						Very often
Client	☐	☐	☐	☐	☐	☐	☐
Main contractor	☐	☐	☐	☐	☐	☐	☐
Jointly by client and main contractor	☐	☐	☐	☐	☐	☐	☐

4. How often do you use the following payment mechanisms when procuring a main contractor?

	Very seldom						Very often
Fixed price	☐	☐	☐	☐	☐	☐	☐
Cost reimbursement	☐	☐	☐	☐	☐	☐	☐
Reimbursement with incentives/bonus	☐	☐	☐	☐	☐	☐	☐

5. To what extent do you use the following tools in order to increase collaboration between the project actors?

	Very seldom						Very often
Formulation of joint objectives	☐	☐	☐	☐	☐	☐	☐
Follow-up workshops	☐	☐	☐	☐	☐	☐	☐
Dispute resolution techniques	☐	☐	☐	☐	☐	☐	☐
Joint project office	☐	☐	☐	☐	☐	☐	☐

Joint IT-tools	☐	☐	☐	☐	☐	☐	☐
Team building activities	☐	☐	☐	☐	☐	☐	☐
Partnering facilitator	☐	☐	☐	☐	☐	☐	☐

6. How often do you procure your construction projects based explicitly on partnering or similar collaborative approach?

Very seldom						Very often
☐	☐	☐	☐	☐	☐	☐

Appendix 2. Interview guide for the first round of interviews

Part 1. General discussion and main definitions

Could you please describe the project and your role?

Could you please describe the project organization?

Could you please describe the project in terms of uncertainty and complexity?

What are the major risks in the project?

What does the term *risk* mean to you?

What does the term *risk management* mean to you?

How would you define *joint risk management*?

Part 2. Risk management

How do you work with the project risks?

How are JRM workshops organized?

Which actors do participate in JRM workshops?

Why do these actors participate and some other actors are excluded?

Where do you organize JRM workshops (client's office, main contractor's office)?

How was the first workshop organized?

- How did you identify risks?
- How did you assess risks?

What RM techniques do you use during the workshops (qualitative, quantitative)?

How do you assess probability and consequences of uncertain events?

Is it difficult to identify which actor should take responsibility for a specific risk?

What are the most important factors that underpin open discussion of risks and JRM?

Part 3. Procurement

Why did you choose general contracting?

What was of decisive importance for this choice?

How do utilized procurement options affect risk management?

How did you choose payment mechanisms?

How did you choose the main contractor?

How were the subcontractors procured?

What are the criteria for incentives/bonus?

Part 4. Collaboration and relationships

What collaborative activities do you use in the project?

Which project actors are involved in the collaborative team?

Who does decide which actors are involved?

What actors do you think should be included?

How would you characterize relationships between the actors?

How to create an open and trustful environment in the group?

When did you meet with the collaborative team for the first time?

How were relational workshops organized?

How did you work on establishment of common goals?

How do you spread common goals in you organization?

What if relationships do not work..?

Appendix 3. Interview guide for the second round of interviews

Part 1. Project outcomes

How do you evaluate the project implementation in terms of the following parameters (with examples)?

- Cost
- Time
- Quality/functionality

Have identified risks occured in the project?

- If yes, what impact on the project cost did they have?
- If yes, why did the risks occur?
- If yes, how the problems were solved?

Have unforeseen risks occurred in the project?

- If yes, what risks?
- If yes, what impact on the project cost did they have?
- If yes, how the problems were solved?

Part 2. Joint risk management

How were JRM workshops organized throughout the project (Who? When? What?)

How do you evaluate collaboration between the actors in general and RM in particular?

How did the chosen form of contract and payment mechanisms affect JRM?

How did the adopted collaborative agreement affect JRM?

How do you evaluate JRM in the project?

What were the main drivers for JRM?

What were the main hinders for JRM?

Are there any aspects of the current JRM strategy you would like to change?

How did you communicate risks throughout the project's lifecycle?

What phases of the project were the most important for JRM?

Part 3. Collaboration and relationships

How do you evaluate collaboration between the project actors?

How were relational workshops organized?

How often did you have relational workshops?

Have you achieved established common goals?

What was of decisive importance for successful collaboration?

Was performance-based bonus fully paid to the main contractor?

What role do incentives play for relationships among the project actors?

How do you evaluate relationships in the project?

What are the main factors that foster strong relationships?

What role did the use of collaborative activities play for fostering relationships?

Did serious conflicts occur during the project implementation?

If yes, how did you solve them?

Appendix 4. Glossary

Client – a part that carries out or assigns others to carry out construction, demolition or land work (PBL, 2010).

Contract – a mutually binding agreement that obligates the seller to provide the specified product and service or result and obligates the buyer to pay for it (Project Management Institute, 2013).

Contractor – a performing organisation whose employees are most directly involved in doing the work on the project (Project Management Institute, 2013).

Design-build – a procurement option where the contractor is responsible for construction and the full design (Murdoch and Hughes, 2008).

General contracting (Design-bid-build) – a procurement option where the client contracts separately with a designer and a contractor (Murdoch and Hughes, 2008).

Joint risk management – a dynamic management of risks at the post-contract stage based on relational contracting principles (Rahman and Kumaraswamy, 2002a)

Opportunity – a source of upside risk (Chapman and Ward, 2002).

Partnering – a form of project governance, which is based on cooperative procurement procedures and facilitates a stronger focus on cooperation than on competition throughout projects (Eriksson, 2010)

Procurement – a combination of different methods (e.g. source of funding, partner selection, price basis, responsibility for design, and amount of subcontracting) for purchasing construction objects (Murdoch and Hughes, 2008)

Project – an endeavour in which human, material and financial resources are organised in a novel way; to undertake a unique scope of work of given specification, within constraints of cost and time, so as to achieve unitary, beneficial change, through the delivery of quantified and qualitative objectives (Turner, 1992).

Practice – a specific type of professional or management activity that contributes to the execution of a process and that may employ one or more techniques and tools (Project Management Institute, 2013).

Project lifecycle – the series of phases that a project passes through from its initiation to its closure (Project Management Institute, 2013).

Project management – the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements (Project Management Institute, 2013).

Project risk – an uncertain event or condition that, if it occurs, has a positive or a negative effect on one or more project objective (Project Management Institute, 2013).

Risk management – a systematic process of identifying, analysing and responding to project risks (Project Management Institute, 2013).

Relational contracting – the working relationship among parties who do not often follow the legal mechanism offered by the written contracts, and the parties themselves govern the transactions within mutually acceptable social guidelines (Macaulay, 1963)

Uncertainty – is an event or a situation that was not expected to happen, regardless of whether it could have been possible to consider it in advance (Perminova et al., 2008)

Appendix 5. List of publications

The following publications have been produced during the research work.

Osipova, E. and Eriksson, P. E. (2013), Balancing control and flexibility in joint risk management: Lessons learned from two construction projects. *International Journal of Project Management*, Vol. 31, No. 3, pp. 391-399.

Osipova, E. and Eriksson, P. E. (2011), How procurement options influence risk management in construction projects. *Construction Management and Economics*, Vol. 29, No. 11, pp. 1149-1158.

Osipova, E. and Eriksson, P. E. (2011), Managing risk together. *International Innovation*, Vol. 2, pp. 62-64.

Osipova, E. and Eriksson, P. E. (2011), The effects of cooperative procurement procedures on joint risk management in Swedish construction projects. *International Journal of Project Organisation and Management*, Vol. 3, No. 3/4, pp. 209-226.

Osipova, E. and Simu, K. (2010), Differences in the application of risk management. *Performance Improvement in Construction Management*, London: Spon press, pp. 259-273.

Osipova, E. and Eriksson, P. E. (2009), Joint risk management as a driver of project performance improvement. *Proceedings of 5th Nordic Conference on Construction Economics and Organisation*, Reykjavik: University of Reykjavik, Iceland. Vol. 2, pp. 109-116

Osipova, E. and Eriksson, P. E. (2009), The effects of procurement procedures on joint risk management. *Proceedings of 25th Annual ARCOM Conference*, Nottingham, U.K., pp. 1305-1314.

Osipova, E. and Atkin, B. (2008), From project-oriented to process-oriented risk management in construction. *Proceedings of International Conference on Building Research and Education: Building Resilience*, University of Salford, U.K.

Osipova, E. (2008), Risk management in construction projects: a comparative study of the different procurement options in Sweden. Licentiate thesis No 2008:15, Luleå: Luleå University of Technology, Sweden.

Osipova, E. and Eriksson, P. E. (2008), The impact of procurement options on risk management. *Proceedings of Joint CIB Symposium: Transformation through Construction*, Heriot-Watt University, U.K.

Osipova, E. (2007), The impact of contractual and collaboration forms on risk management in Swedish construction projects. *Proceedings of 2th International Conference World of Construction Project Management : WCPM 2007,* Delft : TU Delft, The Netherlands, pp. 1-13.

Osipova, E. (2007), Risk management in the different phases of a construction prject : a study of actors' involvement. *Proceedings of 4th Nordic Conference on Construction Economics and Organisation: Development Processes in Construction Management*. Luleå: Luleå University of Technology, Sweden, pp. 307-319.

Osipova, E. and Apleberger, L. (2007), Risk management in different forms of contract and collaboration: case of Sweden. *Proceedings of CIB World Building Congress 2007: Construction for Development*, Cape Town, South Africa, pp.1-10.

Paper I

How procurement options influence risk management in construction projects

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How procurement options influence risk management in construction projects

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Before proceeding with a project, a client has to choose an appropriate procurement option that facilitates an effective project organization in general and a thorough risk management process in particular. By identifying three procurement variables that have a major influence on risk management: project delivery method, form of payment, and use of collaboration or partnering arrangements, the effect of each variable is studied. An exploratory study and a series of interviews with clients, contractors and consultants involved in 11 Swedish construction projects, were performed in order to examine how risk management was carried out in each project. Irrespective of the procurement option, many projects suffered from variations in cost affecting one or more actors. Risk management was not carried out systematically throughout project phases. However, in the projects with early involvement of the actors, their participation throughout the project, and opportunities for open dialogue and collaboration, a more thorough risk management process was found. While project delivery methods define formal risk allocation, the use of incentives and collaboration or partnering arrangements help to establish a collaborative approach to risk management.

Keywords: Contract conditions, partnering, payment, procurement, risk management.

Introduction

Procurement is a combination of different methods for purchasing construction objects and includes such variables as source of funding, partner selection method, price basis, responsibility for design, responsibility for management, and amount of subcontracting (Murdoch and Hughes, 2008). The client's choice of procurement option, i.e. a combination of the above-mentioned variables, implies different ranges of responsibilities and liabilities for the various actors, as well as different degrees of their collaboration in the project (Love *et al.*, 1998; Eriksson and Westerberg, 2011) and may thereby influence risk management (RM). This study focuses on three procurement variables, which are identified through the literature review as having a large influence on RM. These are project delivery method (i.e. who has design responsibility), form of payment (i.e. how contract price was formed and if incentives are used), and use of additional collaboration or partnering arrangements.

From the perspective of design responsibility there are two major methods of project delivery: in general contracts responsibility for design lies with client while in design-build contracts design responsibility lies with contractor. As design is considered to be a significant source of risk (Akintoye *et al.*, 1998), responsibility for design may influence actors' attitudes towards RM.

Form of payment has a significant impact on risk allocation and influences the behaviour of the project actors. Some forms, for example, fixed price, shift most risk and responsibility to the contractor and do not underpin possibilities for joint performance improvement (Floricel and Miller, 2001). In contrast, cost-reimbursement forms of payment imply that the contractors are compensated for their actual costs. However, the use of cost-reimbursement payments in

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Sweden, either with or without incentives or a bonus, is scarce (Eriksson *et al.*, 2008).

Collaboration through partnering arrangements has been increasingly adopted during the last decade in order to underpin relationships between project actors, so that they are based more on openness, trust and cooperation, rather than on sharp contractual formulations (Dagenais, 2007). Collaboration through partnering has been argued to bring several significant benefits to a project, especially when it is based on early involvement of key project actors (Alderman and Ivory, 2007). The early involvement supports the utilization of actors' skills and competences already at the beginning of the project. This enhances more thorough risk identification and assessment but also reduction of risks related to poor constructability through design for manufacturing (Wynstra *et al.*, 2001).

Although previous studies have discussed project performance for different project delivery methods (e.g. Konchar and Sanvido, 1998; Ernzen and Schexnayder, 2000; Miller *et al.*, 2000; Hyun *et al.*, 2008), and how the use of partnering tools affects project success (e.g. Tang *et al.*, 2006), there is a lack of investigations that focus explicitly on RM for the different procurement options from the joint perspective of clients, contractors and consultants. The aim of this study, therefore, is to investigate how procurement options influence RM in construction projects. The research results are based on an exploratory study, including questionnaire and document studies, and subsequently a series of interviews with project actors involved in 11 Swedish construction projects. The results are expected to increase the understanding of RM for the different procurement options and, therefore, assist practitioners in choosing an appropriate option.

Literature review

Risk and risk management

Project risks are uncertain events or conditions that may have an impact on project objectives (Project Management Institute, 2000). A risk has a cause and, if it is triggered, a consequence. RM is a formal process directed towards the identification of, assessment of, and response to project risks (Project Management Institute, 2000). Risk identification is aimed at determining potential risks, i.e. those that may affect the project. During risk assessment, identified risks are evaluated and ranked. The goal is to prioritize risks for management. The risk response process is directed to identifying a way of dealing with project risks and consists of three main techniques: risk reduction, risk transfer and risk retention. Risk reduction aims at reducing the probability and/or consequences of a risk event. Those risks that remain in the project after risk reduction may be transferred to another party either inside or outside the project. Risk retention or acceptance indicates that the risk remains present in the project. Two options are available when retaining the risk: either to develop a contingency plan in case a risk occurs, or to take no action until the risk is triggered.

There are several approaches to classifying project risks and risk sources. Baloi and Price (2003) study risk classification from the perspective of contractors and focus on risks that are project-related and may affect project performance in terms of cost. By conducting an extensive literature review and interviews with construction contractors, they identified the following groups of risk: global risks (e.g. financial, economic, political, legal and environmental), internal risks (e.g. design, construction, management and relationships) and force majeure risks. Several questionnaire surveys have been conducted among construction industry actors in order to investigate risk management practices in different countries. In 1997, Akintoye and MacLeod conducted a survey of 43 practitioners in the UK to explore the use of risk management techniques. In 1999, a similar survey among 200 Australian construction practitioners was conducted by Uher and Toakley. They particularly focused on the use of risk management in early project phases. Lyons and Skitmore (2004) conducted another survey of 44 Australian practitioners based on the results of the above-mentioned studies. The survey covers the whole risk management process, i.e. risk identification, assessment and response throughout all project phases. The most recent survey was conducted by Tang *et al.* (2007) who investigated risk management in the Chinese construction industry. The methods and results of the surveys were somewhat similar. All surveys studied practitioners' RM experiences in general rather than in specific projects. The results show that checklists and brainstorming are the most often used techniques in risk identification. Subjective judgment, intuition and experience are cited as being the tools most commonly used in risk assessment. Risk reduction is the most frequently used technique for risk response. The treatment of RM in this paper follows along the lines outlined above in terms of the recognized stages in that process. However, our study contributes with a project-level focus, investigating how procurement options affect RM in 11 construction projects.

Risk allocation through construction contracts

Risks are allocated to project actors through the contractual arrangements. Many countries have

developed standardized conditions of contract to be used in construction projects. In Sweden, all contracts are based on the general conditions of contract that formalize risk allocation. They assign responsibilities and liabilities to each contracting party regarding job performance, organization, timeframes, guarantees, insurances, errors and payments. General conditions of contract are developed and issued by the Building Contracts Committee (BKK), a non-profit association of authorities and organizations in the construction sector. There are two types of general conditions of contracts for the two project delivery methods that are mostly used in Sweden, i.e. general contracting (GC) and design-build (DB) contracts. 'General Conditions of Contract for Building, Civil Engineering and Installation Work' are used in GC projects. The DB projects are regulated by 'General Conditions of Contract for Building, Civil Engineering and Installation Work performed on a package deal basis'.

General contracts are characterized by a separate appointment of a design team and a construction firm. The client is responsible for the planning, design and function of a construction and the contractor is responsible for the assembly. GC is the most widely used project delivery method in many countries (Ling *et al.*, 2004; Eriksson and Laan, 2007).

In DB contracts, the contractor is responsible for both design and construction. Since there is a single point of responsibility, the popularity of DB contracts has increased in recent years. Konchar and Sanvido (1998) investigate 351 US construction projects using different project delivery methods in order to compare the performance of GC and DB projects. They demonstrate that DB projects on average show a better performance than GC in terms of unit cost, construction speed, delivery speed, cost growth and schedule growth. A study by Ernzen and Schexnayder (2000) showed that the average profit margin for contractors is higher in DB projects than that in GC. From a RM perspective, DB contracts may be more attractive to the client, as the responsibility for design implies that more risk is allocated to the contractor. On the other hand, the DB alternative may be more expensive compared to GC, partly because of the contractors' greater responsibilities and partly because fewer contractors may be available for this larger and more comprehensive type of work (Lind and Borg, 2010). Furthermore, the quality of the final product may be lower if the contractors use cheaper solutions in an attempt to decrease their own costs (Gransberg and Molenaar, 2004). This problem is particularly prevalent in contracts with a fixed price form of payment. In terms of time, the DB system arguably provides an earlier start for project execution than is the case for other systems. From the contractor's point of view, DB construction projects can be very risky if the contractor lacks knowledge and experience of the DB system.

Risk allocation through forms of payment

The form of payment defines who takes a risk if the final cost of construction activities is higher than the estimated cost. The most widely used forms are fixed price and cost-reimbursement (Branconi and Loch, 2004). Fixed price payment shifts the risk of cost overruns during the construction stage to the main contractor. In a study conducted by Floricel and Miller (2001), 60 large-scale engineering projects were investigated in attempt to develop a strategic framework for dealing with project uncertainty. The results show that fixed price contracts do not underpin possibilities for joint performance improvement because the contractor keeps all savings or losses. When a cost-reimbursement form of payment is used, the contractor is compensated for the actual cost during the project execution. Thus, it is the client who takes the risk of cost fluctuations. Branconi and Loch (2004) report their experience with construction contracts in a major engineering company and argue that in the case of cost-reimbursement forms of payment the contractor has very little incentive to find solutions that are more efficient or to cooperate with the client. Both fixed price and cost-reimbursement contracts have adverse effects on communication between client and contractor (Müller and Turner, 2005).

