Challenges in Implementing Systemic Innovation in Transport Infrastructure Projects

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Abstract:

Innovation and productivity improvements are essential ingredients to reduce lead times, costs and environmental impact and improve value for money in the transport infrastructure sector. Transport infrastructure projects are inter-organizational and innovations are often of systemic nature. Prior research indicates that implementation of systemic innovation is difficult in inter-organizational projects. The purpose of this study is therefore to identify differences between prospective opportunities (given by the client) and challenges (perceived by the contractor) that affect the implementation of systemic innovations in infrastructure projects. A multiple case-study of six infrastructure projects, which the Swedish Transport Administration has classified (ex ante) as innovation friendly, have been conducted. The selected projects may be viewed as favorable critical cases; if innovations are not successfully implemented in projects that have been classified as innovation friendly, innovation implementation will be even more difficult to manage in other types of projects. The empirical data is collected through semi-structured interviews with relevant stakeholders from both the client and contractor in the project organizations. Tentative findings reveal multiple implementation challenges throughout the projects. Challenges are often related to the fact that even small innovations become systemic and therefore affect multiple stakeholders. Moreover, it is evident that client and contractors often have different views on these challenges and to what extent the clients' procurement strategies and project management practices have given opportunities for innovation. The findings extend current knowledge of managing innovation within the public transport infrastructure sector.

Keywords: *Innovation management; Construction innovation; Procurement strategies; Project management.*

1. Introduction

Like those in other industries, firms in the construction industry are exposed to increasing competition and customer demands, and hence must be innovative in order to improve productivity and competitive advantage (Winch, 2003; Panuwatwanich et al., 2009). This could be highly significant because many governmental reports and research publications highlight that low productivity is a problem facing the construction industry in many countries, including Great Britain and the US (e.g. Egan 1998; Teichholz et al., 2001). In Sweden there is also an urgent need to raise productivity and client satisfaction in the construction industry (including

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both building and infrastructure sector), which has triggered a number of government investigations (SOU, 2002; 2012).

Measures to increase the productivity of the transport infrastructure sector are particularly important from a societal perspective, since significant amounts of public funds are invested in a sector that is crucial for national development and economic growth (Caerteling et al., 2011). Previous research has found that productivity is a key challenge in this sector, and that many transport infrastructure projects suffer from cost and schedule overruns (Flyvbjerg et al. 2004; Cantarelli et al., 2012). However, introducing extensive innovations, which could lead to increased productivity over time, has been particularly difficult in the transport infrastructure sector. Frequently mentioned reasons for this include the industry’s project-based, engineer-to-order, fragmented and strongly institutionalized characteristics (e.g. Kadefors, 1995; Fairclough, 2002). Due to the highlighted characteristics of the industry, the most common innovations in construction are incremental and arise to solve problems within construction projects (Winch, 1998; Taylor and Levitt, 2004). These incremental innovations seldom leads to systemic changes but remains project-specific.

Innovations in the project-based transport infrastructure sector are always implemented within inter-organizational transport infrastructure projects rather than, as in more traditional manufacturing industries, within the organizations developing the innovations (Winch, 1998). This has profound consequences for the implementation of (especially) systemic innovations (Colvin et al., 2014) since not only the developing company is affected, but rather a number of stakeholders throughout the supply chain. Innovations may be developed inside or outside a transport infrastructure project by stakeholders, such as contractors or suppliers, but the public client must, as a “system integrator”, initiate and manage any subsequent implementation (Segerstedt and Olofsson, 2010). The strong influence of the client with its accompanying norms, regulations and procurement strategies have previously been stressed as barriers hampering the implementation of systemic innovations (Larsson et al., 2014). Thus, owing to the inter-organizational and project-based nature of the transport infrastructure sector, the procurement strategies of the client have the ability to strongly affect the rate of systemic innovations.

The importance of the client has been recognized by the Swedish Transport Administration (STA). STA is the major public client of transport infrastructure in Sweden and consequently the influence of their procedures cannot be ignored. STA has recognized the need to increase rates of innovation, both by initiating an innovation program and by increasing the rate of design-build (DB) contracts, to resolve the issue of low productivity. In prior research, DB contracts and early contractor involvement have been suggested to increase the opportunities for contractors to innovate (Eriksson et al., 2014) and improve cost and/or time performance (Hale et al., 2009; Song et al., 2009; Shrestha et al., 2012). However, recent studies pinpoint that the extent of specification in the contracts, the reward system, and other aspects related to the client’s procurement strategies also affect the contractors’ possibilities and incentives for innovation (Ahola et al., 2008; Eriksson, 2017).

