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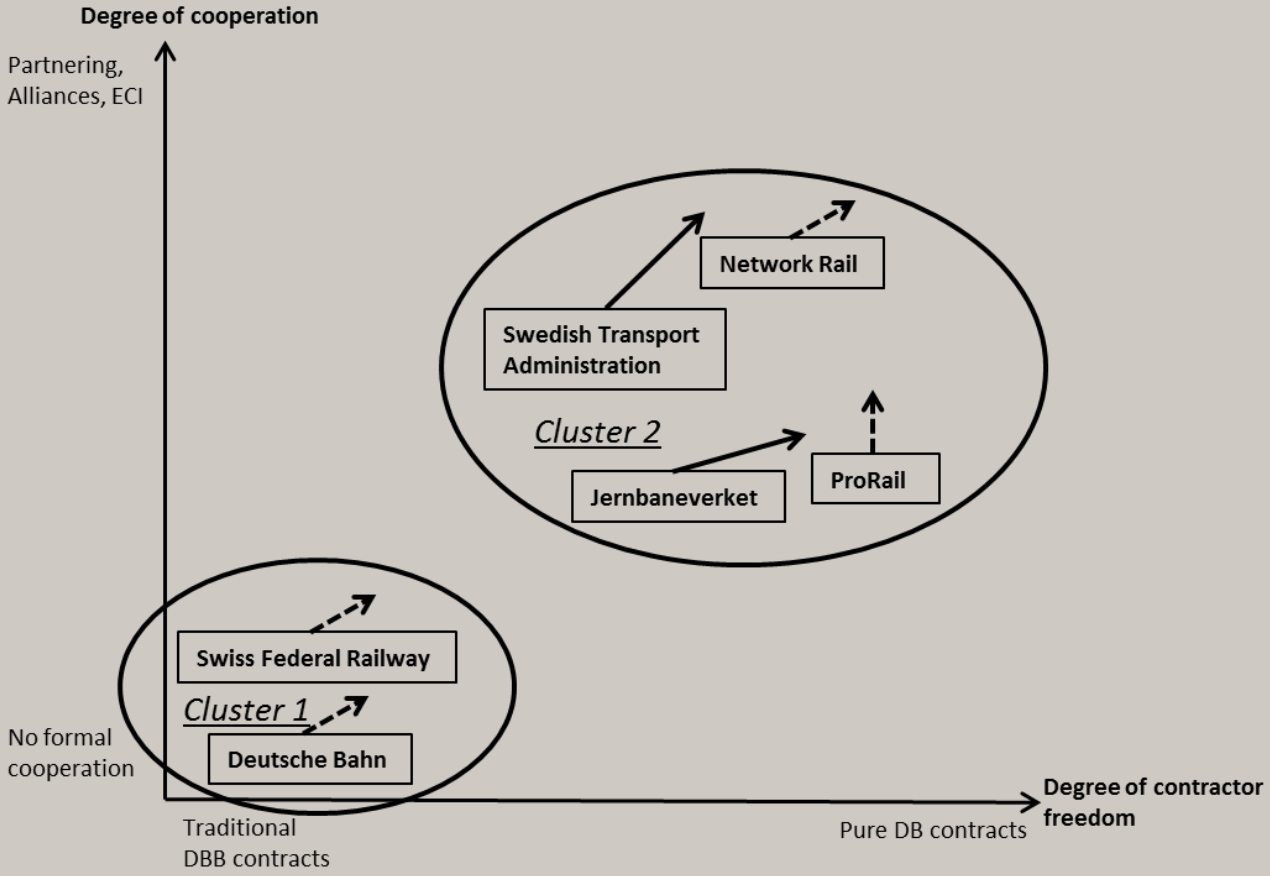
RAPPORT

Procurement of railway infrastructure projects – A European benchmarking study



Trafikverket
Postadress: 781 89 Borlänge
E-post: trafikverket@trafikverket.se
Telefon: 0771-921 921

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Författare: Per Erik Eriksson, Luleå University of Technology
Sofia Lingegård, Linköping University
Lena Borg, KTH Royal Institute of Technology
Johan Nyström, The Swedish National Road and Transport Research Institute (VTI)

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Kontaktperson: Katarina Norén, Trafikverket

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Innehåll

Abstract

The purpose of this benchmarking study is to investigate and compare how railway investments are procured in six European countries: Sweden, Norway, Germany, the Netherlands, the UK, and Switzerland. The aim of the study is to increase the understanding of how and why different procurement strategies are used in different countries, in order to enhance learning across organizations and countries. This benchmarking study was initiated by the Swedish Transport Administration (Trafikverket, TRV) and performed by a group of researchers at four different universities/research institutes in Sweden. In total, 21 people were interviewed, representing procurement managers, project managers, and researchers. This study investigates the clients' procurement strategies, focusing on the four core strategy components: delivery system, reward system, contractor selection, and collaboration model, and how these affect cooperation and competition in railway projects.