In order to overcome the problems with traditional forms of payment, incentive-based contracts were introduced. In incentive-based contracts, both client and contractor share the risks and rewards (Floricel and Miller, 2001). The main purpose of incentives is to facilitate collaboration in problem solving, and reward the actors on the basis of their performance. A case study conducted by Bubshait (2003) in Saudi Arabia on perceptions of project actors about incentive/disincentive contracting shows that the actors are positive about the role of incentives in promoting contractor performance. When incentives are used, rational decision makers tend to put effort into minimizing risk so they can get a reward (Knight *et al.*, 2001). Moreover, they prefer to cooperate when tangible rewards for problem solving are provided (Wong *et al.*, 2008; Cheung *et al.*, 2009). Incentives motivate actors to focus on joint objectives and significantly reduce disputes. Turner and Simister (2001) therefore argue that projects that are based on cooperation and not on conflict require incentivization of all involved actors. Bayliss *et al.* (2004) support this argument when reporting a story of a successful partnering project in Hong Kong, which showed that contract incentive is an essential element of partnering projects.

Risk management in projects with partnering/ collaboration arrangements

Over the last decade, researchers and practitioners have recognized that relationships between clients and contractors play a significant role in successful project implementation. It has been argued that traditional contracts do not support effective cooperation in construction projects (Kadefors, 2004). Thus, collaboration through partnering has become popular during the last decade. Partnering is a project governance form, based on cooperative procurement procedures, that facilitates a stronger focus on cooperation than on competition (Eriksson, 2010). Cooperation between project actors is claimed to lead to fewer disputes, lower construction costs, and a better quality product. Several studies have shown that practitioners are positive about collaborative relationships and believe they lead to cost and risk reduction (e.g. Black *et al.*, 2000; Akintoye and Main, 2007).

In contrast with the UK, partnering does not have the status of a contract form in Sweden. Instead, an additional collaboration or partnering agreement is used as a supplement to the contract. Overall, however, the use of partnering in Sweden is still scarce (Eriksson *et al.*, 2008). Partnering is not a well-defined methodology on how to organize a project but rather a concept that requires a fundamental shift in thinking and culture (Alderman and Ivory, 2007). Thus, to obtain the benefits of the partnering concept, a high degree of professionalism and very good knowledge of the project on the part of the client *and* of the contractor are required.

Research method

The empirical investigations involved an exploratory study and an interview study of 11 construction projects (see Appendix 1). The projects were chosen by five practitioners who were involved in the research project as a reference group. As such, they participated in interactive discussions and shared their perceptions and opinions about current RM practices and the findings of the study. Each member of the reference group was asked to choose two recently finished projects within their own organization. The strength of the method is that the researcher does not have to spend time contacting many organizations and trying to find those who want to participate. Moreover, people share information more easily when they are aware of the research project and its aim. On the other hand, the number of projects is limited and the researcher does not influence the selection process. In order to obtain a suitable sample that could provide a broad perspective of RM in Sweden, the following requirements for project selection were formulated:

- the projects are located in large and small cities;
- they use different project delivery methods, i.e. GC and DB;
- the types of the projects are building and civil engineering.

In the first stage, nine construction projects (projects 1–9 in Appendix 1) adopting different procurement options were chosen, and an exploratory study was conducted. The aim of the exploratory study was to better understand the nature of the problem and obtain a basis for further interviews with project actors. The objectives were to study how the RM process was organized in the projects and to find out what procurement variables identified in the literature influence RM from the practitioners' point of view. The exploratory study included a questionnaire survey and document studies.

A questionnaire was developed consisting of five sections, covering general questions about the respondent, the aspects of the risk management process through the different phases, and relationships and collaboration in RM between the actors. The respondents were also asked to evaluate project performance in terms of time, budget and quality. The survey sample was composed of three groups of actors: clients, contractors and consultants. Within each group of actors, those persons who worked with RM in a particular project were suggested by project managers to participate in the survey. When the potential respondents had been identified, they were invited to attend a workshop organized by the researchers. During the workshop, the aim of the study and the structure of the questionnaire were presented and a pilot questionnaire was distributed. About 50% of potential respondents participated in the workshop. After the workshop, the questionnaire was adjusted and sent in electronic form to the 54 intended respondents in the nine projects. In total, 36 usable responses were received, giving a response rate of 67%. For those people who attended the workshop the response rate was 100%. Detailed information about questionnaire distribution and respondents' profiles is shown in Table 1.

In the second stage, 20 interviews across the nine projects were conducted, based on the compiled results of the questionnaire survey. The objective was to discuss how procurement variables, i.e. project delivery method, form of payment and use of collaboration or partnering arrangements affected the RM process. Interviews were conducted with the client's project manager, the contractor's site manager, and

Table 1 Questionnaire distribution and respondents' profiles

	Client	Contractor	Consultant	Total
Number of questionnaires sent	18	30	6	54
Number of usable responses received	14	18	4	36
Response rate (%)	78	60	67	
Average age (years)	50	50	48	
Average experience in construction industry (years)	24	28	24	

the architect (in GC) or design manager (in DB). Each interview took approximately one and a half hours and consisted of three main parts. First, the main definitions in the research area were discussed. Since the study dealt with the terms: risk, risk management, risk identification, risk assessment, risk response, etc., it was important to understand the respondents' perceptions of these terms. Next, the results of the questionnaire survey were presented and discussed. In particular, the interviewees were asked to comment on the survey results, explain the answers, and suggest solutions for improvements. Finally, some time was devoted to concluding remarks. All interviews were taped in order to get a permanent record.

In the first two stages, only one project with collaboration through partnering and a cost-reimbursement payment form was studied. Thus, two additional projects undertaken in 2008–09, adopting collaboration arrangements and incentive contracts were included in a third stage of the study. Despite the fact that two projects were added some years later, the economic, political, legal and social situation in Sweden was similar during these years. Fourteen interviews with a focus on the RM process were conducted with the project managers, site managers, consultants and architects. Hence, the 34 qualitative interviews included 11 projects with different procurement options (see Appendix 1).

Results

Results of the exploratory study—risk management and actors' involvement

Despite the fact that RM was a part of each project, almost all projects suffered from variations in cost for one or several actors. Both identified and unforeseen risks occurred in the projects and generally had a significant effect on project cost. In Appendix 1, the actors' evaluations of the project performances are provided.

RM was not carried out systematically in all phases of a project. Only in one project were risk identification, assessment and response carried out systematically in each phase of the project. The absence of systematic RM was especially notable in the early planning phase. The design and production phases were critical for RM. Risk identification, assessment and response processes were mostly performed in these phases.

Within the three groups of actors, contractors were the most active in performing risk identification, assessment and response. Moreover, contractors had the largest influence on RM in the project. The influence of clients varied for the different project delivery methods. In GC projects, where the clients were responsible for design, they had a larger influence on RM. Consultants were not involved sufficiently in work with risk and had a low influence on RM. Owing to the limited participation of some actors in some project phases, the communication of project risks between actors did not work properly. Many problems appeared when the consultant and client were not involved in the production phase. Additionally, RM processes were carried out most intensively in the production phase, which implies more responsibility in managing risks for the contractor and more passive behaviour by the other actors.

Communication of known risks and opportunities between actors in the procurement phase varied between 'little detailed' and 'fairly detailed'. Both the client and the contractor communicated known risks as if they were of a low priority during the procurement phase. This created conflicts during implementation in many projects.

Interview results

Influence of project delivery method on risk management

The majority of the respondents argued that traditional general contracts do not create an opportunity for open dialogue and collaboration in RM between the client and the contractor. In the studied GC projects without a collaboration agreement, the contractors executed the projects strictly according to the clients' construction documents and, therefore, did not have joint discussions of the technical solutions and construction risks. Moreover, the contractors did not participate in the design phase and, accordingly, had no collaboration with the architect. The respon-

dents described that each actor was focused on its own part of the project and tried to manage the associated risks. Absence of trust and collaboration in RM led to a low level of risk communication during the procurement phase and clients attempting to transfer more risk to the contractor. From the contractors' point of view, in GC projects the quality of documents and drawings was often insufficient, with many inaccuracies. For example, in Project 1, the poor quality of design documents increased the contractor's cost significantly. Because of the insufficient geotechnical survey in Project 3, the completion of the road was delayed by several months.

The architects, on the other hand, were positive about RM in the GC projects. They argued that the architect had more flexibility and cooperation with the client in such projects than in DB. In the latter, the contractor was a 'filter' between the client and the architect. The contractor was focused on short-term financial results rather than on the life cycle cost and, therefore, used cheaper technical solutions, which are not always optimal. However, general contracts assign more responsibility to the architect, while in a DB project the architect shares risks with the contractor. On the other hand, collaboration with the contractor is worse in GC projects, because the consultant usually does not participate in the production phase.

From the perspective of dealing with risks, early involvement of the contractor in DB projects is considered to be the main advantage of this project delivery method. Moreover, contractors' RM was more thorough in the studied DB projects since they are assigned the responsibility for design. The actors stated that the DB contract might lead to deviations in the quality of the final product because of the client's inability to control the technical solutions chosen by the contractor. To avoid this situation, continual discussion of technical solutions between the actors is required. Therefore, personal commitment of the clients is argued to be the most important factor in securing the desired result. When the client is an active party, DB is claimed to create conditions conducive to better collaboration because the clients and contractors are forced to have a dialogue. Cooperation between architects and contractors is argued to result in better technical solutions and help in avoiding many design and technical risks. Many actors are positive about more thorough RM in DB contracts.

The general conditions of contract are well-developed documents, which assign responsibilities and liabilities to each party. However, the client often deviates from them by trying to transfer more risk to the contractor. In all 11 projects amendments to the general conditions of contract were included; many of them were applied to the length of guarantee and additional insurance. The project actors argued that amendments make the contracts less clear for the contractor and may result in conflicts and disputes.

Influence of form of payment on risk management

The respondents mentioned the form of payment as a very important factor influencing actors' behaviour. In fixed price contracts, there is a lot of financial pressure on the contractor and disputes are common. Project 5 is one of the projects where the actors were very dissatisfied by their work together because of the many financial discussions associated with the fixed price payment form. Fixed price contracts require very detailed and specific technical documentation from the contractor in the tender. In cost-reimbursement contracts, there is less focus on financial aspects and many problems can be solved during project implementation. Communication of risks in the procurement phase depends heavily on the form of payment. The interviewees mentioned that the clients do not communicate risks to a high degree when they procure fixed price contracts.

Fair distribution of opportunities through incentive arrangements (contracts) was recognized as an efficient instrument for RM. Incentive arrangements stimulate better collaboration in finding the best possible solutions, and, therefore, lead to cost reductions. The cost-reimbursement form of payment with incentives in Projects 9 and 10 increased the motivation of the main contractor to decrease the project cost by finding the best suitable solutions and cooperating with other project actors. Moreover, incentive-based forms contributed to the RM process when all actors were interested in minimizing risk instead of shifting it to one another.

Influence of partnering or collaboration arrangement on risk management

In traditional GC and DB projects with fixed price payment the actors often think about different risks and do not see the project as a whole. The contractor, for example, is more interested in identifying risks that can influence cost, while the client is more interested in risks that affect quality of the final product. Great expectations in partnering were found among the project actors, including those who had no experience of partnering. It was argued that partnering allows the actors to see the project as a whole and influence RM throughout the construction process. A possible advantage of partnering is that RM can be carried out jointly from the earliest phases of the project. When the contractor is involved in the early planning phase it makes RM more effective in terms of joint risk identification and assessment. The consultant, in turn, has

an opportunity to assess technical solutions together with the client and the contractor, which results in better solutions and fewer risks in the production phase. Factors that characterize partnering projects, such as open dialogue, trust, and cooperation, help to achieve effective communication and information exchange: all risks are 'placed on the table'.

In Project 10, the client and the contractor together developed a collaboration agreement in order to improve relationships among the actors. In the agreement, they formulated the main principles of their work together. The collaborative approach was then used throughout the project in order to meet tough deadlines and to jointly manage risks.

Discussion

From a risk management perspective, a number of factors influence the client's choice of procurement option. Clients who want to minimize their own risks choose DB contracts with fixed price payment because there is a single point of responsibility for both design and construction and because of the possibility for transferring risks of cost overruns to the contractor. DB creates opportunities for RM discussions between consultants and contractors, but may hamper the client's involvement and influence on RM and project performance. Accordingly, this study illustrates the importance of personal commitment on behalf of the client in order to achieve sufficient RM in DB projects.

Competent clients may favour general contracts partly because the cost may be lower and partly because they want to have a higher degree of influence on the project. However, general contracts often result in a sequential construction process where many actors are involved in some project phases and focus on their own part of the work rather than on the whole project. In particular, a general contract without any collaboration arrangement gives no space for discussion about technical solutions between the client's design team and the contractor. Moreover, non-participation of the architect in the production phase brings additional design risks that the contractor must deal with. When a general contract with fixed price form of payment is used, a strong focus on financial aspects prevents actors from seeking collaboration. In the case where neither partnering or collaboration arrangements nor incentive schemes exist, the actors concentrate on formal risk allocation through the contract and shift risks to each other in an attempt to optimize their own profits. In order to strengthen contractors' contributions to technical solutions and RM in early project phases in GC, key contractors can become involved at that early stage. This study also supports previous research that highlights the benefits of coupling early involvement with partnering arrangements and incentive-based payments (Bayliss *et al.*, 2004; Alderman and Ivory, 2007) in order to further enhance a project environment based on trust and joint commitment on which a throrough RM can rely.

The production phase was where most interest and activity related to RM were found. These results confirm the findings of two surveys (Uher and Toakley, 1999; Lyons and Skitmore, 2004), which show a higher degree of RM in the production phase than in the early phase. Unfortunately, this can easily prove to be too late to manage some risks, including those design risks that might have been avoided in an earlier phase. The majority of respondents feel that RM should be more important in the early phases for several reasons. First, early risk identification makes the client aware of project risks and facilitates the choice of the optimal procurement option. Moreover, significant savings are possible in the early phases, since changes at the beginning of the project cost less money than in the production phase. Procurement options that allow early involvement of the actors can therefore contribute to more thorough RM.

Most of the respondents see risk as a negative event that can affect the project and cause problems. Only a few people mentioned opportunity as the converse of risk. This confirms the results of a study by Akintoye and MacLeod (1997), which show negative perception of risk among practitioners. Furthermore, when describing their work on project risks, the actors often say 'contractor's risk management' and 'client's risk management'. 'Joint risk management' where all actors participate and perform identification, assessment and response together is a weakness in the current practice. This is probably a result of traditional procurement options that distinctly separate responsibilities and risks in time and space. When working jointly with RM based on early involvement, incentives and partnering arrangements it will probably become more natural to search for positive opportunities and not to focus on avoiding negative consequences.

Conclusions

The aim of this study was to explore how procurement options influence risk management in construction projects. This discussion is important from both theoretical and practical perspectives as it provides clarity on how to improve RM by adopting appropriate procurement options in terms of project delivery method, form of payment and use of collaboration or partnering arrangements. Despite the use of general conditions of contract that formalize risk allo-

cation between the project actors, conflicts existed in a majority of the studied projects and led to cost increase for one or several actors. Thus, a formal risk allocation through the general conditions of contract is not sufficient for achieving the desired performance. Informal aspects affected by the use of collaboration agreements and incentives are also critical.

Implementation of additional collaboration or partnering agreements and incentive-based payment forms changes the attitudes of the actors and creates opportunities for their involvement in RM throughout the construction project. As a collaborative approach is intended to improve communication and joint problem solving, it enhances a joint approach to thorough RM. Two projects in this study that used collaborative activities and joint objectives can serve as examples of effective project organizations from a RM perspective. Collaboration between the actors during all project phases resulted in successful problem solving and cost savings for both the client and the contractor.

A client is a party that owns the project, and should therefore be an active part of the risk management process and demand active participation from the other actors. In current practice, very limited interest and activity are found in the early phase. This aspect must be addressed by the project actors as the early phases are commonly recognized to be very important for systematic RM. Thorough attention to the project risks must be paid in the early phases in order to safeguard project objectives. The architects and design managers should be involved more in RM because design is a very significant risk source in a construction project. Currently, RM is not a part of consultants' assignment in traditional contracts. Incentive contracts, where the consultant is involved in profit sharing, create opportunities for consultants' engagement in RM. Moreover, incentives make it crucial for consultants to participate in RM in the production phase in case design risks crop up during construction.

The main limitation of this study is that it includes only three procurement options: general contracts with fixed price, design-bid with fixed price, and partnering with a cost-reimbursement form of payment. Future surveys should aim to target a wider range of procurement options in a larger sample of construction projects.

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Appendix 1

	Project								
	Short description	Project duration	Type of client	Project delivery method	Form of payment	Partnering Collaboration agreement	Project performance in terms of		
							time	budget	quality
1	Rebuilding and additional construction of university premises, located in the north of Sweden	10 months 2004–05	Public/ regular purchaser	GC	Fixed price	No	Very good	Very good for the client/ fairly bad for the contractor	Very good
2	New construction of a road in the north of Sweden	14 months 2005–06	Public/ regular purchaser	GC	Fixed price	No	Very good	Fairly good	Fairly good
3	New construction of roadin the north of Sweden	10 months 2005–06	Public/ regular purchaser	GC	Fixed price	No	Fairly good	Fairly good	Fairly good
4	Reconstruction of infrastructure facilities in Stockholm	3 years 2004–07	Public/ regular purchaser	GC	Fixed price	No	Very bad	Very bad for the client/ very good for the contractor	Fairly good
5	New construction of a house for meetings at the university campus in the north of Sweden	15 months 2003–04	Public/ regular purchaser	DB	Fixed price	No	Very good	Very good for the client/ fairly bad for the contractor	Fairly good
6	New construction of infrastructure in the north of Sweden	13 months 2006–07	Public/ regular purchaser	DB	Fixed price	No	Fairly good	Fairly good	Fairly good
7	Construction of a residential building in Stockholm	17 months 2005–06	Private/ regular purchaser	DB	Fixed price	No	Fairly good	Very good for the client/ fairly bad for the contractor	Very good
8	Reconstruction of a residential building in Stockholm	12 months 2004–05	Private/ regular purchaser	DB	Fixed price	No	Very good	Very good for the client/ fairly good for the contractor	Very good
9	Reconstruction of a residential building, located in Stockholm	6 months 2005	Public/ regular purchaser	GC	Cost reimbursable	Yes Partnering	Very good	Very good	Very good
10	Construction of laboratory facilities consisting of two buildings located in Stockholm	2 years 2007–09	Public/ regular purchaser	GC	Fixed price and cost-reimbursement with incentives/bonus	Yes Collaboration agreement	Very good	Very good	Very good
11	Reconstruction of infrastructure facilities in the north of Sweden	2 years 2008–09	Public/ regular purchaser	GC	Fixed price with incentives/ bonus	Yes Partnering	Fairly bad	Fairly bad	Very good

Note: The characteristics of a project's implementation are based on the assessments of the project participants. Four alternatives were available for assessment of project implementation: very bad, fairly bad, fairly good, very good.