Due to the inter-organizational nature of transport infrastructure projects and systemic innovations, it is critical to increase the knowledge of how the client’s procurement strategies affect the contractors’ perceived opportunities and incentives for innovation. The purpose of this study is therefore to identify differences between prospective opportunities (given by the client) and challenges (perceived by the contractor), affecting the implementation of systemic innovations in transport infrastructure projects. The empirical data is acquired from a multiple case study of six public transport infrastructure projects. The findings from the multiple case study extend current knowledge of the management of systemic innovations within the public transport infrastructure sector.

2. Systemic innovation in transport infrastructure projects

Organizations in the project-based transport infrastructure sector are often fluidly structured to deliver unique and complex solutions for their clients in specific business projects (Gann and Salter, 2000). Transport infrastructure projects, as business projects in the transport infrastructure sector, usually offer unique solutions to each client in an arrangement bounded by contractual agreements (Keegan and Turner, 2002). The client normally initiates projects, defines their specifications, provides financial resources, and benefits from the end delivery (Keegan and Turner, 2002). Owing to the project-based setting, innovative approaches and performance aimed at the successful execution – in terms of budget, schedule, quality, and (hence) short-term efficiency – of individual transport infrastructure projects, have been emphasized in construction management literature (Winch, 1998; Egan, 1998). Therefore, innovation implementation usually occurs during daily design and production in individual business projects. There is however another possibility for achieving innovations where stakeholders develop the innovations in separated development projects followed by implementation in business projects (Blindenbach-Driessen and Van Den Ende, 2006). Stakeholders throughout the supply-chain (e.g. contractors, consultants and material suppliers) therefore handle two distinct types of projects: business projects and development projects. Thus, innovation may arise via either of two paths: via problem-solving in business projects or through development projects in firms followed by implementation in inter-organizational business projects (Winch, 1998; Eriksson, 2013). Furthermore, due to the inter-organizational nature of business projects most innovations, whether they are small or large, affect multiple stakeholders throughout the supply-chain and hence become systemic.

Successful realization of systemic innovations often require coordinated changes by multiple stakeholders throughout the supply-chain (Taylor and Levitt, 2004; Kähkönen, 2015). The new knowledge needed for these systemic innovations often needs inter-organizational knowledge, hence the approach to innovation must become more open. However, a more systemic approach to innovation, which requires collaborative approaches, has scarcely been reported in construction management to date. Control focused project management practices based on planning and control have instead been emphasized as important aspects of business projects to minimize deviations from the pre-determined goals (Crawford and Pollack, 2004; Geraldi, 2009; Karrbom Gustavsson and Hallin, 2014). Most prior studies on construction management therefore promote control focused project management practices to facilitate efforts to minimize change and promote satisfactory performance of individual projects (Dvir and Lechler, 2004; Menches et al., 2008; Giezen, 2012). Furthermore, project managers are generally reluctant to develop innovations within business projects and, if developed, the success of such innovations is limited by the project control systems (Keegan and Turner, 2002). These procedures based on extensive planning and control especially affect the implementation of systemic innovations since they require changes throughout the supply-chain, regardless of the origin of the innovations.