Traditionally, all six clients have focused on enhancing competition in their procurement strategies based on Design-Bid-Build contracts. The rationale for this is that the clients historically have performed both design and construction themselves (in-house), and the first step towards a gradually increased usage of the supply market was to outsource the construction activities while keeping the design and development competence in-house. In a second step, also design and development processes were outsourced to engineering and technical consultancy firms. However, the last few years there is a discernible trend in Sweden, Norway, the Netherlands and the UK towards allocating more design and development responsibilities to contractors and increasing the strategic focus on cooperation. Accordingly, the use of Design-Build contracts has increased and many relationships are now characterized by a high extent of cooperation. The UK and the Netherlands are forerunners in this trend that can be viewed as a third step in the transition towards a market oriented railway sector, whereas Norway and Sweden is in the middle of this transition. Germany and Switzerland have not yet initiated this change but respondents believe that collaboration will become more common in the future, although the use of Design-Bid-Build contracts seems to continue. The transition towards a gradually increased usage of the market seems to have two dimensions; degree of cooperation and degree of contractor freedom, which differ among the countries. The UK and Sweden focus on increasing both these dimensions, while The Netherlands and Norway mostly focus on increasing the degree of contractor freedom. Germany and Switzerland still limit both dimensions by performing design

and development in-house and letting contractors compete for construction work in Design-Bid-Build contracts.

1. Introduction

The railway systems in European countries are critical for both long-distance and commuter traffic, as well as freight transportation. Thereby, railway has critical impact on people's lives from a social perspective, on the economic development of our modern society, and the environment as it is considered to be an environmentally friendly mode of transportation. Until the early 1990s, most European railway systems were organized in the form of state-owned and vertically integrated monopolies (Geyer & Davies, 2000). Since then, the railway systems have been deregulated and restructured in most countries, by separating the ownership and the operation of the infrastructure. The EU directives from 1991 (Dir.91/440/EEG) have been important for the separation of the national railways into different organizations for owning and developing the infrastructure and for operation and transport activities. In this way railway sectors in Europe have been opened up for competition regarding the transport operations. In many countries, also the design, construction and maintenance of railway infrastructure have been deregulated and opened up for competition.

In deregulated railway sectors, procurement of railway infrastructure investments is key to enhance a well-functioning railway system, today and in the future. The challenge for public clients in the infrastructure sector, such as rail administrations in the European countries, is to develop and implement procurement strategies that provide suppliers with possibilities and motivations to enhance both short-term efficiency and long-term innovation.

Railway investment projects mainly involve five different types of work (i.e., five disciplines): civil engineering work (e.g., tunnels and bridges), signaling equipment, electricity supply, telecommunication systems, and the actual tracks. These disciplines are inherently different and require diverse competencies and resources. As such, these five types of work are often performed by different actors and may also require different procurement strategies. This makes the procurement challenge even more complex.

In addition, procurement strategies may be affected by domestic characteristics of the railway sectors in different countries, e.g., extent and timing of deregulation, supply market development and competition. Nevertheless, railway administrations may have much to learn from each

other, when it comes to project governance and procurement strategies. One way to enhance such learning is to benchmark and compare how different clients procure their railway projects and why they have chosen their particular strategies.

The purpose of this benchmarking study is to investigate and compare how railway investments are procured in six European countries: Sweden, Norway, Germany, the Netherlands, the UK, and Switzerland. The aim of the study is to increase the understanding of how and why different procurement strategies are used in different countries, in order to enhance learning across organizations and countries. The empirical findings from this benchmarking study may then serve as a basis for knowledge sharing and organizational learning within and across the public client organizations. The consequences of these procurement strategies are difficult to measure and evaluate. Hence, the benchmarking study doesn't aim to be normative and prescriptive, that is, the conclusions will not present one answer on how to procure railway investments in the best way.

2. Theoretical framework

2.1. Short-term efficiency and long term innovation

Previous research highlight that organizations that exploit existing technologies and knowledge in an efficient manner, while also exploring new business opportunities and technologies, achieve more sustainable competitive advantage (March, 1991; Raisch et al., 2009). Short-term efficiency is enhanced by exploiting current knowledge and technology to increase profits today, whereas long-term innovation is enhanced by exploring new knowledge and technology to innovate and adapt to future demands (March, 1991; Gupta et al., 2006; O´Reilly & Tushman, 2013). Companies in most industries therefore strive to combine short-term efficiency (exploitation) and long-term innovation (exploration) (Benner & Tushman, 2003; Gupta et al., 2006). Balancing exploitation and exploration is however difficult and previous research has shown that many companies focus too much on short-term efficiency and too little on long-term innovation (Uotila et al., 2009). It is the direct advantages of exploiting existing resources that makes it easy for organizations to continue in the current wheel-tracks; you get success in the short term, but stagnation and failure in the long term (March, 1991).

In project based organizations (PBOs), such as client and contractor organizations in the infrastructure sector, innovation can take place both in separate R&D projects and in regular business projects (Keegan & Turner, 2002; Bosch-Sijtsema & Postma, 2009; Eriksson, 2013), that is, construction projects. Compared to other industries, the R&D expenditures generally are low (Miozzo & Dewick, 2004; Reichstein et al., 2005). Accordingly, there is a risk that the need for innovation is not satisfied only through R&D projects. Many organizations may therefore need to facilitate innovation in their regular construction projects too (Eriksson, 2013).

