PROCUREMENT OF RAILWAY MAINTENANCE: COLLABORATION FOR INNOVATION

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Railway maintenance is highly important for a sustainable transport system. A popular choice in Europe is to outsource the railway maintenance obligation through a public procurement process. Public procurement of railway maintenance has gained relatively little attention in research despite that the competitive tendering approach implies several challenges, especially related to collaboration and innovation. Hence, the aim of this study is to explore public procurement of railway maintenance, with a particular focus on how various factors support or hinder collaboration and innovation. A multiple case study approach is used, including interviews with client and contractor representatives and a multidimensional framework on partnering as supply chain integration guides the analysis. Tentative findings indicate that there is potential in strengthening the supply chain integration in the studied context. Findings provide theoretical contribution to supply chain integration, for example by pinpointing the importance of addressing informal relationships at the individual level in maintenance contracts. Furthermore, a practical implication for managing transport infrastructure maintenance contracts is the importance of addressing collaboration depth by allocating sufficient human resources to the client organisation.

Keywords: collaboration, supply chain integration, railway maintenance

INTRODUCTION

Outsourcing infrastructure maintenance, for example roads and railways, to increase efficiency has been an increasingly used strategy in several European countries (Olsson and Espling 2004). When public client organizations outsource infrastructure maintenance there is a need to develop new knowledge on how to procure and manage contracts and contractors. Railway maintenance is complex and there are a number of factors to take into consideration when procuring maintenance contracts. Important challenges are for example that: (I) maintenance is a long-term and continuous process with contract periods of five to seven years (II) infrastructure conditions will change with time due to age and use etc. (III) it is difficult to exactly assess infrastructure condition before, during and after the contract period (IV) and there is major dependence between client and contractor, which makes the contractor's engagement, knowledge and flexibility essential and critical factors (Olsson and Espling 2004). There is also change in train traffic intensity to take into consideration, which affects time allocated for maintenance work (Forsgren *et al.,* 2014).

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To ensure the expected daily service in terms of punctuality and safety, both planning and performance of railway maintenance is crucial (Baldi *et al.*, 2016). Previous research on railway maintenance includes, for example, studies on planning methods (Baldi *et al.*, 2016), competitive tendering and cost impact (Odolinski and Smith 2016) and contract design (Abdi *et al.*, 2014). Previous research (e.g. Olsson and Espling 2004) has shown that contractor's low flexibility for coping with unforeseen events during contract periods has been expensive for the client and has in some cases led to adverse relationships between the parties.

While there is extensive research on collaborative approaches (e.g. partnering) to avoid adverse relationships and improve communication and innovation in construction projects (Bygballe *et al.*, 2010, Eriksson 2010), procurement strategies and collaborative approaches in public procurement of railway maintenance has gained relatively little attention (Aldenlöv *et al.*, 2017). This is despite the fact that innovation and productivity improvements are essential ingredients to gain value for money in the transport infrastructure sector. It is also argued that maintenance has greater need for flexibility than construction (Olsson and Espling 2004) why procurement strategies and collaborative approaches developed for construction projects may not be appropriate for railway maintenance.

The Swedish Transport Administration (STA) has outsourced railway maintenance since 2002. Later, STA developed its procurement of railway maintenance with the intention to motivate contractors to become more innovative and develop their processes. The underlying assumption was that less restrictions and specifications of how the maintenance should be performed would drive innovation and process improvement among contractors (Vass and Karrbom Gustavsson 2017). Hence, the change process was based on increasing the contractors' freedom in performing maintenance services.

The aim of this study is to explore public procurement of railway maintenance, with particular focus on how collaboration and innovation is supported or hindered. A multiple case-study approach is used, including interviews with client and contractor representatives. A multidimensional framework on partnering as supply chain integration by Eriksson (2015) is used to map and categorize the findings related to collaboration. Tentative findings indicate that there is potential in strengthening the supply chain integration in the studied context. Findings provide theoretical contributions to literature on supply chain integration and practical implications for the development of procurement strategies for improving collaboration in transport infrastructure maintenance contracts.

LITERATURE OVERVIEW

Partnering in Construction Projects and Maintenance Contracts.

The construction industry has a history of conflicts, disputes and a perceived reluctance to change (Laan *et al.*, 2011). Public clients have been encouraged to initiate and drive innovation in the construction industry and its supply chains (Kulatunga *et al.*, 2011). Traditionally, construction clients rely on competitive tendering involving several bidders that prepare lump sum contract proposals based on requirements set ex ante by the client and their consultants. In bid evaluation, the lowest lump sum is typically awarded the contract. This type of procurement has received increased criticism for causing disputes and adversarial relationships (Pesämaa *et al.*, 2009).