The early stages of development in business projects involve high levels of uncertainty among stakeholders (Widén et al., 2013), which are gradually replaced by knowledge acquired through various activities. At the end of the development (if successful), the solution can be implemented into its intended context. These processes pose fundamental challenges to project management, and managers (who oversee this development) must maintain sufficient perspective to handle the constant shifts in knowledge, aims, and other issues associated with the project. An understanding of the intricate and dynamic phase of implementation is essential for the introduction of new products, services or processes, but innovation implementation is a difficult and uncertain task. The major steps in the implementation phase of business projects are: providing suitable resources, supplying tenders and planning inputs, and gaining experience and widespread acceptance (Tatum, 1987). Stakeholders play a vital role in implementation of systemic innovations and those who are overlooked will be disengaged and unable to contribute to success (Widén et al., 2013). In fact, the absence of stakeholders in early key decisions/gates could have a devastating effect on the process. The client that manage the process must therefore act as an integrator (rather than as a delegate for stakeholders) who engages stakeholders at the right time and maintains their motivation and focus. These aspects are highly dependent on the client's procurement strategies that affect key stakeholders' opportunities and incentives for innovation (Ahola et al., 2008). Eriksson (2017) argue that the delivery system affect the opportunities for innovation by deciding both the timing and degree of involvement in development work. Furthermore, the reward system and the partner selection procedure affect the contractor's incentives to innovate (Eriksson, 2017). The last component of any procurement strategy, i.e. the collaboration model, affects both opportunities and incentives, especially for systemic innovation where inter-organizational collaboration is critical (Eriksson, 2015).

3. Method

Case studies are beneficial in fields that are still in an exploratory stage, since they can provide rich data, give insights into complex behaviour, and identify new aspects and phenomena (Yin, 2013). Thus, a multiple case study approach seemed the most suitable for the study of challenges for implementing systemic innovation in public transport infrastructure projects.

3.1 Sample

The empirical data used in this study concern six public transport infrastructure projects, with some differences in characteristics and procurement strategies. However, similarities are that all six projects are managed by Swedish Transport Administration (STA) and are rated (ex ante) by the client as innovation friendly. Criteria for selecting cases were therefore based mainly on *critical cases* to achieve data that permits logical conclusions, but to some extent also *maximum variation cases* to be able to detect similarities and differences between projects with different characteristics (Flyvbjerg, 2006). STA provided a list that contained projects that they has rated as innovation friendly. This classification was based on that the client had taken sufficient proactive action (e.g. early market dialogue, external review of tender documents, tender documents based on functional requirements) to promote development and innovations in each project. Table 1 summarizes information about the studied transport infrastructure projects and their respective focus for the identified components in the procurement strategy.

Table 1 Information about the studied transport infrastructure projects

Proj.	Description	Delivery system	Reward system	Bid Invitation	Bid Evaluation	Collaboration model
1	New railway bridge	DB	Fixed price	Open	Lowest price	Basic
2	New and reconstruction of a highway	DB	Fixed price	Open	Lowest price	Basic
3	Strengthening of existing road	DB	Fixed price	Open	Lowest price	Basic
4	Maintenance of existing road	DB	Fixed price with incentives	Open	Lowest price	Medium
5	New railway and road	ECI	Target cost	Selective	Multiple criteria	High
6	New and reconstruction of a highway	ECI	Target cost with incentives	Open	Multiple criteria	Medium

3.2 Data collection

Data for the study were gathered through multiple methods (interviews and secondary data collection). However, most information was collected through semi-structured interviews with respondents playing key roles such as project manager (PM) in each project (Table 2). The interviews were conducted to obtain rich insights regarding procurement related opportunities and challenges for implementing innovations.

Table 3 Roles of interviewees in each of the projects and length (in minutes) of each interview

Project	No.	Respondent	Length
Project 1	1	PM client	63
	2	PM contractor	42
Project 2	3	Procurer client	40
	4	PM client	32
	5	PM contractor	40
Project 3	6	Procurer client	22
	7	PM client	32
	8	PM contractor	51
Project 4	9	Procurer client	31
	10	PM client	38
	11	PM contractor	61
Project 5	12	Procurer client	36
	13	PM client	38
	14	PM contractor	27
Project 6	15	Procurer client	55
	16	PM client	59
	17	PM contractor	38

An interview guide was developed and used to maintain coherence in the data collection and also to facilitate the following analysis. The interview guide (in addition to items regarding background information) included themes such as innovation rate, specific implemented innovations, and perceived barriers, opportunities and drivers for innovation. Departure from the questions included in the interview guide was permitted, to pursue interesting and particularly relevant insights that emerged during interviews. All interviews were audio-recorded and transcribed to enable investigator triangulation (Patton, 2002). Secondary data about the projects was obtained from internal project documents and from publicly available sources. The multiple source approach enabled data triangulation, which helps strengthen the construct validity of case studies (Patton, 2002).