Paper II

Joint risk management as a driver of project performance improvement

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JOINT RISK MANAGEMENT AS A DRIVER OF PROJECT PERFORMANCE IMPROVEMENT

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ABSTRACT

This paper explores key aspects of joint risk management (JRM), i.e. a collaborative approach for handling project risks, and their relevance to the Swedish construction industry. Although JRM is widely held to be the best strategy for handling unforeseen and changing risks, it is still rarely applied in Sweden. The limited use of collaborative approaches in general, and JRM in particular, is clearly a weakness in current practice that impairs project performance. Traditional construction culture and a lack of competence among the project actors are identified as major obstacles hindering effective collaboration and JRM. In order to overcome these obstacles a number of factors must be successfully incorporated in projects. Two groups of factors, procurement-related and relationship-related, are described in detail. The main conclusion is that there is room for improvements regarding overall collaboration in projects and JRM in particular. However, the Swedish construction industry is not sufficiently efficient to expect rapid progress.

Keywords: Joint risk management, collaboration, relational contracting, construction, uncertainty, procurement, Sweden

1. INTRODUCTION

Construction activities in numerous countries usually involve substantial risks that often affect their final outputs, in terms of unanticipated increases in costs, delays and quality deviations (Al-Kharashi and Skitmore 2009, El-Sayegh 2008). Furthermore the risks and associated problems increase with increases in the size and complexity of construction projects. Thus, the ability to manage risk effectively throughout the construction process has become a central element for safeguarding projects' final results (Maytorena *et al.* 2007).

Most relevant literature highlights a clear dependence of effective risk management (RM) on appropriate risk allocation and efficient collaboration between the project actors. Risk allocation influences the behaviour of project actors and thus significantly affects project performance in terms of total cost (Wang and Chou 2003), partly because unclear allocation of project risks leads to disputes between clients and contractors. Further, several empirical studies have shown that efficient risk allocation can be a difficult task. Problems identified in the literature include differences in the actors' perceptions about who should be allocated a specific risk or group of risks (Loosemore and McCarthy 2008). Most respondents in a survey by Hartman et al. (1997) indicated enthusiasm to share

risks, rather than allocating them to specific project actors. However, contractors usually indicate that they have to bear most responsibility for project risks (Wang and Chou 2003), and price these risks through adding a contingency to the bid price (Andi 2006). This a significant source of cost overruns according to many researchers and practitioners (Zaghloul and Hartman 2003). Hence, evaluation and conscious allocation of risks to appropriate actors under contracts allows reductions in contingency funds, and thus both bid prices and total costs (Zack 1996).

However, even efficient contractual allocation of identified risks in the procurement phase does not guarantee that no conflicts will occur in a project, because during its lifecycle the nature and extent of identified risks may change and new risks may emerge. Frequently, effective management of these unplanned changes and unforeseen risks may require joint risk management, (JRM; Rahman and Kumaraswamy 2002) based on collaborative relationships between the project actors. JRM is widely held to be the best option for managing unforeseen risks, but its use is assumed to be limited in the Swedish construction industry (although the true extent of its application, if any, in Swedish projects has not yet been examined).

Thus, this paper has three objectives:

- to explore theoretical concepts and international experience of JRM;
- to determine the factors that contribute most strongly to successful JRM; and
- to discuss why JRM is (probably) not widely used in Sweden.

Since JRM is still (we believe) rarely applied in Sweden, the paper focuses on international experience of JRM, largely by extensive literature review, including an inventory of existing research and theory. The ultimate aim is to acquire sufficiently deep understanding of JRM to allow the development of an appropriate JRM model for use by project actors to enhance RM and (thus) project outputs.

2. RISK MANAGEMENT IN CONSTRUCTION – CURRENT TRENDS

It is widely recognized that construction projects involve substantial uncertainty and an ability to manage the associated uncertainty is crucial for safeguarding project objectives. Formally, RM can be defined as a systematic process of identifying, assessing and responding to project risk (PMI 2000). Few studies have quantified the impact of RM on projects' success. However, according to practitioners surveyed by Raz and Michael (2001), RM contributes significantly to overall project success (rating ca. 3.9 on a 0-5 Likert scale).

Much existing research on risk management mainly considers RM as a process, involving a number of activities, and suggests improvements by proposing new models, methods and procedures for risk identification, assessment and responses. These aspects have been reviewed by Osipova (2008). In most other studies RM is regarded as an interactive process, the role of project participants in successful RM is addressed and the authors explore ways to improve elements such as risk allocation, relationships, organisational structures and collaborative strategies. The focus of this paper is on these elements of RM.

A number of empirical studies have been conducted in various countries to identify current RM practices (Akintoye and MacLeod 1997, Lyons and Skitmore 2004, Osipova 2008, Simu 2006, Tang et al. 2007, Wood and Ellis 2003, Zou et al. 2007). There are many similar findings in these surveys. The results indicate that use of RM techniques is moderate and that the main techniques are checklists and brainstorming. Moreover, current RM systems are argued to be very complicated and difficult to use. One of the main identified reasons for deviations in project performance is the lack of a systematic approach to RM, particularly in early project phases, where it arguably has the greatest potential impact. Open discussions of possible risks in the early phases and collaborative management of risks throughout a project's lifecycles are reportedly important drivers of effective RM. However, the communication of risks between key actors is generally inadequate, at least partly because different actors use different terminology for describing risk, leading to inconsistency and incomplete risk communication (Tah and Carr 2001). Many respondents to the abovementioned surveys agreed that in current procurement practices the lowest bid price is more important than thorough analysis of potential risks for winning contracts, and identified the lack of JRM mechanisms as a weakness in current practice. The actors often have their own management systems and do not use a joint database for RM documents. Further, despite the clear advantages of collaboration, each actor often focuses on his own part of the project and management of associated risks.

To summarise, RM is currently performed subjectively rather than analytically, individually rather than jointly and occasionally rather than continuously, although effective risk management clearly requires a systematic approach based on efficient collaboration between the project actors.

3. PRINCIPLES OF JRM

During the last decade both researchers and practitioners have recognised that relationships between clients and contractors play significant roles in successful project implementation. Akintoye and Main (2007) found that UK contractors favour collaborative relationships and believe they lead to cost and risk reduction, while Drexler and Larson (2000) found that relationships are much more stable in partnership projects than in other types of projects. Adversarial and opportunistic behaviour, which commonly occurs in the construction industry (Cox and Thompson 1997), leads to many conflicts and disputes when unforeseen events occur in projects. To overcome adversarial behaviour the potential value of relational contracting (RC) has been extensively explored in both the research literature and practice. RC focuses on the relationships between contracted parties, recognises the mutual benefits and win-win scenarios that can be achieved through cooperation in projects, supports such cooperative agreements as partnering and alliancing, and facilitates both teamwork and JRM (Rahman 2003). Hartman et al. (1997) use the term "dynamic risk management" to describe a similar approach of proactive and joint management of risks. The cited authors highlight the importance of project actors' commitment to team efforts in order to achieve a win-win scenario.

JRM has been most extensively studied in Hong Kong by Rahman, Kumaraswamy and colleagues (Kumaraswamy *et al.* 2004, Rahman and Kumaraswamy 2005, Rahman and Kumaraswamy 2002, Rahman and Kumaraswamy 2008). The main findings of their investigations are outlined below.

- A survey of construction industry practitioners in Hong Kong found significant differences in perceptions among them about how risks should be allocated in projects, but generally favoured the JRM concept and agreed that most listed risk items listed should be managed through JRM to some degree.
- Both "hard/technical" and "soft/relational" factors play important roles and should be balanced when forming a project team for JRM. Identified "hard" factors include technical capabilities, similar previous work experience, adequate resources, price, and quality of performance. The "soft" factors include commitment to joint problem-solving, a collaborative attitude, creativity/innovation, and commitment to continuous improvement.
- The most important identified factors for creating a successful collaborative environment were mutual trust, open communication among the actors, understanding each other's objectives and clear, equitable allocation of foreseeable risks.
- Early involvement of subcontractors and main suppliers is important as their competence helps in effective risk identification and assessment. Thus, a project team involving clients, contractors and consultants should be formed before the final contract award. This facilitates formulation of an effective project briefing and thus better understanding of the project's objectives by the actors.
- JRM was identified by practitioners as the best strategy for managing unforeseen risks and risks that change during project implementation.

Thus, in order to create a collaborative environment that supports JRM, a number of factors must be taken into account and successfully incorporated in a project. To determine the most critical factors, the literature on relationship contracting, teambuilding, partnering and collaborative agreements was reviewed (e.g. Bayliss *et al.* 2004, Black *et al.* 2000, Cheung *et al.* 2008, Dagenais 2007, Drexler and Larson 2000, Kadefors 2004, Rahman 2003). The identified factors were grouped into two categories: procurement-related and relationship-related (Table 1).

Table 1. *Factors that contribute to successful JRM in projects*

Group	**Factors**
Procurement-related factors	Clear contracts A total cost perspective during partner selection Careful consideration of technical expertise and managerial competence during partner selection Incentives for risk-sharing/problem-solving Joint objectives Team building activities in early stages Long-term agreements

Relationship-related factors	Mutual trust Openness of project participants Effective communication Good relationships and a desire to maintain them Exchange of information Dedicated teamwork Commitment from senior management A long-term perspective Commitment to quality and continuous improvement

The procurement-related group includes factors that are important to consider when choosing the procurement strategy, i.e. form of contract and payment mechanism. The purpose of clear contracts is to ensure unambiguous formal risk allocation in the project. With a clear contract that formalises liabilities and responsibilities of each contract participant as a starting point, further RM activities can be planned and performed jointly. The total cost perspective is critical for taking into account other factors that may influence the final cost, in addition to the lowest bid, during bid evaluation. The technical expertise of the actors, competence and sufficient resources are highly important for project success, as they foster efficient teamwork and environments where actors respect each other's competence. Incentives for risk-sharing/problem solving can be provided through appropriate bonus schemes with monetary rewards for successful completion of projects. The main purpose of such incentives is to motivate the actors to work jointly and proactively, and minimize the likelihood of them shifting problems to each other. Team-building activities in early stages should include initial workshops, where participants discuss their expectations about the project and learn to work as a team to promote establishment of a dedicated team with joint objectives and ability to collaborate. Taking into account the long-term perspective, for example through strategic partnering agreements, facilitates the development of long-term relationships among the actors, which are clearly conducive for successful collaborative work.

The factors in the relationship-related group have a soft nature and their successful incorporation strongly depends on the integration of important procurement-related factors in the project. Mutual trust is argued to be the most important factor for effective JRM and will not inevitably be present in projects. Long-term relationships and previous work experience with the other actors are minimal requirements for creating trustful environments. Openness of project participants is also crucial for successful discussions about risk, particularly risk identification. Effective communication is another requirement for JRM, since risks must be effectively communicated between the actors and between participants involved in different project phases. This must include efficient exchange of information, which assists quick decision making. Good teamwork has many dimensions, and foundations for it should be created during early phases of any project. It is also impossible to create efficient collaboration without continuous commitment from senior management to provide effective leadership and all the essential assistance for project participants. Commitment to quality and continuous improvement are other factors that support the establishments of dedicated, productive relationships in projects.

Both groups of factors described above are important for creating a collaborative environment that supports JRM. However, current procurement practices in

Sweden often do not provide appropriate conditions for incorporating these factors. Possible reasons why JRM is (probably) not widely applied in Sweden are discussed in the next section.

4. DISCUSSION AND FUTURE WORK

In recent years, the Swedish construction industry has shown growing interest in developing collaborative relationships and joint project management. For example, collaboration through partnering has been introduced, and the three largest construction companies in Sweden (Skanska, NCC and Peab) actively engage in partnering projects and report positive results. JRM should be included in such partnering arrangements and include the following activities:

- Joint risk identification and assessment in early phases of projects;
- Joint preparation of risk registers and risk mitigation plans;
- Continuous updates of risk registers and mitigation plans;
- Proactive and joint management of new and changing risks.

The extent that these activities and JRM are adopted in practice in Swedish construction projects has not yet been rigorously explored. However, a number of studies on collaborative relationships have shown that partnering is still rare in Sweden. A survey by Eriksson and Laan (2007) revealed very limited use of collaborative practices in Swedish construction projects, and the following main obstacles to increased collaboration have been identified (Eriksson *et al.* 2008): a conservative culture, adversarial attitudes, short-term perspectives, traditional organisation of the construction process and traditional procurement procedures. Without overcoming these barriers, it will be impossible to foster collaborative environments that support JRM in projects.

The latest government report on the current Swedish construction industry (Gustavsson *et al.* 2009) states that no significant improvements have occurred in recent years. This is partly attributed to low incentives for process improvement and development in construction companies, leading to difficulties in implementing changes and new concepts, communication problems and poor collaboration between key actors. These problems are argued to have strong, adverse effects on construction costs. However, the report also criticises current partnering practices, as the construction practitioners still do not have enough competence for effective collaborative partnership.

This study is a part of a broader research project aiming to develop and test a JRM model that can be used to guide JRM activities and thus enhance project success. In the future two case studies will be performed to explore how JRM works in practice. Case study data will be collected through document studies, observations of JRM workshops and interviews with key project actors (clients, consultants and main contractors).

5. CONCLUSIONS

Different actors often have different perceptions of risk allocation in construction projects and conflicts between the actors may arise that impair the final results.

Moreover, risks are dynamic, i.e. identified and allocated risks may change during project implementation and new risks may emerge. JRM is an approach based on collaborative efforts to manage risks throughout projects' lifecycles. Clearly, it requires an effective collaborative project environment, which is a weakness in current practice. There is limited use of collaborative practices, and a number of significant obstacles prevent the industry moving towards effective collaboration. Both procurement-related factors (a total cost perspective during partner selection, long-term agreements and careful consideration of technical expertise and managerial competence) and relationship-related factors (mutual trust, openness and commitment) must be addressed to foster effective application of JRM. The latest government report on the current state of the Swedish construction industry highlights a lack of collaboration in projects, but also criticises current collaborative agreements, such as partnering, mainly due to the lack of competence among the project actors for effective partnering and consequent failures to reduce construction costs. Thus, research that increases knowledge about optimal ways to incorporate systematic JRM throughout project's lifecycles should be beneficial for all actors. A conservative culture is another important obstacle that prevents development, but changing it will be time-consuming and progress is likely to be slow.

The main conclusion of this study is that there is substantial room for improvements regarding collaboration in projects generally and JRM in particular. However, the Swedish construction industry is clearly not sufficiently efficient to expect rapid progress. Further research in this area is needed to facilitate JRM activities that are required for improving the overall performance of construction projects.

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Paper III

The effects of cooperative procurement procedures on joint risk management in Swedish construction projects

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The effects of cooperative procurement procedures on joint risk management in Swedish construction projects

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Abstract: The paper reports the results of a questionnaire survey and a case study about the effects of cooperative procurement procedures on joint risk management (JRM). The purpose is to investigate how common the use of JRM is in Sweden and how the occurrence is affected by the utilised procurement procedures. The results show a limited use of JRM in Sweden, but clients that work on a national/international level use JRM to a greater extent than those on local/regional markets. The use of JRM is positively affected by cooperative procurement procedures. In particular, the most significant relationship has been found between collaborative tools and JRM – the higher the use of collaborative tools, the higher the use of JRM. The case project is used as an illustrative example where the project management team tried to overcome the traditional construction culture by using a cooperative procurement approach and creating a collaborative environment that supports JRM.

Keywords: joint risk management; JRM; procurement; collaboration; construction industry; questionnaire survey; case study; Sweden.

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1 Introduction

If risk involved in a construction project is not managed properly, this may result in a significant negative impact on the final outcome. Thus a systematic risk management (RM) process is an important instrument that safeguards project objectives. However, research in the construction management field indicates that RM is seldom carried out systematically throughout projects, resulting in cost overruns, time delays and quality problems in the UK (Akintoye and MacLeod, 1997), Australia (Lyons and Skitmore, 2004), China (Tang et al., 2007) and Sweden (Osipova, 2008; Simu, 2006).

In the beginning of a project a great deal of effort is usually spent on identification and allocation of risks among the project actors. Several empirical studies show that efficient risk allocation is difficult due to the actors' conflicting perceptions of to whom a specific risk should be allocated (Loosemore and McCarthy, 2008). Usually, contractors bear the majority of risks (Wang and Chou, 2003) and price them by adding a contingency to the bid price (Andi, 2006). Conscious allocation of risks allows reducing the contingency funds and, therefore, the total cost (Zack, 1996). However, even conscious risk allocation does not guarantee that no conflicts occur in the project, since the identified risks may change and new risks may appear during the project implementation. Very often these unplanned changes and unforeseen risks may require the actors' joint efforts, i.e., joint risk management (JRM), to be managed effectively. A survey study conducted by Hartman et al. (1997), indicates that practitioners are in favour of JRM instead of allocating risk to a specific actor. The results of a Hong Kong survey (Rahman and Kumaraswamy, 2002) confirm these findings – the majority of risk items listed in the survey were suggested for JRM. Moreover, JRM was identified by practitioners as the best strategy for managing unforeseen risks and risks that change during the project implementation (Rahman and Kumaraswamy, 2005). JRM should, therefore, be a vital part of cooperative relationships, such as partnering (Kumaraswamy et al., 2004).

Despite the visible advantages of collaborative management of risk, it is often the case that each actor is focused on her/his own part of the project and management of associated risks. Traditional procurement procedures based on formal contracts are often seen as a main barrier to effective collaboration (Kadefors and Badenfelt, 2009). Moreover, in traditional procurement there is more focus on price and short-term result rather than collaboration and long-term relationship (Eriksson et al., 2008). On the contrary, procurement procedures that underpin collaboration may have a positive effect on JRM (Rahman, 2003). Although a great deal of research has been carried out in Sweden and in other countries about cooperative relationships, there is a lack of investigations explicitly focusing on the nature and occurrence of JRM. The purpose of

this research is therefore to investigate how common the use of JRM is in Sweden and how the occurrence is affected by the utilised procurement procedures.

The study is based on the results of a questionnaire survey of Swedish construction clients and a case study. Through the literature review six hypotheses were formulated, predicting positive effects of cooperative procurement procedures on the use of JRM. The hypotheses were then statistically tested in order to find out what procedures play the most significant role for JRM implementation. The aim of the case study was to further investigate the nature and use of JRM and how JRM was affected by the cooperative procurement procedures in the project.

2 Literature review and hypotheses formulation

Over the last decade, researchers and practitioners have recognised that the relationships between the clients and contractors play a significant role for successful project implementation. Adversarial and opportunistic behaviour that is common in the construction industry (Cox and Thompson, 1997) leads to many conflicts when unforeseen events occur in the project. To overcome adversarial behaviour the concept of relational contracting (RC) has been explored extensively in the research literature and in practice. RC focuses on the relationship between the contract parties and recognises mutual benefits and win-win scenarios through cooperation in the project. RC supports such cooperative arrangements as partnering and facilitates team working and JRM (Rahman, 2003). In this research the following definition of JRM is used: "JRM is a dynamic management of risks at the post-contract stage based on RC principles" (Kumaraswamy et al., 2004). Dynamic management means that risks are continuously identified and evaluated throughout the project. RM based on RC principles means that risks are managed in collaboration, focusing on what is best for the project rather than suboptimising the situation for each specific actor. In order to enhance the establishment of RC and JRM, cooperative procurement procedures are required (Eriksson and Laan, 2007, Kumaraswamy et al., 2004). Through the literature review six hypotheses were formulated about the relationships between various cooperative procurement procedures and the use of JRM.