A client-initiated change that has gained increased interest during the last decades is partnering, which is a collaborative approach based on new procurement strategies for

integrating supply chains, drive innovation, improve performance and increase productivity (Bygballe *et al.*, 2010, Eriksson 2015, Lahdenperä 2012). Clients are encouraged to take on the important role to create renewal through innovation and learning (Ingemansson Havenvid *et al.*, 2016) and to facilitate group work by involving suppliers and contractors early (Kulatunga *et al.*, 2011).

Partnering relationships have been found to improve coordination and flexibility, which is beneficial in contexts characterised by complexity and uncertainty (Anvuur *et al.*, 2007). However, there are researchers arguing for a suitable balance between cooperation and competition depending on the project and the context (Eriksson 2008). In their study, Pesämaa *et al., (*2009) argue that increased cooperation is desirable in contexts characterized by high complexity, customization, time pressures and uncertainty. However, establishing cooperative relationships is not easy (Bresnen 2007) and there seems to be a lack of understanding among clients of how to implement partnering (Eriksson 2008).

In their study on partnering in railway maintenance, Olsson and Espling (2004) suggest a general framework of partnering for infrastructure maintenance based on combining early partnering literature (e.g. Barlow *et al.*, 1997) and key characteristics of maintenance. They conclude that key factors to consider are: the requirements for partnering, the partnering process, success elements and measurements (Olsson and Espling 2004, 245). Their recommendations for successful partnering in maintenance contracts are partly similar to those general for project partnering (e.g. Barlow *et al.*, 1997) but there are also aspects that are specific for maintenance contracts. The general recommendations include: A gain-sharing mechanism and financial incentives, rules for justification of changes in target cost, top management commitment and involvement, a facilitator to co-coordinate and facilitate implementation, a team of key personnel from client, contractor and important sub-contractors, continuous communication between all parties, commonly agreed and ranked objectives and an agreed strategy for meeting partnering objectives. These aspects are very similar to findings in studies on partnering in construction projects, such as Eriksson (2010), Laan *et al., (*2011). The requirements that are specific for maintenance include: clear goals in connection to end users, agreed strategy for developing the maintenance process and a strategy including all personnel in the partnering process, especially those on the floor (Olsson and Espling 2004, 247).

THEORETICAL FRAMEWORK

Partnering As Supply Chain Integration

In the supply chain management literature, partnering and collaboration are often discussed in terms of supply chain integration (SCI) SCI is a concept that originates from a manufacturing industry context and corresponds to the concept of partnering, which is commonly used in the construction industry (Eriksson 2015). While partnering can be seen as a cooperative approach to procurement, SCI can be defined as the degree to which a focal company strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes (Flynn *et al.*, 2010, 59). In order to enable a more detailed and systematic understanding of internal, contractor and customer integration, Eriksson (2015) has developed a multidimensional conceptual framework on SCI. The framework includes four interdependent dimensions: strength, scope, duration and depth of integration and is useful for analysing collaboration in specific projects.

The *duration* dimension is dependent on how long the partners will collaborate and jointly utilize integrative activities and technologies, for example integration across subsequent projects and/or project stages. The *scope* dimension involves the nature and number of companies involved in the integrated supply chain. That is, which organizations that will jointly perform the integrative activities and technologies, for example clients, contractors and consultants.

The *strength* dimension measures the degree of integration, which is dependent on the extent to which integrative activities and technologies are utilized, for example collaborative procurement and contracting related procedures, teambuilding activities and a joint project office. Finally, the *depth* dimension is dependent on the integration of different types of professionals at different hierarchal levels within each partner organization. Due to the interdependences and interaction effects among different SCI dimensions, it is important to manage all four dimensions simultaneously and systematically and not one by one in isolation (Eriksson 2015). Integrative activities and technologies (strength) must thus be implemented together with the right companies (scope), at the right time (duration) and with the right people involved in the companies (depth).

METHOD

The research that underpins this paper involves a multiple-case study of three railway maintenance contracts procured and managed by three different divisions of STA: one in the northern part of Sweden, on in the middle and one in the south. The research approach is qualitative and the empirical material is created during interviews with representatives from client and contractor. This approach enabled the researchers to develop a deeper understanding of how project participants perceive the contract, collaboration and performance. Each interview lasted between one and two hours and allowed for understanding the individual's views and understandings. When put together and analysed against the theoretical framework, the interviews provide a possibility for understanding patterns of behaviour and perceptions, hence providing a broader understanding.