The client's procurement strategies heavily influence both efficiency and innovation in construction projects (Eriksson, 2013). In spite of this, innovation needs and opportunities are seldom considered when choosing procurement strategy (Tawiah & Russell, 2008). Instead it is often more short-term efficiency related objectives, such as cost, time and quality, which are considered (Eriksson & Westerberg, 2011). This focus on short-term efficiency in regular construction projects may hinder innovation and thereby sustainable development. In this study, both efficiency and innovation are addressed to facilitate a more sustainable perspective on procurement strategies.

2.2. Competition, coopetition, and cooperation

In any buyer-supplier relationship it is vital to obtain suitable levels of competition and cooperation. Broadly speaking, cooperation is the performance of an activity in a way that the actions undertaken by one actor facilitate the actions undertaken by the other, whereas competition emerges when the actions undertaken by one actor hinder the actions by the other (Bunge, 1989). Competition and cooperation can thereby be analyzed not only in horizontal relationships between competitors, but also in vertical buyer-supplier relationships. In a vertical relationship it is important to recognize that competition and cooperation are opposites and counteract each other (Eriksson, 2010).

Competition is based on the idea that each actor tries to maximize their own benefits (Bengtsson & Kock, 2000), for which reason competition is related to individualism and self-centeredness. This results in tensions and conflicts when actors have opposing interests (Eriksson, 2008a). Competition can thus be defined as a situation of tension between the different actors that occurs due to their conflicting interests as they strive to achieve their respective goals (Anderson, 1988). Competition is important because it provides the individual

suppliers with incentives to innovate and improve efficiency to become more competitive (Bunge, 1989; Bengtsson & Kock, 2000).

Cooperation is, in contrast, based on trust and reciprocity. Cooperation is related to collectivism and concern for the needs of others and can thus be defined as collective work to achieve mutual goals (Bengtsson & Kock, 2000). One important difference between the concepts is that competition is based on opposing goals while cooperation is based on mutual goals. When different actors have mutual goals a win-win situation arises, where actors are interdependent and therefore benefit from cooperation. Cooperation is also important because it can promote coordination, flexibility, adaptation and exchange of knowledge between partners in a business relationship (Uzzi, 1997).

Since both competition and cooperation are central for facilitating efficiency and innovation in buyer-supplier relationships, it is critical to achieve a balance between them, that is, coopetition. Coopetition may be defined as the balance between **coop**eration and comp**etition** in a specific transaction relationship, derived from the actors' simultaneous cooperative and competitive behaviors (Eriksson, 2008b). When deciding how to balance cooperation and competition the project characteristics at hand are important to consider. Cooperation is particularly relevant in projects that are characterized by complexity, customization, uncertainty, long duration, and time pressure, since they require coordination of actors and their activities, flexibility and adaptation of activities and their contents, as well as knowledge sharing and joint problem solving (Palaneeswaran et al., 2003; Lu & Yan, 2007; Eriksson , 2010). In the opposite situation, simple standardized projects with low uncertainty, short duration and little time pressure can be procured with a focus on competition. However, since most projects have neither very high nor very low values of these variables, some kind of coopetition is often suitable, where the client strives to achieve certain levels of both competition and cooperation. The balance between cooperation and competition may be illustrated in a continuum, as in Figure 1 below.

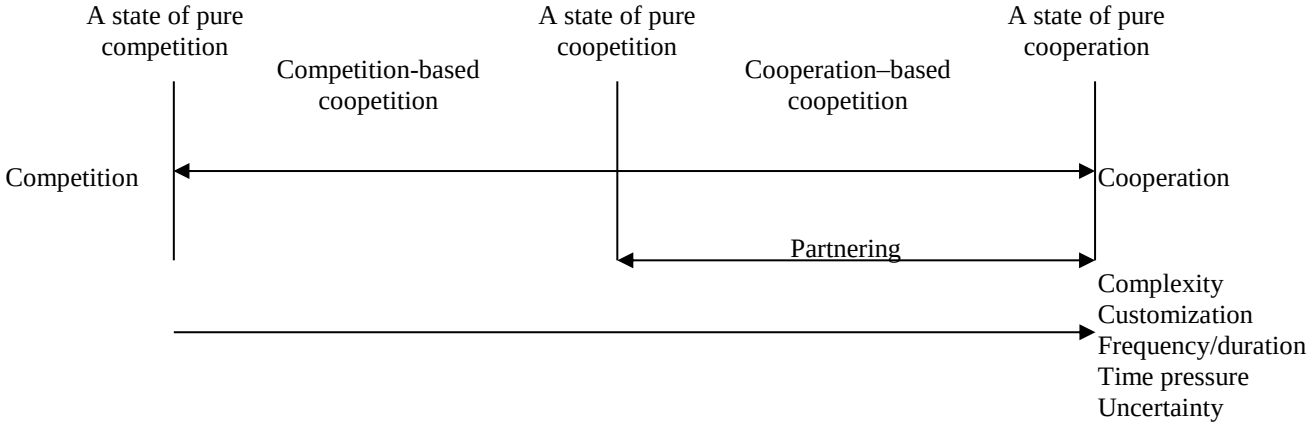

Figure 1. Coopetition continuum –balance between competition and cooperation (Eriksson, 2008b).