In recent years collaboration through partnering has been widely applied in many countries (Bayliss et al., 2004). Partnering is argued to be a means to overcome adversarial relationships and create collaborative project environments. Several studies show that industry practitioners are positive about collaborative relationships and believe they lead to cost and risk reduction (Akintoye and Main, 2007; Black et al., 2000; Karlsen et al., 2008). Drexler and Larson (2000) show that relationships in partnering projects are much more stable than in other types of projects. Such cohesion among project actors is important when dealing with unforeseen risks (Floricel and Miller, 2001). As JRM requires collaborative effort of project participants, partnering can be considered as a procurement strategy that facilitates JRM:

Hypothesis 1 Collaboration through partnering is positively related to the use of JRM.

From the perspective of dealing with risks, early involvement of contractors and consultants is considered to be advantageous (Kumaraswamy et al., 2004). It allows utilisation of their competence and expertise from the very beginning, which, in turn,

leads to better understanding of project risk. Such a team, containing participants with different competences, enhances creative risk responses, which are crucial for efficient JRM (Floricel and Miller, 2001). Cooperative work of the architects and contractors results in better technical specification and minimisation of many design and technical risks. Moreover, significant savings are possible in the beginning of a project, since changes in the early phase cost less money than in the production phase (Uher and Toakley, 1999). Thus, the second hypothesis assumes:

Hypothesis 2 Joint technical specification by client, contractor and consultants is positively related to the use of JRM.

The focus on price when evaluating project bids is a common approach in the construction industry (De la Cruz et al., 2006; Eriksson and Laan, 2007; Tan et al., 2008). At the same time clients often neglect soft evaluation parameters, such as previous experience with contractor, contractor's resources and competence, size and financial stability, attitudes towards changes and continuous improvement, references, and collaborative ability (Eriksson, 2008). There are a lot of examples of poor contractor selections that led to significant cost overruns for clients as the chosen contractors tried to find ways to decrease their own cost (Branconi and Loch, 2004), or worse, were not competent enough. In order to create a successful collaborative environment that supports JRM, these soft/relational parameters must be taken into account when making careful partner selections (Kumaraswamy et al., 2004). Thus, the next hypothesis is formulated:

Hypothesis 3 Consideration of soft parameters during the partner selection process is positively related to the use of JRM.

Today subcontractors carry out the largest part of the construction work, which results in multiple points of responsibility and difficulties in risk communication (Loosemore and McCarthy, 2008). Main contractors often have an arm-length approach towards subcontractors, leaving them out of cooperative relationships even when client-contractor relationships are collaborative (Alderman and Ivory, 2007). In order to better control the whole supply chain, clients should get involved in the selection of subcontractors and integrate them in the project team (Caldwell et al., 2009). A survey conducted by Rahman and Kumaraswamy (2004) indicates positive attitudes towards involving subcontractors and suppliers in the team very early in the project, before the construction contract is awarded. This helps in facilitating an effective project briefing based on joint problem solving and better understanding of the project's objectives:

Hypothesis 4 Joint procurement of subcontractors by client and main contractor is positively related to the use of JRM.

The RC approach highlights the importance of contract incentives in order to facilitate collaboration in problem solving. Some payment mechanisms, for example, lump sum, shift all risk and responsibility to one actor and do not underpin possibilities for performance improvement (Floricel and Miller, 2001). Muller and Turner (2005) indicate that lump sum contracts have adverse effects on communication between client and contractor. On the contrary, in incentive-based schemes client and contractor share the risks and rewards (Floricel and Miller, 2001). When incentives are used, rational decision makers tend to put effort in minimising risk so they can get a reward (Knight et al., 2001). Moreover, they prefer to cooperate when tangible rewards for problem solving are provided (Wong et al., 2008). Turner and Simister (2001) therefore argue that projects

which are based on cooperation and not on conflict require incentivisation of all involved actors. Thus, it is predicted:

Hypothesis 5 Cost-reimbursable payment mechanisms with incentives or bonuses are positively related to the use of JRM.

Various joint activities and collaborative tools are available for creating and supporting collaborative project environments (Bayliss et al., 2004; Black et al., 2000). Some examples are: establishment of joint objectives, relational workshops, joint project database, team building activities, joint project office, and partnering facilitator. These joint actions and socialisation activities increase the participants' commitment to the team and the project, which according to Floricel and Miller (2001) is important for JRM. Usually, the use of collaborative tools is limited in construction projects (Eriksson, 2008) although they enhance cooperative relationships and JRM:

Hypothesis 6 The use of collaborative tools in the project is positively related to the use of JRM.

3 Research approach

3.1 Questionnaire survey

The first part of the empirical study is a questionnaire survey of construction client organisations that are members of the Swedish Construction Clients Forum. Similar to the Swedish construction industry, this population consists of a broad spectrum of clients: regional, national and international industrial and property companies, municipal and regional authorities, and government services and agencies. Hence, it provides a suitable representation of Swedish construction clients. At the first stage, a letter with information about the survey, its purpose and importance for the construction clients, was send by the CEO of the Forum to the 140 organisation members. At the second stage, the registered contact persons were telephoned, in order to inquire their (or another more suitable person's) willingness to participate in the survey study on behalf of their organisations. Hence, it was up to the contact person to choose the most suitable person, given that the survey involved procurement and project management. At this stage, six organisations declined to participate due to lack of time. Finally 134 questionnaires were sent and 111 responses were received after two reminders. From obtained responses five were excluded due to the significant number of missing values. From the population of 140 organisations, 106 usable questionnaires were received resulting in a response rate of 76%. The respondents were procurement managers, project managers, or directors of the construction and facilities departments in these organisations. Because the six respondents that declined participation referred to lack of time as their reason, it is likely that the other non-responses as well as the late responses (received after one or two reminders) are due to the same reason. Thus, it seems plausible to analyse potential non-response bias by comparing early and late responses (Armstrong and Overton, 1977). This comparison indicated no problems since answers from firms responding early and firms responding late were not significantly different.

The survey questions regarding procurement procedures were based on a previously conducted survey presented in Eriksson and Laan (2007) and Eriksson (2008). The

questions were not focused on a particular project but on the clients' procurement procedures in general (for a sample questionnaire, see Appendix). The survey included all procurement procedures discussed in the hypotheses. Responses to the questions were rated on a seven-point Likert scale ranging from 1 = very seldom, to 7 = very often. In addition, three control variables were measured through nominal scales. These variables concerned the type of client (local/regional client vs. national/international client, and private vs. public client); the type of construction work procured (new construction/rebuild project vs. maintenance/refurbishment); and whether the client follows public procurement regulation or not; see Table 1.

Table 1 Descriptive statistics of the client organisations

Sample size	*Clients' market size*		*Type of work procured*		*Public procurement act*	
	Local/ regional	*National/ international*	*New construction/ rebuilding*	*Maintenance/ refurbishment*	*Yes*	*No*
106	72	34	95	11	64	42

When the completed questionnaires had been collected by mail, the data was entered into the Statistical Package for Social Science (SPSS). All questions were converted into variables and each answer alternative was coded using value labels. In order to test hypotheses, relationships between the dependent variable 'use of JRM' and independent variables 'procurement procedures' were modelled using hierarchical regression analysis. SPSS was also used to examine residuals and outliers in order to test the assumption of normal distribution, which regression analyses require. Both the frequency distribution of the standardised residuals and the normal probability plot of regression standardised residuals indicate that the assumption of normal distribution is not violated.

3.2 Case study

In order to enhance comparisons between the empirical data and the conceptual arguments, it is important to select a critical case (Yin, 1994) that is governed through explicit use of JRM. The chosen case study formed the second part of the empirical investigation and focused on JRM practices in an ongoing project procured by a private client active on a national level in Sweden. The project comprises new construction of a laboratory facility consisting of two buildings in Stockholm. The project was procured on a design-bid-build basis with an additional collaboration agreement between the client and contractor. The contract sum is approximately 700 MSEK (~70 M €). Construction started in 2007 and the facility was finished in December 2009. Eleven in-depth interviews with the main project actors were conducted. From the client side, it was a project manager, three construction managers and a design manager; from the contractor side a project manager, site manager and construction engineer; and from the consultant side an architect, and two technical consultants. Each interview took approximately one and a half hours and consisted of three main parts. First, the respondents described the project and their roles. Then the main terms of RM were discussed. Next, the discussion about JRM, project procurement and relationships among actors was held. In particular, the interviewees were asked to describe how they worked with risks, how JRM

workshops were organised, how they collaborated in the project and to outline advantages and disadvantages of the current project organisation. In addition to the interviews, the researcher participated as an observant in two JRM workshops. Finally, RM documentation and collaboration agreement were studied. This created an in-depth picture of how JRM was carried out in the project.

To increase reliability (transparency and future replication), all interviews were tape recorded and case study protocols were constructed with the aim of facilitating retrieval for future studies (Yin, 1994). There are three main uses for case study research: motivation, inspiration, and illustration (Siggelkow, 2007). This case study has been used not only for illustration but also for motivation reasons, giving further empirical support and explanations to the conceptual hypotheses. The qualitative data formed an empirical data pattern, which described why and how the procurement procedures were used in the case study project. The empirical pattern was compared to the theoretical predictions in order to investigate differences and similarities between the process data and theory, i.e., a pattern-matching analysis (Yin, 1994).

4 Results of the questionnaire survey

To fulfil the first purpose of this research – measure the extent of JRM in the Swedish construction projects – the mean value of the dependent variable was calculated. The results indicate a limited use of JRM, as the average score is 3.1 on a seven-point scale.

In order to test the hypotheses a two-step hierarchical regression was performed, analysing the effects of

1 the control variables, i.e., characteristics of the client

2 the cooperative procurement procedures, on the use of JRM.

In Table 2 the items of the cooperative procurement procedures are presented. Reliability in terms of Chronbach alpha (CA) is satisfactory for the multi-item constructs 'soft parameters' and 'collaborative tools' whereas 'incentive-based compensation' is slightly below the suggested cut-off value 0.70 for a reliable scale.

In Step 1 of the hierarchical regression the three control variables were included: public procurement regulation, type of work (new construction/rebuilding) and area of the client's activity (local/international). Model 1 therefore involves the control variables' effects on the use of JRM. In Step 2, the six different procurement related constructs were added. Model 2 therefore involves both the effect of the control variables and the effect of cooperative procurement procedures on the use of JRM. The results of this regression analysis show that both models are statistically significant (Table 3). For Model 1, R square change is 0.105 and significant at the 0.01 level. This means that the control variables have a small but definite effect (Hair et al., 2006) and that they explain 10% of the variation in the use of JRM. For Model 2, R square change is 0.379, i.e., almost 40% of the variation in the use of JRM can be explained by the combination of the cooperative procurement procedures, indicating a moderately strong relationship (Hair et al., 2006). Hence, the more the whole range of cooperative procurement procedures are used, the higher the use of JRM.

Table 2 Items and measurements of procurement procedures

Procurement procedures	*Measurements*
Joint specification	X1: Client, consultants and contractor work jointly with design
X1 – (X2 + X3)/2	X2: Client and/or consultant perform design work
CA = N/A	X3: Contractor performs design work
Soft parameters	X4: Earlier experiences of the bidder
(X4 + X5 + X6 + X7 + X8 + X9 + X10)/7	X5: Project organisation and staffing
CA = 0.89	X6: Company size and financial stability
	X7: Attitudes towards change
	X8: References relating to similar projects
	X9: Collaborative ability
	X10: Technical competence
Joint subcontractor selection	X11: Client and main contractor select subcontractors jointly
X11 – (X12 + X13)/2	X12: Client selects subcontractors
CA = N/A	X13: Contractor selects subcontractors
Incentive-based compensation	X14: Fixed price (reversed scale)
(rev scale X14 + X15 + X16)/3	X15: Reimbursement coupled with incentive/bonus
CA = 0.66	X16: Open book accounting of costs
Collaborative tools	X17: Formulation of joint objectives
(X17 + X18 + X19 + X20 + X21 + X22 + X23)/7	X18: Follow-up workshops
CA = 0.81	X19: Dispute resolution techniques
	X20: Joint project office
	X21: Joint IT-tools
	X22: Team building activities
	X23: Partnering facilitator
Partnering arrangement	X24: Explicit collaborative project governance (e.g., partnering)

Table 3 Regression analysis

Model	*Change statistics*				
	R square change	*F change*	*df1*	*df2*	*Sig. F change*
1	0.105	3.981	3	102	0.010
2	0.379	11.749	6	96	0.000

Table 4 presents detailed statistics regarding all independent variables, relevant for the test of the hypotheses. When looking at the standardised regression coefficients we see that the relationships between the use of JRM and the specific procurement procedures are non-significant at the 0.05 level in five cases, suggesting that the first five hypotheses are rejected. Only the relationship between the use of collaborative tools and the use of JRM is positive and significant at the 0.01 level. The standardised regression coefficient is 0.418 for collaborative tools, indicating an increase of 0.418 in the use of JRM for every one-unit increase in the use of collaborative tools, when all other independent variables are held constant. Thus, Hypothesis 6 is confirmed: the higher the use of

collaborative tools, the higher the use of JRM. Before accepting these results, it is reasonable to look for multi-collinearity problems that may influence the regression by interpreting the collinearity statistics. In the right column of Table 4, the VIF-values are lower than 3.0 for all independent variables, which is considerably lower than the rule of thumb of 5.0 (Hair et al., 2003). We can therefore conclude that correlations among independent variables do not seem to be a problem in our regression model.

Table 4 Coefficients

Model		*Unstandardised coefficients*		*Standardised coefficients*	*t*	*Sig*	*Collinearity statistics*	
		B	*Std. error*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	1.538	0.820		1.877	0.063		
	Public procurement regulation	0.328	0.410	0.091	0.801	0.425	0.684	1.462
	New construction/ rebuilding or maintenance work	–0.185	0.545	–0.032	–0.340	0.735	0.994	1.007
	Local/regional or national/ international market	0.993	0.429	0.262	2.313	0.023	0.684	1.462
2	(Constant)	–0.874	1.080		–0.809	0.420		
	Public procurement regulation	–0.031	0.346	–0.009	–0.090	0.928	0.587	1.703
	New construction/ rebuilding or maintenance work	0.294	0.447	0.051	0.658	0.512	0.908	1.102
	Local/regional or national/ international market	0.961	0.351	0.254	2.737	0.007	0.627	1.596
	Partnering	0.198	0.125	0.198	1.579	0.118	0.343	2.915
	Joint specification	0.070	0.086	0.086	0.815	0.417	0.479	2.088
	Soft evaluation parameters	0.020	0.136	0.013	0.147	0.884	0.713	1.403
	Joint subcontractor selection	0.043	0.086	0.053	0.500	0.618	0.479	2.086
	Incentive-based compensation	–0.064	0.166	–0.046	–0.385	0.701	0.378	2.646
	Collaborative tools	0.631	0.167	0.418	3.783	0.000	0.440	2.272

In Model 1, the variable ‘area of the client’s activity’, i.e., if the client is active on a local/regional market or a national/international market, has a statistically significant Beta value of 0.262. Hence, an additional analysis was conducted to see what type of clients use JRM more actively. A One-way ANOVA compare means test (Table 5) shows that the clients working on a national/international market use JRM to a larger extent (mean value = 3.9) than those who work locally/regionally (mean value = 2.7).

Table 5 Comparison of means

	N	*Mean*	*Std. deviation*	*Std. error*	*95% confidence interval for mean*	
					Lower bound	*Upper bound*
Local/ regional market	72	2.7222	1.63778	0.19301	2.3374	3.1071
National/ international market	34	3.9118	1.81522	0.31131	3.2784	4.5451
Total	106	3.1038	1.77780	0.17267	2.7614	3.4462

5 Results of the case study

The case study provides some more illustrative insights regarding the six hypothesised relationships between cooperative procurement procedures and the use of JRM, as described below.

Despite the fact that the project was not performed as a formal *partnering* project, the client and contractor together developed a collaborative agreement where the main principles of their work and relationships were listed. The collaborative approach was used throughout the project in order to increase efficiency and improve relationships among the actors. Due to many changes from the future tenant during the project execution, there was a significant time pressure in the project. The actors agreed that collaborative attitudes were a must in order to meet these tough deadlines and jointly manage risks.

> "It is people we work with, not companies. We decided to have a very good collaboration and we had it!" (Client's project manager)

> "Today it is very common 'to like partnering' no matter if you really like this way of working. It does not work, you must have real feeling, spirit and culture of partnering." (Client's construction manager 2)

> "Usually it is hard to collaborate when one actor makes a mistake. We overcame this difficulty by joint discussions and a collaborative approach to problem solving." (Contractor's project manager)

As the project was procured on a design-bid-build basis, the *technical specification* was completed by the client and consultants before the main contractor was appointed. However, design work continued throughout the project, which allowed the main contractor to participate in discussions about technical solutions during construction meetings and JRM workshops. All actors agreed that this participation was necessary in the project due to its complexity.

> "In this project we reached very good risk management. We worked together with the client and designers and discussed different solutions on the basis of our joint competence and experience." (Contractor's project manager)

However, parallel design and construction is not unproblematic in terms of resources. The client pointed out some lack of commitment from the contractor when it came to design work.

> "We always invited the main contractor to the design meetings, but it was often the case that design was not their priority." (Client's design manager)

During the discussion with project participants about possible obstacles to collaboration and JRM, the lack of competence and traditional adversarial attitudes were identified as the most important barriers. The client mentioned that despite the importance of price in the bid evaluation process, soft parameters in *partner selection* play a vital role for successful relationships. Therefore the contractor's expertise as well as collaborative abilities was considered in the procurement. Although the actors did not have a previous work experience with one another, they evaluated the developed project relationship as very good.

> "During procurement of the main contractor we paid a lot of attention to its organisation. Budget is budget, but organisation is a very important parameter." (Client's design manager)

Personal characteristics of the project team members also play an important role in the achievement of a good relationship. In the project two members of the management team were replaced due to their inability to maintain a relationship without conflicts.

> "It is important to dare to replace people. It hurts but the consequences if they continue in the same way are much worse." (Client's project manager)

The traditional approach of *subcontractor procurement* was used in the project, i.e., the main contractor was responsible for the process. Moreover, the subcontractors did not participate in JRM and the collaboration workshop. One of the reasons for excluding subcontractors was a risk of getting too large a group, which would decrease the possibility to work effectively in workshops.

> "There is an old tradition of excluding subcontractors from the main collaboration group. For the main contractor procurement of subcontractors is a possibility to earn money." (Client's construction manager 1)

However, the construction managers from the client's side had a lot of technical collaboration with subcontractors during the production phase.