The three cases were selected based on geography (i.e. organizational spread) and time. It was perceived that it would be best if the contracts were signed approximately at the same time and were in late stages or recently have ended and that different divisions of STA had procured them. Respondents were selected to represent at least the project manager from STA and a regional or site manager from the contractor (see Table 1). All interviews were semi-structured and all but one were recorded. One of the respondents did not want to be recorded and hence, careful notes were taken instead. Most of the interviews were performed by two of the researchers in order to gain better understanding of the situation at hand. The analysis began with mapping the empirics on collaboration in relation to the multi-dimensional framework by Eriksson (2015). Hence, the findings are categorised based on duration, scope, strength and depth (see Table 2).

Case Descriptions

Case 1 is based on a railway maintenance contract in the northern part of Sweden. The contract is a Design-Build contract with an incentive mechanism. The incentives focused on reducing overall train delays. The idea was that the contractor should work more proactive than reactive. The contract was initiated in 2011 and had a duration of 5 years, with an option for additional 1+1 years. In this specific contract, the two option years were accepted by STA and the contract ended after 7 years in 2017. The contractor was

initially a joint venture between two contractors who planned to gain benefits by collaborating. However, one of the contractors faced problems and the contract was renegotiated and the other contractor took over the whole contract. Factors contributing to additional complexity in this contract were winter conditions with a lot of snow and the joint venture that didn't work out as planned. In addition, there are only a few contractors active in the northern part of Sweden.

Case 2 is based on a railway maintenance contract in the middle part of Sweden. The contract is a Design-Build contract including a partnering approach. The partnering approach involved a start-up workshop where the client and contractor defined common goals. During the rest of the contract these goals should then be evaluated to make sure they are fulfilled. It was initiated in 2013 and has a duration of 5 years, with an option for additional 1+1 years. In this specific contract, one of the two option years has been accepted by STA and the contract is still on going. The contractor is the same contractor who took over the whole contract in Case 1. Factors contributing to additional complexity in this contract are the high traffic intensity on the infrastructure.

Case 3 is based on a railway maintenance contract in the southern part of Sweden. The contract is a Design-Build contract including a partnering approach, the same as in case 2. It was initiated in 2011 and had a duration of 5 years, with an option for additional 1+1 years. In this specific contract, both option years were accepted by STA and the contract ended after 7 years in 2018. Factors contributing to additional complexity in this contract were the old and fragile infrastructure.

Table 1: Interview Data

Role	Organization	Case
Project Manager	STA, North	1
Procurement Manager	STA, North	1
Regional Manager	Contractor 1a	1
Project Manager	STA, Middle	2
Regional Manager	Contractor 1b	2
Supervisor	Contractor 1b	2
Project Manager	STA, South	3
Procurement Manager	STA, South	3
Site Manager	Contractor 2	3

FINDINGS

In this section, we describe and compare our findings related to collaboration in the three contracts, based on the four dimensions of SCI: duration, scope, strength and depth.

Duration - Time for Collaboration

From a formal contractual perspective, the duration of collaboration is rather long, since the contract period is five years followed by one plus one year as option. The argument for five-year periods, according to the client's project managers in Case 1 and Case 2, is that shorter periods are problematic for contractors because of their investments in machinery, personnel and equipment and longer periods would hamper the client's flexibility. The criteria for if an option year will be used or not is based on the client's project manager's perception of the contractor's delivery.

> Option? Well, it has to do with if you are satisfied with the delivery or not. I would say it is based on gut feeling (Project Manager, Case 2).

However, the duration of collaboration is not mainly dependent on the formal contract period. Railway maintenance is a continuous process and does not have the construction project characteristics, including a definite start and end. Infrastructure assets and personnel are not temporary, but continuous. For example, the contractors that won the contracts in Case 2 and Case 3 were the same contractors as in previous contracts and, especially important when it comes to collaboration and expert knowledge, the key personnel remained mostly the same.

> Yes, it was the same contractor as in the previous contract who won the new contract and it is the same persons…We know each other well, we have camped together in many crises…and thanks to their experience of the infrastructure, their asset knowledge and local awareness, they can do a good job(Project Manager, Case 2).

