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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 (Florice 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 con-

struction 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 perspec-

tive 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 thorough 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 road in 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.