> "Even if subcontractors do not participate in JRM workshops, I always talk to them about risks that are related to their concern and competence. I actually work much more with the subcontractors than with the main contractor." (Client's construction manager 2)

Cost-reimbursable payment mechanism with performance-related bonus was chosen in the project. The client thinks that this makes it possible to motivate the main contractor to achieve better results and cost savings in the project. The actors also agreed that irritating financial discussions that often accompany projects with lump-sum payment mechanisms do not facilitate a collaborative environment.

> "The chosen payment mechanism is extremely important; the use of incentives makes collaboration much easier." (Client's project manager)

> "With all programme changes from the tenant we would normally be stuck in financial discussions with the main contractor, but now with the cost-reimbursable mechanism we focus on joint solutions." (Client's construction manager)

The following *collaborative tools* were used in the project: joint project database, team building activities, establishment of joint objectives, relational workshops, JRM

workshops, partnering questionnaire, and partnering facilitator. According to the actors, relational workshops and JRM workshops were the two most important tools facilitating a good collaborative environment and effective RM.

After the contract was awarded to the main contractor, a relational workshop between the client and contractor was organised. During the workshop objectives of both parties were discussed and joint objectives as well as methods to achieve these objectives were identified. The 'statement of joint objectives' was signed by the workshop participants and reviewed every three months. During the following workshops the participants discussed the collaborative environment and the achievement of the joint objectives. In order to evaluate the project environment each participant answered a short anonymous questionnaire survey. The survey answers were then analysed by a partnering facilitator and presented during the next workshop. The actors strongly believed that the workshop was an effective method for facilitating good relationships.

> "The actors strongly desired that the project relationships work properly. Everyone was interested in succeeding and liked this way of working". (Contractor's site manager)

JRM workshops were initiated at the same time, after the main contract was awarded. The participants in the JRM workshops included not only the client and main contractor but also the architect and other consultants. During the first JRM workshop the participants were divided into several expertise groups. Each group had an assignment to come up with a list of possible risks. Then the risks were discussed by the whole group and a risk register of approximately 50 risks was completed. The risk register contained the following information: name of the risk, probability of occurrence from 1 to 5, possible consequence if risk occurs from 1 to 5, risk rating from 1 to 25 (multiplication of probability and consequence), actor who is responsible for the risk, and description of risk response. Follow-ups of JRM workshops were held every third month. At the workshops the participants went through the risk register and discussed how risks had changed since the last meeting. New assessments of probability and consequences were made based on a joint discussion. All actors regarded the JRM workshops as important and were very proud to achieve well-functioning JRM.

> "It is better to have ten risks identified by ourselves than 100 risks identified by an external consultant." (Contractor's project manager)

> "JRM workshop is a method to locate the risks before they trigger. Through joint discussion and our own work we all get a better understanding." (Architect)

The opinions about the need for a partnering/collaboration facilitator were contradictory. Some actors said that it is necessary to have a person who has a good knowledge of collaborative tools and methods for their analysis.

> "I think we need such a person, since the rest of us are too technology-oriented and have no idea about assessment and management of relationships." (Client's design manager)

Other actors argued that external partnering facilitators that have no inside knowledge of the project cannot contribute to better collaboration.

> "It will never work if an external consultant comes and teaches us how to work together. The consultant has no idea if we were friends or enemies last week." (Contractor's project manager)

6 Discussion

6.1 Questionnaire survey findings

The empirical results show that the use of JRM is limited in Sweden (mean value 3.1), but that national clients use JRM to a greater extent (3.9) than local clients (2.7). Potential reasons for this difference may be that national/international clients identify and adopt management trends from other countries faster than local clients. This line of reasoning assumes that JRM is more common in other countries (e.g., the UK, USA, and Hong Kong) due to larger and more complex projects, nature related phenomena (e.g., earth quakes and hurricanes), and a higher number of litigations than in Sweden. Another reason for the more frequent use of JRM can be that larger companies allocate more human resources to the development and improvement of management activities and have a broader competence related to project management practices such as JRM.

As a group, cooperative procurement procedures enhance the implementation of JRM. However, collaborative tools are the only individual procedure that has significant effects on the use of JRM. The fact that collaborative tools were found to have a positive effect on the use of JRM, confirming Hypothesis 6, is in line with the earlier research, which indicates that a collaborative project environment is a necessary condition for an effective JRM process (Rahman and Kumaraswamy, 2008). In fact, JRM may be viewed as one of the items in the collaborative tools construct. A factor analysis of all collaborative tools items including JRM supports this view since only one factor is formed. Furthermore, the Cronbach alpha value of the collaborative tools construct increases from 0.81 to 0.84 if JRM is included, confirming the view that JRM can be seen as a vital element of this cooperative procurement procedure. More surprising, however, is that the first five hypotheses are rejected. The case study findings provide more insights regarding the connections between cooperative procurement procedures and JRM.

6.2 Case study findings

Despite the fact that the client in the case project did not utilise all cooperative procurement procedures identified in the hypotheses, JRM was actively implemented in the project. A collaborative agreement (similar to partnering) with the contractor resulted in a partnership spirit that, in turn, contributed to stable relationships and a joint approach to RM. The partner selection focused on the ability of the contractor to cooperate and jointly solve possible problems. This consideration resulted in high client satisfaction regarding the chosen main contractor, which made it easier to develop a pleasant working environment. The payment mechanism with incentives raised the motivation of the main contractor to decrease the project cost by finding the best suitable solutions and cooperating with other project actors. Moreover, incentive-based schemes contributed to JRM when all actors were interested in minimising risk instead of shifting it to one another. The use of collaborative tools, especially of joint workshops, was very strong in the case project. A lot of attention and time was spent by the project management team on assuring efficiency and consistency of relational and JRM workshops. The enthusiasm and willingness of all actors made these tools powerful, resulting in a more effective RM process.

The arrangement of parallel relational and JRM workshops further supports the argument that JRM can be viewed as a vital part of collaborative tools. The case study also illustrates the questionnaire survey's finding that together cooperative procurement procedures result in a higher degree of JRM in construction projects. The only cooperative procurement procedures discussed in the literature review that were not utilised by the client were joint technical specification and joint procurement of subcontractors. The case study findings hence suggest that the rejection of Hypotheses 2 and 4 may be correct, since JRM can be successfully performed without early involvement of contractors and subcontractors. The case study findings do, however, suggest that collaborative arrangements (e.g., partnering), careful partner selection based on soft parameters, and incentive-based compensation do facilitate the implementation of JRM, which is somewhat contradictory to the survey findings and the rejections of Hypotheses 1, 3, and 5. Further research on this matter is therefore required.

7 Conclusions

This paper contributes to theory and practice by reporting results from a unique quantitative survey, examining the relationships between procurement procedures and the use of JRM, and by providing deeper insights regarding these relationships in an investigated construction project. Through a literature review six hypotheses were developed, predicting that the use of JRM is positively affected by the following cooperative procurement procedures: collaboration through partnering; joint technical specification by client, contractor and consultant; cost-reimbursable payment mechanism with incentives/bonuses; consideration of soft parameters during partner selection process; joint procurement of subcontractors by the client and main contractor; and the use of collaborative tools.

The results from the survey study constitute the main theoretical contributions of the paper. These findings show that the use of JRM is limited in Sweden, but that national clients use JRM to a greater extent than local clients. This difference may be explained by variations in abilities and willingness to identify and implement 'new' project management practices such as JRM. The survey results also show that cooperative procurement procedures as a group have a significant impact on JRM, but that the use of collaborative tools is the only single procedure that has a significant effect on its own. A theoretical contribution of the paper is that JRM in fact can be viewed as one important element of the collaborative tools, which has been neglected in earlier research. The rejections of all the other five hypotheses are somewhat surprising and the case study findings provided some useful insights into why certain procedures may or may not affect the implementation of JRM.

The case study results further highlight the importance of cooperative procurement procedures for the use of JRM. Those cooperative procurement procedures that were used in the project, i.e., collaborative agreement (similar to partnering), consideration of soft parameters during the partner selection process, incentive-based payment mechanism, and the extensive use of collaborative tools, facilitated the implementation of JRM. To involve a partnering facilitator that guides the joint activities of a project team can be one solution to increase collaboration and promote the use of JRM. In order to overcome adversarial relationships, cooperative procurement procedures are to be utilised as they underpin the principles of RC. The case study findings contradict the rejections of

Hypotheses 1, 3, and 5; a collaborative approach including careful partner selection and incentive-based payments does enhance the implementation of JRM. The rejections of Hypotheses 2 and 4 are however in line with the case study findings, since JRM can be performed without early involvement of contractors and subcontractors.

The contradictory results regarding Hypotheses 1, 3, and 5 may be due to limitations in the survey study. The quantitative data was obtained only from clients. Future investigations into attitudes of contractors, subcontractors, and consultants would contribute to better understanding and a more holistic view. Future surveys should also aim to target larger samples and use multi-item scales for the measurement of JRM.

From a practical perspective, the lack of a cooperative approach is a weakness in current procurement practices and this aspect must be addressed in order to achieve an effective JRM process. The results are expected to increase industry practitioners' awareness of the importance of cooperative procurement procedures, and, therefore, assist construction clients in choosing an appropriate procurement approach that underpins a collaborative environment and JRM.

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Appendix

A sample questionnaire

1 Who performs the technical specification of the product that the construction process involves?

	Very seldom						*Very often*
Client and/or consultant	☐	☐	☐	☐	☐	☐	☐
Main contractor	☐	☐	☐	☐	☐	☐	☐
Jointly by client, consultant and contractor	☐	☐	☐	☐	☐	☐	☐

2 How important are the following evaluation parameters when choosing a main contractor?

	Unimportant						*Very important*
Earlier experiences of the bidder	☐	☐	☐	☐	☐	☐	☐
Project organisation and staffing	☐	☐	☐	☐	☐	☐	☐
Company size and financial stability	☐	☐	☐	☐	☐	☐	☐
Attitudes towards change	☐	☐	☐	☐	☐	☐	☐
References relating to similar projects	☐	☐	☐	☐	☐	☐	☐
Collaborative ability	☐	☐	☐	☐	☐	☐	☐
Technical competence	☐	☐	☐	☐	☐	☐	☐

3 Who chooses and procures subcontractors?

	Very seldom						*Very often*
Client	☐	☐	☐	☐	☐	☐	☐
Main contractor	☐	☐	☐	☐	☐	☐	☐
Jointly by client and main contractor	☐	☐	☐	☐	☐	☐	☐

4 To what extent do you use the following payment mechanisms when procuring a main contractor?

	Very seldom						*Very often*
Fixed price	☐	☐	☐	☐	☐	☐	☐
Reimbursement	☐	☐	☐	☐	☐	☐	☐
Reimbursement with incentives/bonus	☐	☐	☐	☐	☐	☐	☐

5 To what extent do you use the following tools in order to increase collaboration between the project actors?

	Very seldom						*Very often*
Formulation of joint objectives	☐	☐	☐	☐	☐	☐	☐
Follow-up workshops	☐	☐	☐	☐	☐	☐	☐
Dispute resolution techniques	☐	☐	☐	☐	☐	☐	☐
Joint project office	☐	☐	☐	☐	☐	☐	☐
Joint IT-tools	☐	☐	☐	☐	☐	☐	☐
Team building activities	☐	☐	☐	☐	☐	☐	☐
Partnering facilitator	☐	☐	☐	☐	☐	☐	☐

6 To what extent do you procure your construction projects based explicitly on partnering or similar collaborative approach?

Very seldom						*Very often*
☐	☐	☐	☐	☐	☐	☐

Paper IV

Balancing control and flexibility in joint risk management: Lessons learned from two construction projects

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Balancing control and flexibility in joint risk management: Lessons learned from two construction projects

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Abstract

Joint risk management (JRM) is an approach that highlights the importance of collaboration between the project actors in managing risk that cannot be identified at the outset of the project. Despite the recognition of the concept in the literature, the use of JRM in practice seems to be rare. Based on contingency theory, we investigate how mechanistic (control-oriented) and organic (flexibility-oriented) management systems influence the implementation of JRM in two construction projects. In the first project, the actors managed to achieve a balance between control and flexibility, which paved the way for successful JRM. The extensive use of control in the second project hampered flexibility and constrained the use of JRM. We conclude that JRM requires both control for managing risk that has been identified and flexibility for dealing with unforeseen events. When a mechanistic approach is dominant, risk management remains a formal process carried out individually rather than collaboratively.

Keywords: Managing risk; Engineering and construction; Contingency theory; Control; Flexibility; Joint risk management

1. Introduction

Risk management (RM) is an integral part of project management. A great deal of research about risk management has been focused on the development and assessment of models and tools for dealing with project risk (e.g. Baccarini and Archer, 2001; Baloi and Price, 2003; Chapman and Ward, 2003; Del Cano and De la Cruz, 2002). Despite the variety of available tools and techniques, RM is often criticized for being inadequate (e.g. Osipova and Eriksson, 2011a; Tang et al., 2007) and not achieving its main objective — to bring more certainty to a project by minimizing threats and maximizing opportunities. While some risks can be foreseen at the beginning of a project and allocated among the project actors, other risks are difficult to predict. For example, in their early stages, the majority of construction projects are very abstract and involve risks that are derived from uncertainty about project scope, organizational structure, the responsibilities and liabilities of different actors etc. These risks are difficult to allocate between the parties at the project outset. Moreover, even risks that have been identified and allocated may change in scope and require different types of response. In order to manage such risks successfully, collaborative efforts among project actors are needed. Joint risk management (JRM) is about the dynamic management of risk (Rahman and Kumaraswamy, 2005). A dynamic approach implies that the identification and assessment of project risk, along with the response to it, are performed proactively and jointly throughout the project (Hartman et al., 1997). Despite the fact that JRM is arguably an effective tool, the use of JRM still seems to be rare (Doloi, 2009; Osipova and Eriksson, 2011b; Rahman and Kumaraswamy, 2004).

Opportunistic behavior is an inherent phenomenon in projects because participants have different objectives and strive to optimize the result for their own organizations rather than the project (de Man and Roijakkers, 2009). To handle opportunistic behavior, the majority of project management tools are control-oriented, emphasizing hierarchical structures, centralized decision-making and the division of work and responsibilities (Lenfle and Loch, 2010). The drawback with such a control focus

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is that it hampers collaboration and adaptability. At the same time, project organizations have to be flexible to changes and challenges in order to be able to manage the uniqueness, uncertainty and complexity of projects (Geraldi, 2008). Thus, control and flexibility are both needed if a project is to be managed effectively. As control and flexibility are two contradictory approaches, the achievement of an optimal balance between them is one of the greatest challenges for a project organization (Raisch, 2008).

Burns and Stalker (1961) were pivotal pioneers of contingency theory. They investigated the circumstances under which control-oriented mechanistic organizations and flexibility-oriented organic organizations were most prosperous. Subsequent studies have followed in their footsteps and supported their theory, mostly at a company level. More recently, studies have also discussed the roles of control and flexibility in project management (e.g. Geraldi, 2008; Koppenjan et al., 2011; Lenfle and Loch, 2010; Sine et al., 2006). These authors agreed that modern project organizations have to manage the coexistence of mechanistic (controlling) and organic (flexible) approaches in a way that facilitates the achievement of project objectives. Risk management is a part of the overall project management process and, therefore, is affected by mechanistic and organic management systems.

However, there is still a lack of knowledge about how to manage the tension between control and flexibility in project organizations. There are no ready answers about how organizations achieve an optimal combination and studies that improve our understanding about weaknesses and strengths of different approaches are relevant. Furthermore, despite the fact that risk can significantly affect project objectives, the influence of control-oriented and flexibility-oriented approaches on the RM process has not been investigated. It should thus be worthwhile to examine how the extent of control and flexibility in projects influence JRM. We attempt to address this question by integrating risk management literature and organizational theory about mechanistic and organic management systems in a study of two construction projects.

The purpose of this paper is to investigate how mechanistic and organic management systems influence the implementation of JRM. We have formulated two research questions:

1. What is control and flexibility from a project-based organizational perspective?
2. How do control and flexibility affect the implementation of JRM?

The paper begins by presenting a theoretical framework that aims to identify the characteristics that distinguish between control-oriented and flexibility-oriented project organizations. In the next section, uncertainty and risk management literature is presented and the connections between control/flexibility and RM are discussed. Following the two theoretical sections, the empirical methods are described and two case studies serve as illustrative examples of how different extents of control and flexibility can affect the implementation of JRM. The paper ends with a concluding discussion about the practical and theoretical contributions of this research.

2. Theoretical framework

2.1. Mechanistic and organic approaches to project management

One of the fundamental pieces of research within organizational theory is the work by Burns and Stalker (1961), who studied 20 firms in which they observed, followed and interviewed personnel in order to describe how the firms were managed. As a result of their study, they proposed two contrasting management systems, mechanistic and organic. A mechanistic system, which is characterized by a high level of control, specialized differentiation, hierarchical structures and the importance of individual knowledge and skills, is considered to be appropriate in stable environments. When there is a high level of uncertainty, a more flexible approach is needed. The organic system, which is characterized by a network structure, spread of commitment and informative communication, is therefore more appropriate when there are changing conditions. The two approaches are contradictory and characterized by distinctly different management philosophies (see Table 1).

Based on the theory of Burns and Stalker, researchers have studied how mechanistic and organic approaches affect project management. In many studies, the main characteristic of mechanistic organizations is associated with the use of control, while organic organizations are associated with a high degree of flexibility. Aaker and Mascarenhas (1984) defined control as an approach that aims to mitigate all undesirable changes. Flexibility, in turn, is about adapting to uncertain and rapidly-occurring environmental changes that might affect the organization's performance. Koppenjan et al. (2011) defined two approaches to project management based on the level of control and flexibility in the project. A predict-and-control approach has a strong focus on planning and control, aiming at eliminating uncertainty and complexity. In contrast, a prepare-and-commit approach aims at a constant and shared management of uncertainty and complexity and is characterized by close cooperation between the project

Table 1
Characteristics of mechanistic and organic organizations (from Burns and Stalker, 1961).

Mechanistic	Organic
The specialized differentiation of functional tasks	The contributive nature of special knowledge and experience
The abstract nature of each individual task (distinct from the whole organization)	The "realistic" nature of the individual task (task is seen as set by the whole environment)
The precise definition of rights and obligations attached to each functional role	The shedding of responsibility (problems may not be defined as being someone else's responsibility)
Hierarchical and vertical structure of control, authority and communication	A network and lateral structure of control, authority and communication
Location of knowledge at the top of the hierarchy	Knowledge can be located anywhere in the network
Working behavior is governed by instruction and decisions made by superiors	Superior function of information and advise rather than instructions and decisions
Importance and prestige of individual knowledge	Importance and prestige of common knowledge

actors, in order to achieve flexibility. In a study of project-based organizations in different countries, Keegan and Turner (2002) found that firms used mechanistic control-oriented approaches, regardless of the nature of the project, and this stifled flexibility and innovation.