3.3 Analytical procedure

The analysis follows the steps for qualitative research proposed by Miles & Huberman (1994): data reduction, data display, and conclusion drawing and verification. In the data reduction step, interview responses were first summarized and transferred into a database to focus and organize the data. This was followed by a thematic analysis where the empirical data were coded into categories, based on opportunities and challenges related to innovation, to make the data more manageable and meaningful. The coded data were then displayed in a table to facilitate interpretation. During the data analysis, iterations between emerging results, theory, and empirical data related to the projects were performed to consolidate the developing conclusions (Yin, 2013).

4. Findings

4.1 Project 1

Project 1 involves construction of a new railway bridge located in a very challenging terrain requiring adaptation of traditional production methods. The most challenging task is not the actual construction of the bridge but the logistical task of transporting building materials to the site. The difficult site conditions led the client to invite each potential bidder to a guided site visit. The project also encompasses a rather tight time schedule since the bridge is to be opened for traffic before a certain large sport event. Due to this issue, the procurement have run parallel to the process of establishing the required plan of the project scope, which contains information about where the road/railway is to be built in terms of a road corridor with fixed height and width. The usual procedure is to have this scope plan approved before the procurement of the contractor since this simplifies the process of establishing certain requirements and demands in procurement documents.

The client was of the general opinion that they had created significant opportunities for the contractor to innovate. First, even though the position of the rails are fixed, all other requirements of the structures beneath the rails are based on functionality, which should increase the freedom for the contractor to select suitable types of structures and construction processes. The other action that is conducted to facilitate for innovation is that the project has been provided with a larger terrestrial access around the site than what is traditionally provided. This should, according to the client, increase the possibility to use more innovative logistical solutions for the contractor during construction. The positive view of opportunities for innovation is not shared by the contractor in any of the above aspects. The contractor instead means that their entrance point in the project should have been in an earlier stage to enhance their opportunities for innovation. The PM of the contractor meant that when they got involved in the project: *"everything was already decided except quantities"*. Further, the contractor meant that the client's reason for using DB instead of DBB contract is to put more responsibility on the contractor since the project involves an extensive amount of complexity linked to the extreme site conditions.

4.2 Project 2

Project 2 is one part of a larger megaproject that aims to renovate and increase the capacity of one of the large highway routes in Sweden. The studied subproject is a traditional road project that contains widening the road and building four new bridges. The corridor for the road was fixed before the contractor entered the project and least possible land area needed for constructing the road was provided.

The client's procurement manager stated that "*this is a genuine DB contract that gives the contractor large degrees of freedom and opportunities to choose other solutions*". The aim of choosing a DB contract was to facilitate innovative thinking in early stages. However, the procurement manager also pinpointed the importance of promoting innovation after the contractor had been procured and that this depends on personal interests of project participants. Whereas the client believe that most of the procurement documents involved functional requirements, the contractor argued that the degrees of freedom were slim, not least regarding the bridges. The PM of the contractor said: *"This project is very controlled and constricted; there are so many specified technical solutions, which describe how things should be"*. This difference in perception was highlighted already at the start-up meeting when the contractor emphasized that the client had exceptionally many technical requirements in the specifications. Not only the procurement documents were perceived as a limitation for innovation, but also the tight time schedule and the narrow road corridor contribute to low degree of innovation.

4.3 Project 3

Project 3 involves reconstruction and strengthening of an existing road with rather low traffic load. This project is characterized by the client as rather standardized but the contract includes incentives for the contractor to both maintain high quality of the temporary gravel road as well as conducting the project in an efficient manner, contributing to an earlier opening of the reconstructed road.

The client has tried to define functional requirements instead of technical solutions but in reality the procurement documents contained a mix of both. Some of the expressed technical solutions are due to safety issues of both workers and road users during the time of construction. A suggestion from the client regarding production planning that could lead to increased quality of the end product is also included in the procurement documents. In this project the client's PM however realizes that the opportunity for innovations are limited mainly to production processes and the choice of material in the coating. This is also confirmed by the contractor that express the lack of freedom due to fixed road corridor and "too" high demands on certain quality aspects. The client further point out that by using a DB contract the warranty is ten years which increased the risk for the contractor. The contractor confirms this by saying that the demand and risk that are transferred from the client to the contractor in a DB contract lead to less tendency of testing innovations. The communication and collaboration between stakeholders during the detailed design stage has however been positive, which is emphasized by both client and contractor, meaning that many issues have been easily solved. This positive climate is according to the contractor due to the choice of DB contract where they are given a certain amount of opportunity to discuss and implement their production experience better than in a DBB contract.