This show that duration have an informal relational dimension that in some cases (for example Case 3) is very long - 14 years or longer. In addition, duration also has a geographical, or physical, dependency. The infrastructure, i.e. the railway, is built many years ago and will remain at the same location for many years to come. When a new contractor wins a contract, personnel usually switch employer, from the previous contractor to the new one, while continuing the maintenance work on the same infrastructure. This way, the name of contractors might change from one contract to the next, but the key personnel - and the relationships between client and contractor representatives - often continues. This is how expert knowledge about the infrastructure is developed over time.

When personnel switch employer, they bring the tacit knowledge with them (Project Manager, Case 1).

To conclude, duration as time for collaboration in railway maintenance has less to do with the formal contract period and more to do with informal relations and physical closeness. The duration of collaboration may therefore be very long, far exceeding the contractual period of 5-7 years, at least at the individual level.

> When we lost the tendering, our contract manager meets with the contract manager of the new contractor, just to sort out the terrain and personnel situation. We do not stand in the way for anyone who wants to change employer (Regional Manager, Case 1 and 2).

Scope - Nature and Number of Collaborating Companies

The scope dimension includes the nature and number of actors or companies involved in collaboration. In the three studied cases, the scope of collaboration is rather limited as the contract is only a matter between the client and contractor. No other actors or companies are directly involved. However, all three contractors use sub-contractors to perform maintenance work and contractor representatives mention the sub-contractors occasionally during the interviews, for example when time in track is mentioned (e.g. the time when there is no traffic and maintenance work can be done). The contractor's supervisor (Case 2) also raised the issue of including the sub-contractors more in the collaboration because of the importance of keeping them and their specific expert knowledge. Motivating them to stay in the business of railway maintenance and not change to other jobs, is perceived as very important, especially since there is a perceived shortage of experienced personnel.

Strength - Degree of Collaboration

The strength of collaboration is heavily dependent on the extent of collaborative activities and technologies used. The question of applying partnering arrangements or not seems to have been up to each project manager but there also seems to have been a wide spread scepticism towards a partnering approach.

> It was optional to work with partnering at that time. Now it is mandatory. It was up to the project manager…Several project managers, at least on maintenance, were sceptic toward partnering. Many of them don't like that way of working because they only see it as additional work that don't give anything back (Procurement Manager, Case 1).

However, both Case 2 and Case 3 are procured as partnering contracts including the ambition to collaborate more extensively. Both contracts began with engaging an external partnering facilitator and having joint workshops but these collaborative activities did not continue for very long.

> We began the contract with rather high ambitions, saying that this time it will not be only empty words and we had a workshop and a kick-off. But it faded away almost directly (Project Manager, Case 2).

Representatives of both clients and contractors explain that they already know each other and have long-term relationships. Hence, collaborative activities and technologies are not perceived important. They have their regular meetings and reach each other by phone when needed. Also, they use inspections to gain understanding of the infrastructure condition. Case 1 used an incentive model that turned out to be a complicated history (Regional Manager, Case 1). The incentive model was aimed to drive innovation and performance but was perceived by both client and contractor as too complicated.

> It has worked but it has been difficult to interpret and it is hard to read in STA systems… (Regional Manager, Case 1).

The infrastructure is old and fragile in Case 3, which makes it difficult to decide on the infrastructure condition. This has made the client, contractor and user (i.e. operator) to initiate joint study visits to gain a better understanding of the condition and to include the user's perspective. Even though these safety rounds were first considered as a waste of time, it gave the contractor a broader perspective on safety issues.

The Depth of Collaboration - Type of Processionals

When different professions and roles collaborate, the depth of collaboration increases. In the case of railway maintenance, the depth varies between the procurement process and the execution of the contract. During procurement, the client's procurement managers and technical specialists, including the client's project managers, collaborate internally in order to prepare requests for proposal. Contractor representatives then collaborate internally in teams in order to develop their bids. Then, during execution, client and contractor representatives collaborate during regular construction meetings and there is no direct collaboration between the client's procurement manager and client's project manager during contract management, unless there are problems and disputes.

> No, not any collaboration [with procurement] after signing of contract (Project Manager, Case 2).

The professionals that collaborate during contract management are the client's project manager including a project engineer and the contractor's site manager including supervisors and technicians. Hence, the contractor usually has numerically more representatives at the meetings than the client. The imbalance of the client and contractor sides of the collaboration is something that one of the client's project managers has raised

as a concern, especially when it comes to negotiations. To conclude, the depth of integration is limited to a few professionals and there seems to be little, or no, collaboration internally between those who manage the procurement and those who manage the contract.