On the other hand, Brown and Eisenhardt (1997) argued that pure approaches i.e. purely mechanistic or purely organic, are seldom used by organizations. Instead, the two approaches often need to be combined. Their comparative study of six firms showed that a successful combination is both structured (so that chaos cannot ensue) and unstructured (so that the firm can respond quickly to changes). In particular, combining clear responsibilities and priorities with extensive communication and freedom is found to be a successful strategy in continuously changing environments (Brown and Eisenhardt, 1997). A study by Ahrens and Chapman (2004) confirmed these results and showed that control systems can simultaneously support flexibility. In their case study, a mechanistic management approach coexisted with a flexible approach through intensive discussion and analysis.

Bettis and Hitt (1995) discussed organizations operating in changing environments and stressed the increasing level of uncertainty and decreasing predictability that these environments presented. They highlighted two components of organizational strategic response capability — robustness, that implies that the organization is immune to uncontrollable changes, and flexibility, which is related to the ability to react to changes rapidly. A study by Geraldi (2008) also focused on a changing environment and on multi-project organizations that have to manage the coexistence of order and chaos. In her study, she proposed five parameters to measure the flexibility of organizations involved in projects (Table 2). According to Geraldi's model, project organizations that face a high level of uncertainty should strive for a high level of flexibility. Otherwise, the project organization gets into 'bureaucratization of chaos' i.e. adding rules, constraints and strict instructions which do not represent the reality.

2.2. Uncertainty and risk management

Uncertainty is inherent in projects and refers to elements that change over time and are hard to predict and control. It can be described as the difference between the information one has and the information one needs to complete a task (Galbraith, 1973).

Table 2
Attributes of a project organization's flexibility (based on Geraldi, 2008).

What	Ability to define and change the scope and goals of the project (contract flexibility)
How	Ability to define and change the implementation process (tools and instrument flexibility)
Who	Ability to define and change who is carrying out the project tasks (human resources flexibility)
When	Ability to define and change the time constraints for different tasks (schedule flexibility)
Where	Ability to define and change where the tasks are performed i.e. infrastructure of organization, joint project office, location of employees (location flexibility)

According to Atkinson et al. (2006), there are three major sources of project uncertainty. First, uncertainty in project estimates originates from incomplete and inaccurate data and a lack of a structural approach to deal with missing information. This uncertainty results in erroneous estimations of cost, time and quality. Second, uncertainty in the project organization emerges from the fact that different actors work together and so problems of opportunistic behavior and risk allocation arise. Third, uncertainty associated with the project life-cycle is generated throughout the project and is related to the inputs and outputs of each phase and the interactions among them.

The difference between the terms 'uncertainty' and 'risk' is widely discussed in the research literature (e.g. Perminova et al., 2008; Ward and Chapman, 2003). It has been argued that the term 'risk' is mostly associated with treats and 'known unknowns', leaving positive sides of risk out of scope in the established frameworks. Uncertainty, on the other hand, has a broader perspective and focuses on both positive and negative effects as well as 'unknown unknowns'. However, many well recognized frameworks, e.g. the guide "Project Management Body of Knowledge", PMBOK, (Project Management Institute, 2000), use the term 'risk management' while describing the process of dealing with uncertainty. This affects practitioners, making them more comfortable with the term 'risk management' than 'uncertainty management'. Therefore, the terms 'risk management' and 'joint risk management' are used throughout the paper and the term 'risk' includes both threats and opportunities.

According to the PMBOK, risk management is a systematic process of identifying, assessing and responding to project risk. The overall goal is to maximize the positive opportunities and minimize the negative consequences of an uncertain event. Previous literature has included discussions of a variety of RM models, which formalize the process into different numbers of stages. The majority of these models are based on planning, forecasting and control. Risk identification is the first step in the process. It is aimed at determining potential risks i.e. forecasting those events that may affect the project. PMBOK suggests that as many project stakeholders as possible should participate in the identification process. However, in construction projects, the participation of many different actors in the identification process is not very common (Rahman and Kumaraswamy, 2004). Instead, every actor carries out their own risk identification. Furthermore, it is impossible to predict all the risks even with a thorough identification process. Assessment of the identified risks is the second step in the formal process. The goal is to prioritize events that have to be managed. There are both qualitative and quantitative methods for assessment. However, practitioners rely mostly on qualitative methods such as professional judgment, intuition and experience (Akintoye and MacLeod, 1997; Tang et al., 2007; Wood and Ellis, 2003). Subjective assessment brings the problem of different perceptions, as each group of actors may have its own view of the importance of risks. Hence, the collaboration of many different actors is important in order to obtain a comprehensive view and avoid a narrow and biased perspective of project risk. The response process, which is the third step, is directed at finding a way of dealing with risks. It is based on the planning of

appropriate actions to minimize important risks and how to handle risks if they actually occur. As risks change constantly during the project implementation, the effectiveness of planning, forecasting and control tools may be low. Therefore, flexibility must be a vital part of the RM process as it allows unforeseen events to be dealt with.

As mentioned earlier, mechanistic and organic management approaches have a significant influence on project management. In line with this reasoning, risk management, as a part of the overall project management process, may also be affected by these two approaches. When a mechanistic management system prevails, RM focuses on reducing risk beforehand i.e. identification and allocation of potential risks to the project actors using contracts. When risks are allocated among the actors at the beginning of the project, this allocation is based on forecasting — the actors try to predict what might happen in the project over the following months or years. However, the changing environment implies that forecasts are accurate for a very short time: not years and months, but weeks (Bettis and Hitt, 1995). The organic management system is more appropriate for changing environments. Such project management approach is more flexible and sees change as a vital part of the project that has to be handled jointly. The focus on flexibility enhances the possibility for RM to focus on finding the best possible solutions when changes occur during the project implementation. Floricel and Miller (2001) argued that achieving a high project performance requires the application of both approaches — a robust, or formal approach for the management of anticipated uncertainty (i.e. related to control) and a dynamic, or governable approach for the management of unforeseen and unexpected events (i.e. related to flexibility). This highlights the importance of finding a balance between control and flexibility when performing RM.

3. Research method

A case study approach was adopted for several reasons. JRM is a rather new concept in Sweden and, therefore, it is important to obtain a detailed and comprehensive view of it by investigating it in ongoing projects. In particular, how JRM is carried out in projects and how various factors influence its implementation, were two areas of interest. A case study approach provides an opportunity to investigate processes to a sufficient depth and is therefore suitable for answering research questions such as those formulated in this study (Pratt, 2009; Yin, 2009). In order to observe the JRM process, it was important to follow the projects from the beginning of execution to completion using a longitudinal study. Therefore, the start time was an important condition for the choice of cases. Another important factor was the intention of project management to perform joint risk management throughout the project. According to these criteria, two projects were chosen and studied over two and a half years.

Methods for data collection included observations, interviews and document studies. As observers, researchers attended joint risk management workshops and construction meetings. Before observing an event, some preliminary data were collected through e-mail communication in the first case study and through a web-based project database in the second case study. Preliminary data included information about the organization and objectives of the project along with risk and contract documentation. The information collected was used to understand the project environment i.e. participants' roles, the project's main phases and schedule, contract conditions, RM and collaborative activities.

Semi-structured, in-depth, face-to-face interviews with the main project actors were conducted. From the client's side of the project, a project manager, client's on-site representatives and a design manager were interviewed; from the contractor's side, a project manager, a site manager and a construction engineer were interviewed; and from the consultant's side, an architect and two technical consultants were interviewed. In total, 21 interviews were conducted. Each interview lasted approximately one and a half hours. First, the respondents described the project and their roles. The most detailed discussion was about the organization of JRM, factors that influenced collaborative work and working relationships among the project actors. In particular, the interviewees were asked to describe how they worked with risks, what tools were used, how joint workshops were organized, how they collaborated in the project and to outline the advantages and disadvantages of the current project organization. To increase reliability (transparency and future replication), all interviews were tape-recorded and case study protocols were constructed with the aim of facilitating retrieval for future studies (Yin, 2009).

Finally, RM documentation and collaboration agreements were studied. Together with interview data, documentary materials were used to draw an in-depth picture of how joint JRM was carried out in the project and how collaborative activities and tools were organized and used.

Data analysis was done in two steps. First, within-case analysis was performed in order to investigate the unique patterns of each case (Eisenhardt, 1989). The analysis focused on how each project was managed related to organic and mechanistic management systems. We analyzed the project's scope, procurement procedures, sources of risk, organization of the risk management process, collaborative activities and the project result. Second, cross-case analysis was performed in order to examine similarities and differences in the projects. Based on the categories presented by Burns and Stalker (1961) and Geraldi (2008), we compared how different management systems in the two projects affected JRM in different ways. We try to describe whether the organization's approach to RM is more mechanistic or organic (see Table 1). Further, we determine the degree of flexibility using the five parameters identified in Table 2.

4. Empirical findings

4.1. Description of case study 1 — PharmaLab

The project entailed the construction of new pharmaceutical laboratory facilities consisting of two buildings. Construction started in 2007 and the facility was finished in December 2009. The client is a large public organization that regularly undertakes construction works and has a long experience of the construction industry. The project was procured on a general contract basis with an additional collaborative agreement. The contract was worth

approximately 700 MSEK (~70 M €). During the bid evaluation, the expertise of potential contractors as well as their collaborative abilities were considered and the contract was awarded to one of the largest contractors in Sweden. A cost-reimbursement payment mechanism with performance-related bonus was chosen for the project.

In terms of the uncertainty sources identified by Atkinson et al. (2006), the project organization and project life cycle were the two largest sources of uncertainty at PharmaLab. Uncertainty about the project organization arose from the fact that actors did not have any previous experience of working with each other. Uncertainty about the project life cycle was generated by the end-user, i.e. the main tenant, who continuously changed the scope of the project during the construction stage. In order to deal with the project organization uncertainty, a relationship-building workshop was organized after the project had started. During the workshop, joint objectives were formulated, documented and signed by the client and general contractor. In addition, the following collaborative tools were used during the project: joint project database, team-building activities, partnering questionnaire and a partnering facilitator. The project risks were managed using joint risk management workshops and a close collaboration between the actors.

The project was finished and was considered a success in terms of function and quality. According to the respondents, an unusually small number of errors were found during the final inspection. In terms of budget, both parties achieved their objectives and a full bonus was paid by the client to the general contractor. Despite many changes originating from the end-user during the construction process, the project was completed on time. Because the project objectives were achieved successfully and the relationship well-maintained, the client chose to work with the same project team for the next project i.e. conditions for strategic partnering were created.

4.2. Description of case study 2 — HydroPlant

The project entailed the first stage of reconstruction of a hydroelectric power station. The client is a large public organization that operates in the energy sector and is a regular purchaser of construction services. The project was procured on a general contract basis with both fixed price (bill of quantities) as well as cost-reimbursement payments and a performance-related bonus. During the bid evaluation, the lowest price bid was chosen.

At HydroPlant, all three sources of uncertainty (Atkinson et al., 2006) were present. Uncertainty in estimates was very significant due to an incomplete geotechnical survey at the beginning of the project and the contract being awarded to the bidder with the lowest price. After the project was started, it transpired that the budget was too optimistic and the costs were going to increase significantly. The project organization uncertainty arose from the absence of previous experience of working with partnering projects in general and working with the other actors in particular. After the contract was awarded, the client requested a partnering approach with the general contractor. A partnering facilitator was invited to lead collaborative activities which resulted in a joint project database and two team-building workshops during the construction phase. However, financial discussions between the client and the contractor resulted in a conflict in which the actors tried to protect their own interest instead of finding the best possible solutions. This created uncertainty about the project life cycle because the lack of agreement resulted in many delays. As a result, the project was delayed by several months and relationships within the project team were destroyed. For the second stage of the project, a new team from the same general contractor was set up.

4.3. Mechanistic and organic characteristics of the projects

Based on the interviews, observations and studied documentation, projects are categorized from the perspective of mechanistic and organic approaches (Table 3).

The standardized conditions of contracts that formalize the rights and the obligations of each party were used in both projects. In order to facilitate collaborative activities in general and JRM in particular, additional arrangements were implemented.

At PharmaLab, the actors felt that collaborative arrangement was necessary because of the complexity of the project and the tough deadlines caused by multiple changes by the end-user during the project implementation. In terms of financial incentives, a performance-related bonus was introduced to motivate the general contractor into achieving better results and cost savings. During the construction phase, a series of relationship-building workshops between the client and general contractor was organized. The main purpose was to discuss and establish joint objectives and then to follow up and evaluate whether those objectives had been met. In order to assess the collaborative climate and satisfaction of each member of the project team, anonymous questionnaire surveys were used prior to each workshop. JRM workshops were initiated

Table 3
Characteristics of case studies from mechanistic and organic perspectives.

	Organizational characteristics	PharmaLab	HydroPlant
Mechanistic	1. The precise definition of the rights and obligations through the construction contract	✓	✓
	2. Hierarchical structure of control — client has a strong control function	✓	✓
	3. Project manager provides instructions and decisions	–	✓
	4. The specialized differentiation of special knowledge and task	–	✓
	5. Importance and prestige of individual knowledge	–	✓
Organic	1. The contributive nature of special knowledge and expertise	✓	–
	2. Each individual task is seen as a part of the project — understanding of the project as a whole	✓	✓
	3. The sharing of responsibility	✓	–
	4. Authority and communication have a network and lateral structure	✓	–
	5. Common knowledge has a great value	✓	–

for the purpose of identification and assessment of project risks and the response to them. The JRM team included not only the client and the general contractor, but also the architect and other consultants, in order to draw on a broad range of knowledge and expertise. During the first workshop, a risk register was completed, which included a description of the risk, probability of occurrence from 1 to 5, possible consequence from 1 to 5, risk score (multiplication of probability and consequence parameters) and a risk response description. Follow-ups of JRM workshops were held every third month and included a revision of the risk register based on a joint discussion.

At HydroPlant, there was an attempt to create a collaborative environment by employing a partnering facilitator who organized a number of joint activities. The project team had one meeting at the beginning of the project where the facilitator introduced the partnering concept and the main principles of collaborative work. For both client and contractor, it was their first partnering experience. During the introductory meeting, a short JRM session was held and a number of risks were identified. After the first partnering meeting, no special JRM workshops or another structured JRM forum were organized. Instead, risks were discussed during construction meetings, often without any documentation of those joint discussions. Very soon, there started to be financial disagreements within the project and these created a serious conflict between the actors. Unfortunately, the conflict was not resolved before the end of the project and this destroyed any possibility of creating a collaborative environment and achieving JRM. In the interviews, the general contractor pointed out that the client was very focused on the conditions of the contract and did not want to share responsibility. The contractor felt that the client was not interested in creating a joint team but wanted to control the project and reduce their own costs.

Despite the fact that both client organizations had a strong control function with project managers who provided instructions and decisions, a more horizontal structure of control was observed at PharmaLab. For example, the client's representatives on-site had direct contact with subcontractors and were allowed to make decisions without going via the client's project manager.

From the perspective of knowledge and task differentiation, there is a significant difference in the approaches adopted. Whereas at PharmaLab, the actors strived for a common understanding about the technical details, the HydroPlant team focused on the importance and prestige of individual knowledge. As a result, actors at PharmaLab shared understanding and expertise with each other through continual dialogue and close collaboration. In contrast, a lack of joint discussions and the absence of collaborative environment were present at HydroPlant. During the interviews, the client and general contractor at HydroPlant pointed to an unwillingness to accept each other's competence and a lack of ability to find the most appropriate technical solutions jointly. They kept the traditional roles of client and contractor as rivals and not as collaborators.

4.4. The extent of flexibility in the projects

Evaluation of the projects regarding the degree of flexibility is based on a model developed by Geraldi (2008). According to this model, flexibility can be characterized by an ability of the project organization to change the scope, process, tools, roles, schedule and location of the project. Comparing the projects, the level of flexibility is higher at PharmaLab than at HydroPlant (Table 4).

Table 4
Extent of flexibility in case study projects.

	PharmaLab	HydroPlant
What	Many changes suggested by the end-user, which were solved successfully.	Bid based on a very optimistic bill of quantities. Changes were not addressed adequately, which resulted in a conflict between the client and the general contractor.
How	Joint discussion between client, contractor, consultants and subcontractors. JRM workshops with the opportunity to change a process or a set of actions when needed.	No JRM workshops. Client adopted a controlling function and refused to listen to contractor's suggestions about change of methods and tools.
Who	When required, roles could be changed between employees. When a person was absent there was always an additional resource.	Project was under-staffed. Roles were rigid especially within the client's organization.
When	Strong focus on keeping to timetable. Higher degree of schedule flexibility made it possible for many changes to take place during the project implementation without delay to the final date of completion.	Strong focus on keeping to timetable. Many contractors involved who were responsible for different parts of the project. Penalties were introduced for not keeping to the schedule.
Where	Location of the project facilitated a high degree of flexibility. Consultants had an opportunity to work in a joint project office.	Very little flexibility in terms of location of employees due to large distances between client, contractor and consultants.

4.4.1. Ability to define and change the scope and goals of the project (contract flexibility)

At PharmaLab, there were significant changes introduced by the end-user during the construction phase. These changes required a large amount of additional work by the designers, consultants and the general contractor. The flexibility of the project actors and their collaborative attitude allowed tough deadlines to be met and the joint management of the associated risk while adapting to scope changes.

At HydroPlant, the contract was awarded based on a very optimistic estimation of quantities that did not work in reality. Due to the incomplete geotechnical survey during the initiation phase, condition of the underlying rock was misreported and subsequently required much more excavation work and supporting material. These changes were not addressed adequately using collaborative efforts to find the best possible solution. This resulted in a disagreement concerning project finances and an unresolved conflict between the client and the general contractor.

4.4.2. Ability to define and change the implementation process (flexibility of tools and instruments)

At PharmaLab, the ability to change the implementation process was supported by joint discussions between the client, general contractor, consultants and subcontractors. During JRM

workshops, the actors decided when a problem required a change of method, technique or tool. For example, the contractors had many technical suggestions that required a change of drawings in collaboration with the architect. A joint discussion led to a common understanding of how these changes could be implemented effectively.

On the other hand, at HydroPlant, the client adopted a controlling position and refused to consider the general contractor's suggestions about a change of methods and tools. For example, when the problems with the tunneling works emerged, the contractor had ideas about how to strengthen the rock. The contractor claimed however, that the client was extremely focused on the financial issues and did not want to discuss the contractor's proposal. As a result, the general contractor used the prescribed method, which he thought was not the best solution and which led to significantly greater costs.

4.4.3. Ability to define and change who is carrying out tasks for the project

Flexibility regarding human resources was rather low in both cases, due to the nature of construction projects where the actors have well-defined roles. However, almost all the members of the project team at PharmaLab were located in the same building and when one person was absent, there were always others that could take on that role. HydroPlant was significantly under-staffed with team members located in different locations. This caused problems with respect to changing roles between employees and finding additional resources.

4.4.4. Ability to define and change the timetable for different tasks

In both projects, there was a strong focus on keeping to the timetable, especially the final date of completion. The PharmaLab project was finished on time, while the HydroPlant project was delayed by several months. As mentioned above, at PharmaLab, many changes by the end-user caused significant delays to the internal schedule during the construction phase. According to the actors, keeping to the main timetable became possible because of the actors' flexibility and ability to manage higher workloads when collaborating. At HydroPlant, delays were connected to the inferior site conditions and an inability to solve the problem jointly.