4.4 Project 4

Project 4 includes a road maintenance contract that extends over 15 years. The agreement contains coating work and road marking of a specific highway section. This is a DB contract with functional responsibility for the contractor. The functional responsibility means that the client demand a certain quality of the road but the contractor can decide when, what and how the required actions to maintain the quality are to be performed. The client has included a penalty into the contract to ensure that the contractor delivers the requested quality of the product.

Both stakeholders were rather satisfied with how the procurement strategy works and especially the contractor was satisfied with the long-term contract since that gives opportunities and incentives to increase the rate of innovations and efficiency. The contract invites the contractor to choose from a variety of production methods, types of asphalt, when the actions are to be conducted, etc. The client's PM believes that this freedom contributes to innovation: *"I think we've opened up very well for innovation"*. This is the first time the client has procured road maintenance by functionality and the client's PM points out that there exists an internal uncertainty about this approach: *"It is with some internal concern and uncertainty, how dare you do it and how will it go?"* Those who are skeptical means that the contractor will do minimum actions to maintain the required quality, especially in the end of the contract: *"They will not do more than what is required. The last few years, they will probably not do anything at all"* (the client's PM). However, the contractor points out that the long-term contract allows them to invest in innovation and efficiency improvements in terms of machinery and equipment. However, the contractor stresses that it is a lack of incentives for the contractor to deliver a better solution than what is required, and that such incentives would promote even more innovations.

4.5 Project 5

Project 5 is one part of a larger megaproject that involves upgrading of the railway network in a metropolitan region. This subproject contains new construction of railway, road and several bridges. The complexity is rather high since the construction has to be integrated into the current transport infrastructure network that comprises several of the busiest roads and railway connections in Sweden. The high complexity lead the client to choose an early contractor involvement (ECI) approach with two stages, where the aim is to utilize the contractor's production knowledge in the early design stage. The first stage contains an 18 months period where the client, the contractor, and two different consultant firms are located together in a joint project office to design technical solutions, plan the construction work, and generate a target cost for the subsequent production. In the first stage, the contractor and consultants are engaged through a consultancy contract. After this target cost has been agreed and approved by the client, the actors enter the second stage, which contains production based on a DB contract.

The client has, due to the complexity and uncertainty in early stages, put emphasis on a high degree of cooperation and quality during the bid evaluation. Hence, the traditional focus on lowest price has been of less importance when selecting the contractor before the first ECI-stage. However, despite the ECI-approach, the railway and road corridors were fixed before the contractor entered the project, which arguably puts limits on the degrees of freedom and possibilities for innovation. Nevertheless, the contractor describes that high degree of cooperation and the joint project office facilitates innovation since a large amount of knowledge and experience is collected under the same roof in an effort to achieve a joint goal in the best way. High degree of cooperation and the work with many parallel project processes also cause some difficulties. Since the stakeholders have different organizational goals and internal processes, the contractor emphasizes that it has been a struggle to get everyone into the same boat. The parallel processes conducted during the early stages increase the intertwining between certain tasks, sometimes leading to long waiting times. However, both the client and the contractor emphasize that this type of complex project would have been difficult to accomplish with a more traditional contract. The contractor's PM pinpoints that *"Looking at the complexity of what we are going to construct, I find it hard to see a different arrangement or another type of delivery system for this project…"*.

4.6 Project 6

Project 6 is another subproject within the abovementioned megaproject that aims to renovate and increase the capacity of one of the large highway routes in Sweden. The client conducted an early market dialogue with the aim to increase the interest for the project. This aim succeeded according to the contractor that won the contract. The contractor highlighted that this market dialogue triggers the organization to start discussing the project internally. The project is based on a two stage ECI-approach. The first stage contains a design and planning stage where the stakeholders together develop the scope plan in terms of the road corridor and subsequently design technical solutions and plan the construction work. During this stage the contractor also generates a target cost for the project which will then be discussed and approved by the client before the project enters the second stage, containing the construction work.