The balance between cooperation and competition is highly influenced by the client's procurement strategies. The different procurement strategy components affect cooperation and competition in various ways. By combining the components in purposeful ways that are tailored to the project characteristics, clients can thus achieve suitable levels of cooperation and competition. In order to achieve an appropriate balance the client must adopt a system perspective, where all procurement strategy components and their effects are analyzed with a coopetition framework (Eriksson & Hane, 2014). Prior research on procurement in the construction industry has distinguished how four different procurement strategy components affect competition and cooperation in buyer-supplier relationships (Eriksson, 2010). The four components are: the delivery system and the nature (e.g., timing) of the contractor involvement, the reward system, the contractor selection procedures, and the collaboration model, see Table 1.

Table 1. Procurement strategies and their effects on competition and cooperation.

	Competition	**Coopetition**	**Cooperation**
Delivery system	Design by contractor (DB)	Early involvement in joint design, contractor responsible (DB)	Joint design with shared responsibilities. ECI based on consultant contract
	Design by client (DBB)	Early involvement in joint design, client responsible (DBB)	
Reward system	Fixed price (lump sum)	Cost reimbursement with incentives and target cost	Cost reimbursement with bonuses
	Fixed unit price		
Contractor selection (invitation+evaluation)	Open invitation	Pre-qualification	Direct negotiation
	High focus on lowest price	Lowest price and soft criteria	High focus on soft criteria
Collaborative tools and activities	No collaborative tools/activities	A few collaborative tools/activities	Many collaborative tools/activities

These four procurement strategy components and their effects on cooperation/competition and exploitation/exploration are discussed in section 2.3 below. The four components also formed the basis for the empirical investigation, as described in the method section.

2.3. Procurement strategies and their components

2.3.1. Delivery system, type of contract, and nature of contractor involvement

There are two main delivery systems based on two fundamentally different types of contracts; Design-bid-build (DBB) and Design-Build (DB). Traditionally, DBB involves a separation of design and production as the client and their consultants perform detailed design before the contractor is involved to execute production. One advantage of DBB contracts is that a competent and experienced client more easily can ensure that they get the quality they want by specifying the design in detail (Cheung et al., 2001). When a certain level of quality (or safety) is critical, DBB-contracts may be preferable if the client has sufficient expertise and experience to know what he wants and how to achieve this. A disadvantage is that the client's detailed specification reduces the contractors' opportunities for innovation; there are simply not that many technical aspects to develop. The usual separation between planning and production also reduces the learning between the actors in the different stages (Styhre et al., 2004), which can extend the duration of the project and reduce the constructability. The absence of contractors' production knowledge during the design stage could thus impair the efficiency during the production stage, especially in more complex projects. Another disadvantage of the early conducted detailed specification is that changed circumstances create a need for time-consuming re-planning and re-negotiations of additional work and change orders in complex and uncertain projects (Eriksson & Hane, 2014).

In a DB-contract, contractors are ideally involved early and responsible for detailed design work. This can promote greater exchange of knowledge between consultants and contractors, which can lead to product design with improved constructability, because contractors' production experience is exploited during the design stage. DB-contracts also mean that the contractor can start building before the product is completely specified in detail, which saves time (Cheung et al., 2001). From an innovation perspective, the effects of a DB-contract are more complex. DB-contracts improve the contractor's opportunities for innovation but the actual incentives to perform innovation work are more affected by partner selection and reward systems. Accordingly, when DB-contracts are procured based on traditional competitive tendering focusing on the lowest price, the contractor has no clear incentive to spend time and money in the project on innovative development (Ahola et al., 2008). To minimize the risk of exceeding tight time and budget frames, the design and production are rather based on known solutions, methods, and

existing knowledge. Another potential problem regarding innovation is rebranding of DBB contracts into DB (Nyström et al., 2016). DB contracts without degrees of freedom for the contractors are not to be expected to deliver innovation.

The basic forms of DB (i.e., ABT 06) and DBB (i.e., AB 04) contracts in Sweden promote a focus on competition as they separate, allocate, and clarify the actors' different responsibilities, which makes the contracts more transparent and less risky. However, DBB-contracts can be based on early involvement of contractors and DB-contracts can include client involvement in the design stage although the contractor has the main responsibility. Hence, both types of contracts can involve joint specification where clients, consultants and contractors work together to promote a synchronized focus on explorative development issues and short-term exploitation of resources in efficient production. In such cases, when the contractor is procured early and the actors engage in joint planning and design based on either DB or DBB contracts, where one party has the main responsibility and the other is more consultative, coopetition is promoted. Because of the inter-organizational nature of construction work, innovation is developed and implemented in multi-actor settings, meaning that innovation involves coordination and negotiation among project actors (Winch, 1998; Bygballe & Ingemansson, 2014). Hence, early contractor involvement supports explorative development and innovation (Caldwell et al., 2009) through joint problem solving and knowledge transfer between design and production. Client engagement in complex DB-contracts is also critical. Due to the strong need for co-creation in complex construction projects, knowledgeable clients need to get involved and contribute to joint development work (Jacobsson & Roth, 2014).