4.4.5. Ability to define and change where the tasks are performed i.e. infrastructure of organization, joint project office, and high flexibility of location of employees

There was a significant difference between the two projects in terms of geographical flexibility. The PharmaLab project team was located in the same city and a joint project office near the construction site was established. The representatives of the client and the contractors could reach the site and thus the other actors very quickly. The location also provided good facilities for the organization of workshops and meetings. The actors at HydroPlant were located in different parts of the country, making it difficult to meet as often as the PharmaLab project team. The flexibility was low in terms of location due to the remoteness of the construction site.

5. Discussion

According to Burns and Stalker's (1961) contingency theory, a mechanistic (controlling) management system is more suitable in a stable environment, while an organic (flexible) system is to be used in a changing environment. Construction projects involve a great deal of uncertainty and change, making an organic approach more suitable for managing these projects. However, the majority of the currently used project management tools focus on control rather than flexibility (Keegan and Turner, 2002; Lenfle and Loch, 2010). Traditional RM tools are based on predicting risk and allocating it to the different project actors i.e. a pure mechanistic view. At the same time, a collaborative way of working and managing project risk has become increasingly popular. Although a combination of both approaches was used in the case study projects, the extent of control and flexibility varied significantly between the projects. While PharmaLab had more focus on flexibility in order to cope with the project uncertainty and changes, HydroPlant adopted a controlling approach despite the significant amount of uncertainty that required collaborative management.

Our empirical findings contain several examples showing how the different management systems influenced RM. At HydroPlant, the client's focus on control and pre-established solutions resulted in very poor collaboration and inability to adapt to changing circumstances. The actors used risk registers to transfer risks to each other instead of handling them jointly. Moreover, unwillingness to accept each other's competence led to a lack of ability to find the most appropriate technical solutions. At PharmaLab, the client's representatives on-site had direct contact with subcontractors without involving the general contractor. They also could make decisions without going via the client's project manager. This resulted in a shorter decision-making process and more flexibility, which, in turn, underpinned JRM. Thus, one of our key findings shows that aspects related to an organic management system facilitate collaborative activities and JRM.

The PharmaLab case shows an importance of including the end-user in the JRM team. Continuous changes from the main tenant, i.e. the company that moved in the facility, were a significant source of risk throughout the project. Therefore, the end-user's involvement in the JRM workshops would provide a better understanding of how requested changes influence the project. It would also give an opportunity to follow the process more closely and plan the changes in cooperation with the construction team.

In terms of the debate about how the balance between control and flexibility can be achieved, we suggest that there is a need for a deeper understanding of collaborative relationships among the project actors. Clients often require that projects are carried out using collaborative arrangements. However, it is often the case that contractors do not have an adequate understanding of what this means and how they should behave in such a project (Davis and Love, 2010). HydroPlant is an example where neither client nor contractor used the partnering concept in an appropriate way. They thought that partnering would solve the problems of adversarial behavior but did not have adequate knowledge about how to implement partnering. Our findings suggest that successful implementation of JRM requires the actors to establish

collaborative relationships based on joint objectives and mutual respect for each other's competences.

6. Conclusions

By combining organizational theory on mechanistic and organic management systems with risk management literature, we have pinpointed the importance of managing the tensions between control and flexibility when implementing JRM. Our results support earlier research, suggesting that when a mechanistic management system dominates, RM is implemented as a formal process carried out individually rather than in collaboration with other project actors. The findings suggest that a strong focus on control hampers a collaborative project environment and, therefore, does not create suitable conditions for JRM.

Furthermore, previous research has shown that a flexible management approach is a weakness of current practice because existing project management tools focus on forecasting, planning and control (Lenfle and Loch, 2010). From a practical perspective, the results of the case studies show the importance of flexibility and its role in increasing the chances of implementing JRM.

The main theoretical contribution of this study is that JRM requires a combination of the formal and collaborative processes, calling for a balance between control tools in order to manage identified risks and the flexibility to cope with unforeseen events. Further studies into the characteristics of mechanistic and organic approaches that are crucial for JRM are necessary.

There are some limitations of this study. We focused on how mechanistic and organic management systems influence implementation of JRM, leaving other contextual factors outside the scope of the study. However, the results show that the choice of management system can be explained by many factors, such as scope of the project, complexity and uncertainty, procurement procedures as well as skills and attitudes of the project management team. Therefore, the conditions that affect the choice of the management system are a very important subject that needs to be further developed. Finally, we encourage academics and practitioners to reflect further on how to combine different management systems in order to achieve JRM and how to avoid an extra formalization of the risk management process.

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Paper V

Establishing cooperative relationships and joint risk management in construction projects– An agency theory perspective

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Establishing cooperative relationships and joint risk management in construction projects – An agency theory perspective

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Abstract

Through construction contracts, clients and contractors are involved in principal-agent relationships. These relationships are argued to be adversarial and characterised by two main features of contracting parties: different goals and different attitudes to risk. Agency-related problems contribute to the actors concentrating on risks associated with their own parts of projects instead of joint risk management (JRM). The aim of this study is to investigate how project actors address problems associated with principal-agent relationships and thereby enhance cooperative relationships and JRM. The empirical findings show that strong collaboration is a multi-dimensional activity that is crucial for JRM. Effective JRM is highly dependent on other dimensions of collaboration (such as cooperative procurement, establishment of common goals and open communication) and should be implemented together with other factors.

Keywords: Joint risk management, procurement, project management, collaboration, agency theory

1. Introduction

In construction projects the actors are contractually involved in principal-agent relationships. Agency theory suggests that contracting parties focus on maximizing their own utility rather than the project as a whole, i.e. their relationship is adversarial (Eisenhardt, 1989). Consequently, there is high reliance on the contracts and formal risk allocation, which is often not optimal (Cox and Thompson, 1997). For example, contractors may ignore some risks when tendering because of desires to be optimistic and win the contract. In addition, initial risks may change and new risks may emerge during projects' lifecycles. High reliance on contracts and inefficient risk allocation may also lead to numerous disputes and conflicts during projects' implementation and impair the results (Wang and Chou, 2003).

According to fundamental assumptions of agency theory, relationships between principals and agents have two main characteristics. First, cooperating parties have different goals, which may result in goal conflicts (Jensen and Meckling, 1976). In construction projects, these may arise because clients focus on lifecycle costs of structures but contractors have short-term perspectives and try to minimize production costs. Thus, various strategies to overcome

problems associated with adversarial relationships and move towards collaboration have been considered by researchers and applied, to varying degrees, by practitioners for several decades. These include relational contracting (RC), which refers to a set of practices (e.g. partnering, alliancing and integrated project delivery) that reportedly foster cooperation between project actors. Lahdenperä (2012) presents an overview of RC approaches, discusses their similarities and differences, and concludes that shared features include: early involvement of project actors, joint decision-making, shared risk and reward mechanisms, transparent budgeting and collaborative agreements. The extensive use of collaborative tools such as joint workshops and team-building activities also help the creation of a favorable project environment and contribute to better final results. However, despite these advantages use of collaborative working methods in construction is limited (Eriksson, 2008).

The second main assumption of agency theory is that principals and agents have different attitudes to risk (defined below), which can lead to risk-sharing problems (Fama, 1980). There are risks in all construction projects that may negatively affect project delivery in terms of cost, time and quality. Thus, risk management (RM) is an important component of overall project management and is essential for achieving project objectives (Chapman and Ward, 2004). RM aims at identifying, assessing and responding to risks throughout the project, but traditional RM procedures have been criticized for being too formal, rigid and standardized (Corvellec, 2009; Zou et al., 2010), control-oriented rather than flexibility-oriented (Osipova and Eriksson, 2013) and lacking a collaborative approach (Rahman and Kumaraswamy, 2002b; Tang et al., 2007). Moreover, in the construction industry risks are still often shifted through disclaimer clauses in contracts (Zaghloul and Hartman, 2003).

Joint risk management (JRM) is a powerful collaborative strategy for addressing inefficient risk allocation and identifying closer to optimal ways of dealing with unforeseen events (Osipova and Eriksson, 2013; Rahman and Kumaraswamy, 2002b). JRM activities, such as joint workshops, also facilitate better understanding of project risks and consequences of different actors' actions. This is particularly important in the characteristically uncertain and changing environment of a complex construction project, where there is a clear need for collaborative working methods and JRM throughout the project beyond the contract boundaries (Hartman et al., 1997). However, despite the advantages of such collaborative approaches to RM, JRM is still rarely used in construction projects (Doloi, 2009; Osipova and Eriksson, 2011; Rahman and Kumaraswamy, 2004; Tang et al., 2007).

RC approaches and collaborative tools have been intensively researched. However, fewer studies have discussed JRM although risk-sharing is a key issue in principal-agent relationships, and agency-related problems (notably those associated with different attitudes to risk) must be effectively addressed to establish strong collaboration. Furthermore, previous JRM investigations have focused mainly on its potential benefits (Rahman and Kumaraswamy, 2002a; Rahman and Kumaraswamy, 2002b), project team coordination (Rahman and Kumaraswamy, 2005), the role of JRM in achieving project success (Doloi, 2009), and JRM frameworks for multi-organization projects (Lehtiranta, 2013). No previous studies have explicitly focused on JRM from the perspectives of the multiple actors that are typically involved through principal-agent relationships in construction projects. Agency theory offers a useful framework for identifying issues that may significantly impact relationships and elucidating their effects. The presented study explores how actors in construction projects address agency-related problems and enhance collaboration generally and JRM specifically. Therefore, agency theory is applied as it is highly relevant to approaches for fostering the collaborative relationships among contracting parties that are

essential for effective JRM. The empirical data applied were collected from a longitudinal case-study of two connected projects where joint objectives were established and JRM was successfully implemented.

2. Theoretical framework

2.1. Agency theory

To describe the theoretical framework of the study, agency theory is briefly introduced, largely based on a review by Eisenhardt (1989) and references therein. Researchers started to discuss agency theory in the 1960s and 1970s. Initially, they were interested in mechanisms for sharing risks between contracting parties that have different attitudes to risk, and subsequently focused on goal conflicts between principals and agents arising from differences in goals and division of labour. Agency theory emphasises the importance of finding and applying the most efficient contract strategy for governing the relationship between contracting parties. Two main contract strategies (behaviour-based and outcome-based) are generally discussed in agency theory literature. In addition to the two major problems of differences in goals and risk attitudes between principals and agents, projects are characterized by outcome uncertainty, variations in outcome measurability and task programmability, information asymmetry, and length of the relationships (Figure 1). The main agency theory assumptions are presented and discussed in detail below.

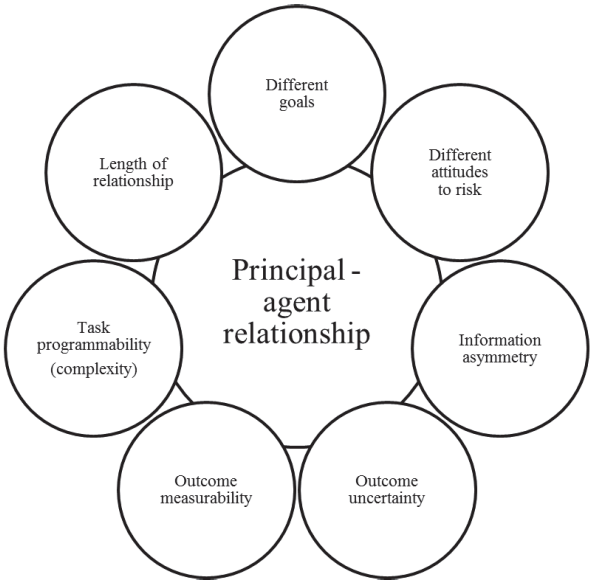

Figure 1. Agency-related problems, adapted from Eisenhardt (1989)

Conflicts arising from differences in the goals of a principal and an agent may cause the agent to act in his/her self-interest rather than the interest of the principal (Eisenhardt, 1989). The construction industry is perceived as being highly goal-conflicted because numerous stakeholders with different goals are typically involved in a project (Toor and Ogunlana,

2010). Thus, goal alignment is important for delivering a final product with good quality within budgetary and time specifications. The problem of risk-sharing arises when the principal and agent prefer different actions due to differences in their attitudes to risk (Eisenhardt, 1989). Risk attitudes refer to the willingness of parties to take risks based on the expected trade-off between risk and reward (Ward et al., 1991). Because of the differences in willingness to take risks, responsibilities and liabilities for risks are frequently transferred in the construction industry (Akintoye and Main, 2007). However, several problems are associated with the risk transfer process. Contractors often do not evaluate risks properly because of the lack of information in the beginning of the project and lack of time for thorough bid preparation (Ward et al., 1991). This may result in costs for the contractor during project implementation exceeding initially calculated contingency funds (Laryea and Hughes, 2008). In such situations contractors may attempt to pass risks further down the supply chain, resulting in shifts of substantial amounts of responsibility to the actors with the least power and control in the project (Hanna et al., 2013). Significant disagreements among construction practitioners have been found about where risks should be allocated within a supply chain. A questionnaire survey of 89 Australian practitioners found that the responsibilities and liabilities of subcontractors aroused the strongest disagreement (Loosemore and McCarthy, 2008).

Information asymmetry refers to differences in the abundance, and quality, of information available to different project actors, which make it difficult to ascertain if decisions taken by contractors are optimal for clients. According to the agency theory, information has a cost and can be purchased. Before selecting an agent, a principal has to estimate if candidates have the required skills for performing the desired task (Bergen et al., 1992). Researchers argue that careful partner selection through cooperative procurement procedures helps to reduce risk and uncertainty (Pesämaa et al., 2009). However, in construction projects clients often choose the lowest bid and ignore other factors, which hampers collaboration and causes conflicts during project implementation. After a contract is awarded, the principal needs to communicate with the agent to obtain information about the agent's actions, and supply information about any changes requested by the client and risks that may have changed or emerged. Such exchange of information is vital for establishing and maintaining an effective project environment (Dagenais, 2007).

Outcome uncertainty refers to the fact that project outcomes only partly depend on the behaviour of the actors (Eisenhardt, 1989) as numerous external factors, such as changes in legislation, economic conditions or environmental states, may also affect them. Bettis and Hitt (1995) examined organizations operating in changing environments and found that forecasts may be accurate for a very short time due to high uncertainty and low predictability. A study by Geraldi (2008) focused on multi-project organizations operating in changing environments and concluded that organizations have to manage the coexistence of order and chaos. Thus, several researchers have suggested that project managers should use a combination of control and flexible approaches to manage outcome uncertainty. For example, Koppenjan et al. (2011) argued that a prepare-and-commit approach, aiming at shared management of uncertainty and characterized by close cooperation between project actors is superior to a predict-and-control approach with a strong focus on planning and control, aiming at eliminating uncertainty and complexity. The length of relationship is argued to decrease information asymmetry (Eisenhardt, 1989), and thus is beneficial for collaboration. Output measurability refers to the variability in the ease of measuring (and managing) different types of outcome (Eisenhardt, 1989). It is particularly difficult for tasks that take a long time to finish or require joint effort by multiple project actors. However, many output parameters can

be measured by using appropriate variables to obtain accurate, reliable assessments of project actors' performance (Das and Teng, 2001). Target price is an example of such a parameter: if the final cost is lower than the target price, a performance-related bonus may be paid to the contractor(s). In construction projects, output parameters are usually measured in the final inspection. However, a potential flaw in this procedure is that a contractor may complete allocated tasks within time and budgetary constraints, but in a manner that severely hampers other contractors or sub-contractors, thereby impairing project performance. Task programmability, or complexity, refers to the ability to define the behaviour of agents in advance. For example, complex and problematic projects require more managerial efforts than easy or typical projects. Complexity has been studied extensively because it has multiple dimensions (e.g. organizational, technological and environmental dimensions) and is regarded as a key contextual element of project management (Maylor et al., 2008).

2.2. Relational contracting

A long history of traditional contracts and adversarial behaviour are argued to be important reasons why collaborative working methods are still rarely used in practice (Gil, 2009; Kadefors, 2004). In addition, it has been argued that traditional construction contracts promote self-interest, opportunism and adversarial behaviour rather than collaborative relationships. Thus, for several decades researchers have called for flexibility and a stronger focus on fostering collaborative relationships in contracts (Macneil, 1974), and various relational contracting (RC) strategies have been developed to encourage client-contractor cooperation. RC enables clients and contractors to work together for a common objective and achieve good project results. An extensive literature review of existing definitions of RC is presented by Yeung et al. (2012). The authors identify five common elements of RC: commitment, trust, cooperation and communication, common goals and objectives, and win-win philosophy. Other elements that may be present in some (but not all) forms of RC include: formal contracts, agreed problem resolution and continuous improvement procedures, facilitated workshops, equity, a joint declaration statement, and real gain share/pain sharing.

Results of an investigation of formal and RC strategies, based on an analysis of 125 inter-organizational relationships, challenge the view that RC strategies are the best for responding to uncertainty and opportunism (Carson et al., 2006). The cited authors conclude that both strategies have advantages and disadvantages, and are not substitutes for each other. In contrast, Doloi (2013) argues that relational contracts are superior to formal contracts as they foster a culture of integrated project delivery and enhance mutual benefits in projects. He also identified factors that are critical in both formal and relational contracts, including: understanding risks, proactive problem resolution, trust and communication. Gil (2009) contributes to this debate with a case study indicating that RC fosters cooperative relationships between project actors, but only if it is implemented appropriately. Therefore, a clear understanding of the advantages and limitations of both formal and RC is crucial for identifying and implementing optimal strategies.

In another contribution, Cheung et al. (2009) surveyed practitioners' views and found that most respondents did not perceive their contract behaviour as aggressive and regarded themselves as non-confrontational. They also identified and rated drivers of cooperative and aggressive behaviour in construction contracts. Significant cooperative drivers were found to include: openness of contracting parties/contract settings, good relationships among contracting parties, contract completeness, good teamwork, incentives for risk-sharing/problem-solving, effective communication, and a desire to maintain relationships. The

most important drivers of aggressive behaviour included unfavourable past experience, goal-orientation, and difficulties in meeting contractual obligations.

Advocates of the RC approach criticize lump sum payment mechanisms and endorse the use of contract incentives to promote collaborative problem-solving. It has been argued that lump sum payment mechanisms shift all responsibilities and liabilities for risks to one actor, thereby hampering possibilities for performance improvement (Floricel and Miller, 2001). Moreover, a study by Müller and Turner (2005) indicates that lump sum contracts have adverse effects on communication between clients and contractors. In contrast, use of incentives is positively related to risk reduction because rational decision makers are likely to minimize risk so they can get a reward (Knight *et al.*, 2001), they prefer to cooperate when tangible rewards for problem-solving are provided (Wong *et al.*, 2008), and when incentives are used clients and contractors share both risks and rewards (Floricel and Miller, 2001). Thus, Turner and Simister (2001) argue that cooperation throughout the project requires incentivization of all involved actors.