This ECI contract was procured in a very early stage when even the road corridor was still not fixed. Such an early procurement is unique for STA and thus this is considered a pilot project. The contractor that won the contract was involved in the deciding road corridors that suited efficient production. The involvement of the contractor in early stages is expressed by both stakeholders as a contributing factor for high rate of innovation. The client's PM states that *"When the contractor is involved in the design, they can take care of constructability issues and consider where it is good or bad to construct the road when choosing corridor. In this way, we are confident that we will have a better road to a more optimal price and a faster (construction) process. We avoid trouble when we start building"*. This is also confirmed by the contractor's PM: *"In this project we work together and decide on solutions together, the contractor participates and influences constructability"*. The difficulty for the contractor has been to perform calculations and produce an accurate tender since the procurement documents mostly consist of functional requirements. This is the first ECI contract managed by STA that is procured before the road corridor is fixed. Both the contractor and client stress the importance that the process will become even better if this pilot project is followed by others, since the approach demands a new mindset for both stakeholders. Collaboration between stakeholders in early stages has therefore been necessary and both stress the importance of joint goals and team spirit. The contractor's PM expresses that this is a really good opportunity and that *"STA has completely opened for novel solutions, because we do this together, nothing is fixed, there is total freedom, it is the dream for us"*.

5. Discussion

The discussion is divided into two separate parts where the six studied transport infrastructure project are divided into two groups based upon their procurement strategy. This separation allow a comparison of opportunities and perceived challenges between procurement strategies and other project procedures. The first group of projects (projects 1-3) consists of design-build (DB) projects with conventional procurement strategies that are based more on competition, whereas the second group of projects (projects 4-6) have procurement strategies focusing more on collaboration , either through early contractor involvement (ECI) or long-term contracts.

5.1 Competitive procurement strategies based on design-build contracts

The case study shows that the procurement strategies in these projects focus more on competition than on collaboration to achieve satisfactory project outcomes. The applied project management approach severely hamper intended innovative purposes in several ways. First, all these projects have a clear cost focus where the reward system is based on a fixed price and the contractors are procured entirely based on lowest price. This conventional competitive tendering approach has been found to hinder innovation in DB contracts (Ahola et al., 2008; Eriksson, 2017). Further, to secure a certain level of quality and minimize the risk of cost overruns the specifications and tendering documents comprise many technical solutions. Hence, the needed freedom for the contractors to choose other solutions and achieve innovations is lacking. These practices based on monitoring, extensive planning, and constraints are typically found within the control focused project management paradigm, which is the most common in construction (Karrbom Gustavsson and Hallin, 2014). The control based project management paradigm is most efficient when projects are rather simple and straight forward, making it possible to calculate costs, reduce uncertainty, and execute projects according to plans and pre-determined goals, while it is less suitable for complex and uncertain projects requiring collaboration and innovation (Crawford and Pollack, 2004; Geraldi, 2009; Karrbom Gustavsson and Hallin, 2014).

Findings reveal that all contractors agree that the late entering point and the lack of early joint development and problem solving pose a challenge for realizing systemic innovations. Hence, the vital sense of solidarity to do their utmost in the project is missing. This issue has been found to hinder innovation since disregarded stakeholders often becomes disengaged and unable to contribute to success (Widén et al., 2013). The empirical findings also show that more conflicts arise within this group of projects and that these are more difficult to solve due to the rather competitive climate and low degree of collaboration, which is created by the applied management practices and procurement strategy.

It was evident that the clients and contractors within this group of projects had different or even opposing views of the opportunities for and challenges of innovation. The clients seem to put a lot of hope and anticipation that the DB contract in itself will provide contractors with opportunities for innovation. Indeed, the aim of using DB contracts instead of DBB contracts is to improve efficiency and innovation. The contractors are of a different opinion. Since the contractors are involved when most important design parameters are already decided and fixed, the project becomes control focused and competition between stakeholders is evident for all projects in this group. Hence, the contractors perceive that everything is controlled and constrained by the client from the start, which complicates the implementation of systemic innovations. Accordingly, it seems that the clients are not aware of that they have adopted a control focused project management approach that hamper innovation.