An even more collaborative approach is to fully embrace early contractor involvement (ECI) by adopting a two-stage approach, in which partners first carry out joint planning and design based on consultant contracts (i.e., ABK 09 in Sweden) before going into detailed design and production based on DB or DBB-contract. Such an ECI approach gives a high focus on cooperation. This is suitable when the uncertainty is very high and the client requires contractor involvement in very early design stages to integrate production knowledge when designing the product. ECI is a term that has different meanings in different parts of the world (Rahmani et al., 2013). A common denominator is that ECI involves a two stage process where contractors and other partners are procured in the early stages to jointly design and define the project until it is possible to set a target cost and sign contracts for the production stage (Kadefors & Eriksson, 2015). During the initial design stage

contractors are reimbursed for their expenses. Then the team continues the cooperation during the production stage, often with open books and incentives connected to a target cost. The ECI term was first used in the UK where it is associated with work under the standard contract PPC2000 (Mosey, 2009). In the UK infrastructure sector, the ECI is used mainly by Network Rail and British Highways Agency (Kadefors & Eriksson, 2015).

Despite the rich theoretical literature comparing DBB and DB, there is still a lack of empirical studies deciding on which one to prefer. The statistical studies on the topic can be divided into two groups. A first group (Thomas et al., 2002; Ibbs et al., 2003; Shrestha 2007; Hyun et al., 2008; Perkins, 2009; Bogus et al., 2010, Minchin et al., 2013) use cost- and time growth as an output variable in the comparison. These output variables are however problematic. Without controlling for the initial estimated budget and time, one could end up with a fast and cheap project being outperformed by a slow and expensive project due to generous ex ante estimation in the latter case. Despite this problem, still no general conclusion on the results can be seen in these studies. The second group of papers (Konchar & Sanvido, 1998; Hale et al., 2009; Shrestha & Mani, 2012) use absolute values in comparing DBB and DB. These papers indicate that DB outperforms DBB in regards of time i.e., construction is faster in DB-contracts.

2.3.2. Reward system

In construction projects, the two main reward systems are fixed price (or lump sum) and cost reimbursement (or cost-plus) (McAfee & McMillan, 1988). There are also intermediate alternatives, based on fixed unit prices or cost reimbursement coupled with incentives, fixed contractor fee, and/or bonuses. By procuring a contractor through competitive tendering based on a fixed price the client wants to facilitate competition and receive the market's lowest price. But in practice, this assumes that the tender documentations and specifications are both flawless and exhaustive, something that is often very difficult and costly to achieve, especially when the conditions are not fully understood due to high complexity and uncertainty. Bajari and Tadelis (2001) therefore claim that fixed price is appropriate in simple projects with low uncertainty where the product is easy and inexpensive to describe and design. This type of payment scheme does not involve any economic incentives for joint problem solving and collaborative development, as the contractor will take all profits from cost efficient solutions. Another disadvantage is that the contractor has no incentive to deliver added value in the form of higher quality than promised (Ballebye Olesen, 2008). Fixed price is also inappropriate when innovation work is demanded during the project

execution. This is because developing and implementing something new means high uncertainty and in fixed price contracts contractors rather exploit proven methods to minimize risks.

Fixed unit prices connected to a bill of quantities are common in the infrastructure sector. This reward system enhances competition even when there are uncertainties about the scope of the work in terms of quantities of different types of work. It also provides flexibility compared to a pure fixed price since it is easy to make changes in the quantities; the contractor gets paid for the actual quantities of work, not the planned or forecasted amount of work. A drawback is that the contractor might not have any motivation to innovate or increase the efficiency to lower the amount of work, since that will lead to reduced payment (Eriksson & Hane, 2014).

In contrast, pure cost reimbursement means that the contractor receives payment for all costs incurred, which decrease the risk for the contractor (Korczynski, 1996; Bajari & Tadelis, 2001). The contractor then has no obvious reason to make more effort than necessary to carry out the work, which is negative for cost efficiency. Nor is there any incentive for cost-saving innovation or development as they only lead to reduced compensation. Quality-enhancing innovations may be somewhat more interesting for the contractor but they cannot lead to higher profits, only cost recovery. Due to the drawbacks with pure cost reimbursement, this reward system is often coupled with economic incentives connected to a target cost, where the actors share gains and pains when the real costs differ from the target cost. When incentive-based payment is based on a 50/50 gain/pain share this reward system can be regarded as a mix of fixed price and cost-reimbursement, facilitating coopetition. Incentive-based payment is particularly suitable for early procurement of contractors and joint specification (Chan et al., 2007), as it provides collaborative project stakeholders a common fate reward for gains due to innovative technologies and efficient improvements. A disadvantage of incentive-based payment is that rules on adjusting the target cost tends to be rather complex contractual terms that often give rise to discussions or even disputes (Kadefors, 2004; Badenfelt, 2008; Boukendour & Hughes, 2014). Hence, it is not suitable in projects with high uncertainty.