The roles of trust and communication (formal and informal) between owners of projects (principals) and project managers (agents) in the context of principal-agent theory have been examined in an international study by Turner and Müller (2005; 2004) They found that a balance between formal and informal communication (mediated through official and ad hoc channels, respectively) is required for optimal project performance. They also found that regular, face-to-face meetings are valuable for fostering efficient communication. Similarly, Westbrook (1996) highlights the importance of information exchange and open communication for collaboration generally and joint problem-solving specifically. Rahman and Kumaraswamy (2008) have also argued that trust and trust-based arrangements underpin RC. Doloi (2009) identified JRM as a major aspect of RC strategies, and presented a questionnaire survey of 97 Australian construction practitioners' views indicating that JRM capability heavily depends on the levels of trust and confidence among the project actors. Finally, for this summary of the theoretical framework Lentiranta (2013) found that three collaborative RM practices (risk workshops, contractor integration in RM, and a multi-directional performance feedback system) facilitate an integrated approach to RM, improve risk communication and allow flexible risk-sharing in the project.

3. Method

Through a literature review, a number of agency-related problems were identified, as shown in Figure 1. A longitudinal case-study was chosen as the main research method, on the basis of three criteria: the type of research question, extent of control over behavioural events and degree of focus on contemporary events (Yin, 2009). This study is contemporary with no control or manipulation of the project actors' behaviour. The research questions are of a "how" type: for example, how do project actors create compatible objectives, and how do they cope with the problem of differences in risk attitudes? Thus, case-study is the optimal approach as it provides opportunities to investigate contemporary processes to sufficient depth and is suitable for addressing research questions such as those formulated in this study (Pratt, 2009; Yin, 2009).

3.1. Case selection and description of case study projects

There were two main criteria for selecting case study projects. First, as the investigation focuses on collaborative relationships and JRM, we sought projects where the managers intended to implement RC and JRM. Second, the projects should be in early stages to allow opportunities for directly observing JRM workshops, interviewing key personnel, and reviewing project documentation. Third, access to potentially important data, and hence willingness of the project managers to share information and permit access to such data, was regarded as highly important. Initially, one construction project was chosen for investigation. When the first project had successfully finished, the researchers decided to follow a new project undertaken by the same team, partly to examine how experiences and the relationship history from Project 1 affected working procedures and activities in it.

The two projects involved the construction of new pharmaceutical laboratory facilities consisting of three buildings, as shown in Table 1. Two were constructed in Project 1 (designated PharmaLab here) and one in Project 2 (designated BioLab). Construction started in 2007 and the facilities were finished in autumn 2013. The client is a large public organization that regularly undertakes construction works and has long experience of the construction industry. Both projects were procured on a general contract basis with an additional collaborative agreement. The general contractor is one of the largest contractors in Sweden.

Table 1. Characteristics of the case study projects

Case study name	**Construction type**	**Construction time**	**Area (m^2)**	**Type**	**Payment mechanism**
Project 1 (PharmaLab)	Construction of new two buildings	2007-2010	20 000	Laboratory facilities	Fixed price with cost-reimbursable and bonus
Project 2 (BioLab)	Construction of one new building	2010-2013	10 000	Laboratory facilities	Fixed price with cost-reimbursable and bonus

3.2. Data collection

As multiple sources of evidence improve the quality of findings, analysis and conclusions (Yin, 2009), three kinds of evidence were utilized in the study: direct observations, interviews, and documents. Eight JRM workshops in two projects were observed by the researchers. Before observing a workshop, some preliminary data were collected through email communication, following suggestions that observations before interviews can provide valuable insights about questions to be asked during interviews (Alvesson, 2011). The preliminary data included information about the organization and objectives of the project along with risk and contract documentation. The information collected was used to understand the project environment i.e. participants' roles, the project's main phases and schedule, contract conditions, RM and collaborative activities. A qualitative technique was adopted

during observations, i.e. the researcher recorded events to provide a relatively incontestable description for further analysis (Stake, 1995).

In total, 23 interviews were conducted. In each case project there were two rounds of interviews. In the first round, during implementation of the project, the respondents described the project and their roles then cooperative procurement issues, organization of JRM and relational workshops were discussed. In the second round, after the projects had finished, JRM and factors that influenced collaborative relationships amongst the project actors were discussed in more detail. In particular, the interviewees were asked to describe how they dealt with risk and their JRM activities, i.e. what tools they used and how JRM workshops were organized. Then, collaboration and relationships among the actors were discussed. The interviews were semi-structured, in-depth, face-to-face, and lasted approximately one hour. The interviewees included representatives of the client (the overall project manager, a design manager and on-site staff), contractors (a project manager, a site manager and a construction engineer) and consultants (an architect and technical consultants). To increase reliability (transparency and replicability), all interviews were tape-recorded and case study protocols were constructed (Yin, 2009).

Finally, RM documentation and collaboration agreements were studied. Together with interview data, the documentary materials were used to draw an in-depth picture of how joint JRM was carried out in each project and how collaborative activities and tools were organized and used.

3.3. Data analysis

Each case was described using RM and RC documentation, interview transcriptions and observation notes. First, within-case analysis was applied to investigate the unique patterns of each case (Eisenhardt, 1989). The organisation of JRM and establishment of collaborative relationships in the projects were analysed using explanation building, which is valuable for not only explaining processes such as JRM but also for reflecting upon the underlying factors that affect their implementation (Yin, 2009). We analysed how project actors created common goals, how they addressed differences in risk attitudes, and how they managed information asymmetry, outcome uncertainty and complexity. The variable “length of relationship” differed significantly between the projects, as key actors were involved in both projects. Thus, cross-case analysis was applied to examine similarities and differences in the projects. For this purpose, the data were organized in matrices with defined rows and columns (Miles and Huberman, 1994). The rows included the agency-related problems and columns contained data describing how the problems were addressed in the projects. The results of the analysis were compared to theoretical propositions about RC and JRM.

4. Results

The projects were considered successful in terms of function and quality for the following reasons. According to the respondents, an unusually few errors were found during the final inspection. In budgetary terms, both parties achieved their objectives and the client paid the general contractor a full bonus. Despite many changes originating from the tenant during the construction process, the projects were completed on time.

4.1. Establishing cooperative relationships

In both projects, there was a strong focus on fostering cooperative relationships from procurement onwards. During bid evaluation, soft parameters such as the contractor's expertise and collaborative abilities were evaluated by the client. The client mentioned that despite the importance of price, soft parameters in partner selection are particularly important as they underpin cooperative relationships. Moreover, incentives were used in the projects through a performance-related bonus, as the client believed that incentives would help to motivate the main contractor to deliver cost savings in the project. The actors also agreed that financial discussions that often accompany projects with lump-sum payment mechanisms do not foster a collaborative environment. Therefore, a mixture of lump-sum and cost-reimbursable payment mechanisms was chosen. A lump-sum payment covered frame erection, renting of machines, and wages of the project team, while a cost-reimbursable mechanism was used for building materials and works. A target price was set for the cost-reimbursable part and a performance-related bonus was connected to the target price. The project actors highlighted the importance of choosing a payment mechanism that shifts the focus from financial discussions to identifying the best possible solution for the project.

The subcontractors were jointly procured by the client and general contractor, and the client's construction managers collaborated extensively with them when addressing technical issues during the production phase. However, the subcontractors were excluded from the JRM and relational team in PharmaLab, partly to avoid the team becoming too large and thus reducing the possibility to work effectively in workshops. In BioLab, main subcontractors participated in relational workshops, but not JRM workshops.

In addition, the project actors emphasized the importance of straight, honest communication in order to underpin good relationships and decrease information asymmetry. The client's and contractor's offices were located close to the construction site, making it easy to communicate during the project. Moreover, subcontractors were located at the same premises as the general contractor and the client maintained broad communication with them. As design work was conducted in parallel with construction, extensive communication between the design team and general contractor was particularly important. The actors also noted that both formal and informal communication were important for dealing effectively with information asymmetry. Formal communication was maintained through meeting protocols, email communication, maintenance of a joint database and mandatory reports. Equally important, according to many respondents, there was abundant informal communication during coffee breaks and lunches.

Overall, collaboration in the projects was very high. In addition to JRM workshops (which were highly rated by the project actors), the following collaborative activities were used: relational workshops, establishment of common goals, a joint project database, and team-building activities. According to the actors, relational workshops and JRM workshops were the two most important activities for both fostering strong cooperative relationships and the effective RM process.

4.2. Relational workshops

After the contract had been awarded to the general contractor in the *PharmaLab* project and the frame had been constructed a relational workshop was organised to identify the client's and contactor's perceptions of each other and then establish a productive relationship. The discussion revealed traditional views, i.e. the client and contractor saw each other as rivals with different, often conflicting, goals. During the workshop the parties discussed how they

could change this situation and create a collaborative relationship. During the workshop 15 common goals were identified, including the following six:

- Joint cost management;
- Straight, honest and benevolent communication;
- Open exchange of information about problems and risks that emerged in the project in order to solve them jointly;
- Joint and open discussion about the schedule and consequences of schedule changes;
- Helping and caring about each other;
- An intention to spread a collaborative spirit throughout the whole supply chain.

A "statement of common goals" was prepared and signed by all the workshop participants and reviewed every three months. During the follow-ups the participants discussed relationships in the project and their collaborative work towards the common goals. In order to evaluate relationships each participant answered a short anonymous questionnaire survey. The survey answers were then analysed by a partnering facilitator and presented during the next workshop. The actors strongly believed that holding workshops was an effective method for facilitating good relationships.

The success of the PharmaLab project resulted in the client deciding to work with the same project team and general contractor in the *BioLab* project. This allowed for a quick project start because the actors already had a well-established relationship. However, the BioLab project management team decided to delay formulation of the common goals until the main sub-contractors had been procured. According to the partnering facilitator this was done because there would then be more knowledge about the project, allowing common goals to be formulated more precisely, while early formulation could result in very vague goals.

Relational workshops started in January 2012. They involved a significantly larger group than in the first project, including an architect, technical consultants and the main sub-contractors in addition to representatives of the client and general contractor. The partnering facilitator introduced the main principles of collaborative work and described the collaborative activities that were used in the first project. During the first exercise the group members focused on differences in their prejudices about each group of actors (clients, contractors and consultants). Clients were characterised as being time optimists, stingy, reliant on formal contracts, and eager to pass all risks to contractors. Contractors were regarded as conservative, focused on short-term goals, poor communicators and likely to blame consultants for problems. Consultants were criticised for being too theoretical and unrealistic, negligent about cost, and blaming all other actors. Then, expectations were discussed and 14 common goals were formulated, including the following six:

- To do the right things in the beginning to avoid having to re-do them later;
- To communicate creatively about alternative solutions;
- To identify critical project points and prepare them in detail;
- To minimize conflicts;

- To dare to propose and prove new systems and materials;
- To maintain a clear focus on operations from the outset.

Finally, a statement of common goals was drafted, concluding with the following promise "We agree to work according to these intentions and strive to achieve our common goals", and signed by the actors involved.

Follow-up relational workshops were organized every three months, following a similar approach to the one adopted in the PharmaLab project. Before each of these workshops the actors responded to an anonymous survey about relationships in the project then the results were presented and discussed during the workshop to improve the collaborative climate and catch potential problems. Overall results of the surveys show that the actors evaluated the relationships as being warm, friendly, effective and (moreover) increasingly harmonious after several relational workshops.

4.3. JRM workshops

In *PharmaLab*, JRM was initiated by the client after the contract was awarded to the general contractor. The client emphasised that it was very important to start soon. The JRM team included not only the client and the general contractor, but also the architect and other consultants, in order to draw on a broad range of knowledge and expertise and smooth the problem of different risk attitudes. The client organized a two-day kick-off for the risk management group to identify and evaluate risks. During risk identification several groups of 4-5 people were formed, each with a suitable range of expertise, and assigned to identify as many risks as possible. In a subsequent interview the project manager highlighted the importance of the positive environment, which bolstered the group members' confidence.

Then the risks were discussed by the whole group and a risk register of approximately 50 risks was compiled. During risk analysis, the probability and potential consequences of each risk were identified, based on judgements of the project participants, on scales from 1 to 5, and a risk score was calculated by multiplying the probability and consequence parameters. Finally, risk response actions were defined. After the initial meeting, follow-ups were organized every third month, which included revision of the risk register based on a joint discussion.

In *BioLab*, a similar approach was adopted. However, the RM group was extended by including representatives of the prospective tenant. The initial meeting was held in the project office. Representatives of the client, contractor, tenant and consultants were invited and the risk register from the first project was used together with brainstorming to identify new risks. The project manager explained that the previous risk register was used because the second project was similar to the first and some risks were the same. During subsequent interviews many project participants commented on this approach and argued that it would be more fruitful to start with no risks listed. The risk register was updated every third month during JRM workshops. During the project implementation there were several personnel changes, for example both the client's and end-user's project managers changed. The project manager emphasized the importance of JRM workshops for new team members as it can be difficult to understand identified project risks without involvement in them.

5. Analysis and discussion

Principal-agency theory is highly relevant to a number of problems that may arise in relationships between project actors. The empirical results illustrate how these problems were addressed in the two case study projects, which were very similar in terms of project conditions, procurement methods, organizations, and applied tools and methods. The main difference was in the length of relationships among project actors, which differed significantly because the actors in BioLab had already established strong relationships with each other in PharmaLab.

A fundamental proposition of agency theory is that relationships between contracting parties are characterized by adversity generated by their *different goals* (Eisenhardt, 1989). Exercises conducted during the relational workshops showed that the project actors perceived that they may have had different goals, partly because of traditional roles associated with them, and partly because of the different tasks they had in the projects. In both PharmaLab and BioLab there were successful attempts to create common goals through relationship workshops. The project actors agreed that the "statement of common goals" facilitated solution of many problems during the project, and that promising to pursue the common goals encouraged them to strive to collaborate effectively.

In the studied projects *differences in risk attitudes* were managed through cooperative procurement procedures, cost-reimbursable payment mechanisms and the use of incentives. The payment mechanism with incentives raised the motivation of the main contractor to decrease the project cost by finding the optimal actions in cooperation with other project actors. This cooperative approach helped to overcome the problems of different perceptions about where risks should be allocated within a supply chain, identified in prior literature (Hanna et al., 2013; Loosemore and McCarthy, 2008). Moreover, use of incentives underpinned a desire to minimize risks instead of shifting them to one another, thus contributing to JRM. However, the subcontractors were excluded from incentive-based schemes. Therefore the problem of strong disagreement about risk allocation further down the supply chain has not been addressed.

Due to the relationship history among the project actors and experience from the similar previous project, initial *information asymmetry* was lower in BioLab. For example, the main project actors had already undertaken a similar project together and thus were aware of each other's ways of working, communicating, and decision processes. Hence, there was no need to estimate if candidates had the required skills (Bergen et al., 1992), which saved time in the early phases and allowed for quick start of the project. A joint database for project documentation was used in both projects, which also decreased information asymmetry. Intensive communication through both formal and informal meetings provided important forums for discussions of problems (actual and potential) and possible solutions. The project actors mentioned that straight, honest communication facilitated better understanding of the project and underpinned JRM.

Numerous changes required by the prospective tenant led to significant deviations in project schedules and created high *outcome uncertainty*. The actors agreed that collaborative attitudes and strong relationships were essential for managing the consequent time pressures and meeting the tough deadlines. To *measure outcomes*, a number of internal controls were used. The experience from the PharmaLab project was highly beneficial in the BioLab project. Notably, the problems that the project team faced at the final stage of the first project were

identified and addressed much earlier in the second project. Moreover, a desire to meet the building's functional specifications was included in the statement of common goals and technical controls were performed to identify potential problems. The target price was also used as a key output control in both projects. Joint cost management was identified as one of the common goals and the project actors had open discussions on the project budget. The use of multiple output parameters suggested in the research literature (Das and Teng, 2001) resulted in reliable assessments of project actors' performance.

Both PharmaLab and BioLab were characterized by high *complexity*. Technical complexity was present as there are many interconnected installations in the laboratory facilities. Moreover, organizational complexity was present as many subcontractors were involved that had to be subordinated. Design work continued throughout the projects and required continuous interaction among the actors. These discussions allowed the main contractor, designers and consultants to jointly find the best potential solutions and were valuable for enhancing JRM. The project actors generally agreed that there is a greater need to exploit all the available competence and knowledge, and thus for collaboration, to find optimal solutions in difficult and complex projects. They also highlighted the importance of good relationships for solving many technical problems, and commitment of the project management for managing high complexity.

To summarize, effective methods were adopted in both projects to solve the agency-related problems and establish strong cooperative relationships that enhanced JRM. The attitude of the project management played an important role in fostering collaboration and creating an environment where personnel felt confident about their roles. The degree of collaboration observed in the case-study projects is rare in the Swedish construction industry, and the project actors mentioned that it was difficult initially to understand the nature of collaboration. They understood the guidelines and that everyone was expected to do the right thing at the right time, but less sure what would happen if someone did something wrong. The answer was joint discussion of the problems to ask for help without anxiety about losing prestige.

6. Conclusions

Adversarial relationships in construction projects result in actors being more concerned about maximizing their own utility than the overall project results and thus concentrating on risks associated with their own part of the work instead of JRM. However, successful RM requires actors to establish collaborative relationships based on common goals, trust and mutual respect for each other's competence. Our findings suggest that establishment of such relationships requires agency-related problems to be addressed successfully. Using agency theory, the most important problems that may hamper collaboration are identified in the paper and include: different goals and attitudes to risks, information asymmetry, outcome uncertainty and measurability, complexity and length of relationships.

The empirical findings provide illustrative examples of how the problems were addressed in the two case construction projects. Goal alignment can be achieved through relational workshops and formulation of "a statement of common goals", while differences in risk attitudes can be managed through cooperative procurement procedures, cost-reimbursable payment mechanisms, and the use of incentives. Straight, honest communication is vital for minimizing information asymmetry and may be underpinned by maintaining a joint project

database, informal meetings and team-building activities. Long-term focus (related to the length of relationship) underpins collaboration and may significantly decrease time required for establishing strong relationships.

The empirical findings also show that strong collaboration is a multi-dimensional activity that is crucial for JRM. Effective JRM is highly dependent on other dimensions of collaboration (such as cooperative procurement, establishment of common goals and open communication) and should be implemented together with other factors.

This study contributes to both RM literature and practices. By identifying agency-related problems that have major impact on collaborative relationships in general and JRM in particular, this research contributes to RM literature where fewer studies have discussed JRM from the perspective of the principal – agent relationships. This research also increases understanding of how strategies to handle agency-related problems can foster collaborative relationships and JRM. In addition, this study increases awareness of the importance to establish collaboration further down the supply chain. Although the findings were obtained from observations of construction projects, the author believes that the findings may be useful in other project-based industries and complex, uncertain projects where strong relationships and extensive JRM are crucial.

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