5.2 Collaborative procurement strategies based on ECI or long-term contracts

The case study shows that the procurement strategies in these projects focus more on collaboration to achieve satisfactory project outcomes. ECI and long-term contracts spanning several years (15 years in Project 4) are important strategies to make the duration of collaboration longer, which is especially important in projects facing high complexity and uncertainty (Eriksson, 2015). Collaboration and knowledge integration among key stakeholders are critical aspects for managing complexity and uncertainty through flexibility and adaptation. These elements are central in the flexibility focused project management paradigm, which focuses on facilitating learning, innovation and development by embracing and dealing with complexity and uncertainty rather than reducing and controlling them (Crawford and Pollack, 2004; Geraldi, 2009; Karrbom Gustavsson and Hallin, 2014). Accordingly, the procurement strategies adopted in these projects seem appropriate to facilitate collaboration and adaptation in these complex projects with long durations.

The early joint development and problem solving by key stakeholders are stressed in all three projects as an important component to create a foundation for an innovative climate. These proactive discussions are most effective when important design parameters are not yet fixed and when the client is willing to listen to the contractor and change already established parameters to increase the innovation space. The motivation and collaborative climate are found to be better in all projects in this group. These project procedures integrate vital construction knowledge into early design decisions, which have long been recognized as important for achieving satisfactory performance in construction projects (Song et al., 2009).

It was evident that the client and contractors within this group of projects had similar views and anticipations of the opportunities and challenges for innovation. Both clients and contractors were very optimistic about their projects and all interviewees highlighted that the procurement strategies had set the stage for collaborative development efforts and joint problem solving. Because the systemic innovations that are common in this empirical context require inter-organizational collaboration and knowledge integration (Taylor and Levitt, 2004; Kähkönen, 2015), it seems that the flexibility focused project management approach adopted within these projects is suitable and that the stakeholders' common and positive opinion about the approach taken is justified.

6. Conclusions

The comparison of clients' and contractors' opinions about the opportunities and incentives for innovation in the six studied projects resulted in several interesting and relevant findings and contributions. First, we contribute to the procurement literature within the construction management field by highlighting the importance of choosing a suitable delivery system for the project at hand. Although some studies have found that DB contracts enhance project performance (Hale et al., 2009; Shrestha et al., 2012), we argue that that the choice of delivery system is not foremost about the type of contract. Instead, our findings suggest that the timing of contractor involvement, the length of the contract, and the extent of specification in the contract, have a stronger effect on contractors' performances in general and their possibilities and incentives for innovation in particular.

Second, we contribute to the project management literature by discussing how clients' procurement strategies are related to the two main project management paradigms, based on either control or flexibility. Our findings indicate that clients in the Swedish transport infrastructure sector believe that DB contracts procured by competitive tendering strategies provide contractors with opportunities for innovation. These clients do not seem to be aware of that such procurement strategies are related to a control focused project management paradigm that hampers innovation. Accordingly, to adopt a flexibility focused project management approach is not mainly about the type of contract (DB or DBB); it requires a more collaborative procurement strategy based on early contractor involvement and/or long-term contracts with less restricted specifications.

Third, we contribute to the construction innovation literature by discussing how systemic innovations can be enhanced in the transport infrastructure sector by adopting a flexibility focused project management approach based on collaborative procurement procedures. Prior research have found that systemic innovations require collaboration and knowledge integration among key stakeholders with different knowledge sets (Taylor and Levitt, 2004; Kähkönen, 2015). Hence, it is important to highlight that DB contracts procured through traditional competitive tendering procedures are not a strong basis for systemic innovations. Instead, our findings indicate that a flexibility focused project management approach based on early contractor involvement and/or long-term contracts may enhance contractors' opportunities to participate in innovative work and joint development efforts.

This multiple case study has some limitations that may spur further research on this topic. The sample is limited to six Swedish infrastructure projects procured by one public client. It would therefore be interesting to conduct a similar study in other empirical contexts, involving other construction and engineering sectors (e.g. housing and commercial buildings), both private and public clients, and projects in other countries. Furthermore, due to the small sample our findings are indicative and testable, rather than verified and valid. Hence, it would be relevant to make a large-scale quantitative study to investigate how different procurement strategies (competitive vs collaborative) and project management approaches (control focused vs flexibility focused) affect innovation and project performance in a large sample of projects with different characteristics.

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