Table 2: Mapping of the four SCI dimensions in the three contracts

Contract	Case 1: 2011-2017	Case 2: 2013- on-going	Case 3: 2011-2018
Contract type	DB-contract with functional requirements.	DB-contract with functional requirements. Partnering	DB-contract with functional requirements. Partnering
Complexity	High organizational and external complexity (joint venture and winter).	High operational complexity (high traffic intensity on track).	High technical complexity (old infrastructure).
Duration	Contract: 5+1+1 years. Relations: New contractor, mostly same key personnel.	Contract: 5+1+1 years. Relations: Same contractor for several succeeding contracts. Mostly same key personnel.	Contract: 5+1+1 years. Relations: Same contractor for several succeeding contracts. Mostly same key personnel.
Scope	Client and contractor(s).	Client and contractor.	Client and contractor.
Strength	Construction meetings every month. Initial inspection before taking over. Incentive model for decreasing train delays.	Construction meetings every month. Informal communication via phone. Initial inspection before taking over. Initially an external partnering facilitator, partnering targets and workshop.	Construction meetings every month. Informal communication via phone. Initial inspection before taking over. Initially an external partnering facilitator, partnering targets and workshop. Safety rounds with client, contractor, and operator.
Depth	During operation: Project manager. Site manager, supervisors and technicians.	During operation: Project manager and project engineer. Site manager, supervisors and technicians.	During operation: Project manager and project engineer. Site manager, supervisors and technicians.

DISCUSSION

Research on partnering (e.g. Eriksson 2015) argues that all four dimensions of SCI are needed in a successful partnering approach and since the dimensions are interdependent, they need to be combined in order to achieve successful inter-organizational collaboration and facilitate innovation. Our findings indicate that duration and strength are the two most developed dimensions in the studied contracts, while scope and depth are dimensions less developed. The lack of scope might hinder innovation when relevant sub-contractors are not included in collaborative activities. Also, the lack of depth, exemplified by the lack of internal collaboration between client personnel (e.g. procurement management and project management), is a potential hinder for development and innovation because of difficulties in implementing gained knowledge and experience. The lack of human resources at the client side also creates an imbalance that reduce the collaboration strength; there are few people at the client side for the contractor to discuss and collaborate with. Furthermore, while long-term relations support collaboration strength, they might also be a hinder for developing new ways of working (i.e. for innovation). Findings thus indicate that all four dimensions of SCI were not addressed in the studied contracts. In addition, comparing the findings to the framework on partnering in maintenance contracts, developed by Olsson and Espling (2004), confirms that neither the general partnering recommendations, nor the special partnering requirements in maintenance were implemented in the studied contracts.

To conclude, our findings indicate that collaboration in the studied contracts is supported by informal long-term relationships based on physical dependencies rather than a formal collaborative procurement approach, as recommended by Eriksson (2015).

Representatives from the client and contractor know each other well after having worked many years on the same infrastructure. This stability in personnel and expert knowledge can be understood as a way to keep expert knowledge but it can also be a hinder of innovation. Findings thus indicate that railway maintenance contracts procured in the period 2011-2013 are procured in a way that sustains industry norms and traditional ways of working rather than driving innovation and performance.

CONCLUSIONS

The aim of this paper was to explore public procurement of railway maintenance, with a particular focus on how collaboration and innovation in railway maintenance is supported or hindered. Mapping empirics from three cases with the four dimensions of SCI (Eriksson 2015) provides a deeper understanding of what supports or hinders collaboration and innovation in railway maintenance contracts. This understanding contributes to procurement research, in particular on procurement of maintenance. Findings indicate that the duration-dimension is especially central in maintenance contracts, both due to the formal length of contracts and the informal relationships at the individual level. Hence, when analysing maintenance contracts, the aspect of informal relationships on the individual level need to be added to the SCI framework developed by Eriksson (2015). An important practical implication of our findings is that the lack of human resources in the client organisation hampers collaboration depth and in turn collaboration strength, because the contractor staff doesn't have sufficient amount of people to discuss and collaborate with. STA has recognized this shortcoming and in future collaborative contracts more human resources will be allocated.

The identified lack of collaboration and integration in railway maintenance contracts, indicate challenges to drive innovation in railway maintenance by applying established collaborative approaches. Our findings thus indicate that established project partnering and SCI frameworks don't fit well with the special characteristics of railway maintenance contracts and that there is a need for more research on how procurement of railway maintenance should be performed to achieve much needed innovation and increased performance.

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