It has become increasingly common to abandon the usual type of economic incentives because they may lead to disruptive disputes of target cost changes. Instead many clients use a reward system that includes a fixed contractor fee, covering profit, risk and central administration. In pure cost reimbursement the fee is based on a certain percentage of the direct costs, hence the higher the costs, the higher the fee. When using a fixed fee, the contractor will get

cost reimbursement for the direct operating costs, but the absolute value of the profit is fixed from the outset. For the contractor, the fixed fee provides incentives for cost-saving efficiency and innovation as reduced costs will lead to a greater relative gain, in terms of a larger profit margin.

Another, even more collaborative, alternative is to link bonuses to non-economic aspects, such as quality, timeliness, work environment, and environmental impact (Tam & Tam, 2008; Eriksson & Westerberg, 2011; Love et al., 2011). The contractor can then receive monetary bonuses if certain levels of different functional requirements are exceeded. This provides motivation to deliver better than any minimum levels specified in tender documents.

2.3.3. Contractor selection and bid evaluation

In construction projects, selecting capable contractors is a critical task for clients (Kumaraswamy & Anvuur, 2008; Caldwell et al., 2009). Partner selection is carried out through bid invitations of potential bidders and bid evaluations that can be focused on lowest price or multiple criteria. Sometimes, the bid evaluation may be preceded by a pre-qualification stage where suitable contractors are pre-qualified and invited to submit tenders. Whereas an open tender procedure enhances competition, pre-qualification and invitation of fewer bidders facilitate more cooperation.

A focus on lowest price enhances competition and it is often the most important bid evaluation criterion, especially among public clients (Kadefors, 2005; Eriksson, 2008b). This is because public clients risk appeals if soft criteria have not been evaluated in sufficiently transparent and objective ways, according to the regulations in the Public Procurement Act (PPA). A disadvantage of price-focused evaluations is that they mostly lead to new teams constantly being formed, reducing the possibility of exploitative learning and continuous improvement across projects. In addition, focus on lowest price generates an emphasis on short-term benefits by taking into account investment costs rather than long-term life cycle costs and innovation. Lowest price selections also reduce contractors' motivation to innovate. At the tender stage, the contractor cannot invest too much in innovation work because of uncertainty whether he will win the contract or not. After a contract is awarded based on lowest price there are no strong incentives to innovate either. The outcomes of investments in innovation work are uncertain and to reduce the risk of cost overruns the contractor is driven to use proven solutions with relatively certain consequences for time and cost performance. Hence, lowest price only facilitate implementation of

cost-saving innovations that already have been developed. These may however be facilitated by multiple criteria including technical solutions.

Due to the drawbacks of lowest price selections, there has been growing interest in a shift to multi-criteria selections, also considering soft criteria (Hatush & Skitmore, 1998; Kumaraswamy & Anvuur, 2008) since it enhance cooperation (Eriksson, 2010). It is especially vital that tender evaluation focuses on soft criteria in complex projects or when the contractor is expected to contribute to innovation in the design stage (Bosch Sijtsema & Postma, 2009). Prior construction management research suggests that multiple criteria that consider appropriate competences, experiences and attitudes can improve many different performance aspects, such as reducing cost and time overruns (Chan & Kumaraswamy, 1997; Assaf & Al-Hejji, 2006), and improving quality (Yasamis et al., 2002), innovation (Bosch-Sijtsema & Postma, 2009; Caldwell et al., 2009), and environmental performance (Shen & Tam, 2002).

2.3.4. Collaboration model and partnering arrangements

In the construction industry, there are many different terms and labels describing collaborative relationships (e.g., alliance and integrated project delivery), but the most commonly used term is partnering (Kadefors & Eriksson, 2015). Although partnering arrangements are based on collaborative procurement strategies affecting all four strategy components, the collaboration model is often considered as the core component (Eriksson & Hane, 2014).

Since the client and the contractors have to interact to co-create the construction product, extensive use of collaborative activities and tools may be suitable to strengthen cooperation in the partnering team (Bayliss et al., 2004; Olsen et al., 2005). Prior research suggests that some examples of such vital activities and tools for strengthening cooperation are: formulation and follow-up of joint objectives, joint IT-systems, and a joint project office (Bayliss et al., 2004; Eriksson, 2008a). These collaborative activities and tools cost both time and money to implement, but especially in large and complex projects they may have positive effects on many performance aspects, making these investments worthwhile (Eriksson, 2015). Joint IT-systems facilitate integration and communication among project actors and can thus improve time, cost, and quality performance (Woksepp & Olofsson, 2008). Joint objectives enhance the development of a win–win situation in which all project participants together strive to improve project performance as formulated in objectives (Swan & Khalfan, 2007; Eriksson, 2015). Co-location in a joint project office on site enhances face-to-face communication

and interaction, which is important for innovation (Olsen et al., 2005; Alderman & Ivory, 2007), environmental performance (Cole, 2000; Shen & Tam, 2002), and work environment (Cole, 2000).

3. Method

This benchmarking study is mainly based on interviews in the six European countries: Sweden, Norway, Germany, the Netherlands, the UK, and Switzerland. In each country 1-2 interviews were held with procurement managers and 1-2 interviews with project managers or project department executives. In addition, one interview with an academic with experience of infrastructure research was held in Norway and the Netherlands to get a holistic and overall view on the procurement strategies from a scientific perspective. In each country 3-5 interviews were performed, with the exception of Switzerland that was added in the end of the study; here only one interview was held. In total, 21 people were interviewed. See Table 2 below for a summary and the appendix for a short presentation of the interviewees. Each interview lasted 30-120 minutes, with an average of 90 min.

When the empirical data from the interviews had been analyzed and summarized into a written within-case story for each country, the texts containing the empirical description for each country was sent to one or two of the respondents in the particular country. Each respondent then read the text to verify the content and in some occasions they added and clarified the text to give a more accurate and clear picture of their procurement strategies. This approach improved the reliability and validity of the findings. However, it is important to note that a weakness of this study, as with most other qualitative studies based on nonprobability sampling, is that the results are heavily dependent on the selection of respondents. Hence, a different set of respondents may have produced a bit different findings. We have tried to reduce this risk by interviewing several respondents in each country and discussing potential inconsistencies with the respondents.

Table 2. Interviews in six European countries.

Country and organization		Number of respondents and their roles/professions			
		Project manager/ executive	Procurement officer/ manager	Researcher	Country total
Sweden	Trafikverket	2	2		4
Norway	Jernbaneverket	1	1		3
	Trondheim University			1	
Germany	Deutsche Bahn	1	3		4
The Netherlands	ProRail	2	1		5
	Amsterdam Metro	1			
	Delft University			1	
The UK	Network Rail	2	1		4
	Dept. for Transport	1			
Switzerland	Swiss Federal Railway		1		1
Total		10	9	2	21

In addition to the interviews, a literature review and document studies were also performed. The literature review involved investigation of prior procurement related research within the construction industry, to form a theoretical framework that served as a basis for the collection and analysis of the empirical data (see the theory section above). Furthermore, document studies focused on domestic articles and reports that could shed further light on the procurement strategies and the railway sector of each country. The interviews and the document studies formed the basis for the empirical findings, presented below.

4. Empirical findings from six European countries

4.1. Trafikverket and the Swedish railway sector

In 1988 it was politically decided that the Swedish state railway (Statens järnvägar, SJ) should be split up so the railway infrastructure and the train operations were separated in two governmental units. SJ continued to manage the train operations as its major task (but was also a real estate owner) and the new Rail administration (Banverket) managed the infrastructure. The following years, parts of SJ were gradually transformed into limited companies, and it was finally disbanded in 2001. The assets of SJ were transferred to seven separate companies; all owned by the Swedish Government, but later some of these were sold off. The Rail administration included both the owner and client functions and the supply function that

designed, constructed and maintained the infrastructure system. In 1998, the supply part of the rail administration was separated from the client organization and formed its own internal unit called Rail Production (Banverket Produktion). But it was not until 2001-2002 that decisions were taken to deregulate the market and start to expose Rail Production to competition (i.e., privatization). After these political decisions, the Rail administration started to procure investment projects and maintenance services from other companies too. However, Rail Production continued to be the major supplier.

In 2010, the Swedish Road and Rail Administrations were terminated and their responsibilities transferred to the new authority; the Swedish Transport Administration (Trafikverket, TRV). In 2010, when TRV was formed, the deregulation of the market was strengthened by further separation of client and supplier functions. Rail Production was hived off and formed a separate, but publicly owned company, called Infranord. In 2010, Infranord also starts to bid for contracts abroad and wins its first contract in Denmark and later also in Norway. Although the increasingly strong focus on enhancing competition in deregulated markets, Infranord is still the largest supplier in both new production and maintenance services in Sweden. However, during recent years also other larger international companies have started to enter the market.

In 2011, TRV initiated a change process towards a more professional client that leaves more freedom and responsibilities to the supply market in designing and executing the deliveries. The change process aims to develop the supplier market towards improved innovation and productivity (Sveriges Bygguniversitet, 2013; Statskontoret, 2015). The changes have, however, been implemented to a larger degree in road production than in railway. "*Historically, the Rail administration has performed a lot of design, construction, and maintenance work in-house, so it is in the walls"* (PR). Due to the potentially catastrophic consequences of railway accidents and the possibility and responsibility to control the traffic, the focus within the railway sector has always been on safety. Hence, due to formal responsibilities and regulations related to safety, the change towards increased reliance on the market is more challenging to implement in the railway than in the road sector.

In line with the recommendations from Produktivitetskommittén (2012), the delivery system is at the core of the change process and the aim is to go from almost 100% DBB-contracts to at least 50% DB-contracts in a few years. This has initiated a major change in both TRV and in contractor and consultant

organizations (Sveriges Bygguniversitet, 2013). *"Previously, DB-contracts and collaborative contracts have been used to some extent, but the focus and the governance package are clearer now than before"* (LB).

It is important not only to change the type of contract used, but also to purify the contracts so that DB-contracts indeed mean that contractors have a lot of freedom to choose methods and solutions that suit their capabilities. Some of the respondents mentioned that in the beginning of the change process, a lot of contracts were merely relabeled from DBB to DB but without changing the degree of details in the design (see also Nyström et al., 2016 for the same type of reasoning). Today, TRV explicitly points out the importance of leaving much more design work to the contractors and avoid too many constraints in their DB-contracts.

During the last few years there has been an increase in railway sector investments. TRV indicates a need for more resources to maintenance and reinvestment. This is particularly relevant in case of the increase in traffic. More funding reinforces the need to find ways for getting better value for money also for maintenance and renewals, issues that are addressed in Odolinski (2015).

4.1.1. Procurement of railway investment projects in Sweden

1. *Delivery systems*

Railway investments have traditionally been procured based on detailed design in separated DBB-contracts, both regarding civil engineering work (e.g., tunnels), signaling systems, electricity systems, telecommunication systems, and the actual rail work. Each of these five disciplines has traditionally been separated in different contracts, and coordinated by the client. Within the civil engineering works, certain parts, such as bridges, have often been separated and based on DB-contracts within the larger DBB-contracts. The reason for the separation of contracts is that these competencies have been separated in different types of actors. Hence, no actor has been able to perform all disciplines. *"Historically, there have not been so many benefits to reap by procuring a single contractor who would then coordinate all disciplines. Because then you had to pay for the coordination and the hassle, so you could just as easily procure it yourself and by dividing it into its components you may obtain lower prices, with the drawback that you then have to coordinate it yourself*" (LM).

The change towards more usage of DB-contracts in TRV has been slower in railway than in road investments (Statskontoret, 2015). *"It has a great*

foundation in culture; traditionally we have been accustomed to do much of the design work ourselves in the Railway administration" (BK). Hence, many contracts are still procured in traditional ways, based on separated DBB-contracts. In accordance with the ongoing change process within TRV, there are however also a lot of railway projects based on DB-contracts. TRV is a large and geographically dispersed organization and the change process have come further in some regions than in others. Especially the more general civil engineering work, which is similar to road projects, is increasingly based on DB-contracts and in some projects all five disciplines are procured in one large package. The main contractor then procures and coordinates the different specialty contractors. This strategy based on large scale DB-contracts may be used more often in large and complex projects. *"When it comes to more complex projects with larger contract value, we try to achieve more degrees of freedom and use DB-contracts. Projects with smaller contract values or at least less complex projects we turn more towards DBB-contracts"* (LB).

Although the large contractors active in Sweden have the capacity to manage this coordination function in large contracts comprising all disciplines, their experience of doing this is limited due to TRV's traditional role. Another problem with larger DB-contracts including all disciplines is that there are very few suppliers in the four specialty disciplines in the Swedish market. Hence, although TRV may attract several bids from different main contractors, these bids are based on work from a small set of specialty contractors.

Another factor that complicates the change towards more degrees of freedom for suppliers is that TRV has a large set of strict rules and regulations that all infrastructure developments must adhere to. These frameworks constrain the design of new railways and they don't leave much for the contractor to decide upon. However, these rules and regulations are now being adjusted and developed in collaboration between TRV and the supply market, to increase the freedom for suppliers to choose their own solutions. So in the future, DB-contracts may become less constrained. This is considered critical since a main purpose of DB-contracts is to enhance creativity and innovation from the contractors. "*When our own engineers develop a solution in-house for a DBB contract, then we get only one solution, but if we instead let the market do the development, then we get more creativity among those who will compete for a DB contract, and then maybe we get three solutions"* (JB).

Another factor that limits contractors' degrees of freedom is TRV's material service unit that provides suppliers with all strategically important material, in

terms of components and sub-systems. Hence, contractors and suppliers must choose inputs that are provided by the material service unit. This approach increase economies of scale, since TRV procures most of the inputs, but also homogeneity and standardization in the railway infrastructure, which enhance maintenance. However, it hinders contractors and suppliers to choose and design other solutions, thereby diminishing their productivity and innovation. Since most technical inputs are constrained, DBB-contracts are more natural than DB-contracts. To increase the degrees of freedom for contractors and improve the potential gains from DB-contracts, one respondent argue that the material service unit may have to enlarge their selection of available goods and components in the future. Another solution is to close down the material service altogether and rely more heavily on contractors' purchasing processes in DB-contracts. This may lead to a more heterogeneous stock of railway, which may or may not be a problem for maintenance. "*If there is a problem that we receive a railway system that is a bit different in various respects, we must of course deal with that, but it's not for certain that there is a problem*" (LM). It is then important with a long-term view on innovation and development, since poor innovations may be inefficient from a short-term perspective, but in the long run they will be avoided. "*Inappropriate developments may be implemented, but they will be discovered and handled and can therefore be avoided in the future, but there is such a problem that yes, innovations may sometimes be bad*" (LM).

Produktivitetskommittén (2012) points out that TRV may achieve productivity and innovation in complex and uncertain projects based on DBB contracts by strengthening the cooperation among the actors. Through joint problem-solving and knowledge sharing among early involved project actors, development and innovation may be enhanced also in DBB contracts. One respondent highlights that this approach has been successfully implemented in the large project Citybanan. This approach also shows the importance of a systemic perspective that incorporates other procurement components as well, besides the delivery system (Sveriges Bygguniversitet, 2013).

The respondents believe that DB-contracts probably will be increasingly common in the future, as part of the change process, especially for civil engineering work and work on the tracks. For the three other specialty disciplines DBB-contracts will probably still dominate but some specific objects that are easy to detach and delimit (e.g., large tunnels or bridges), may be procured based on larger DB-contracts including all five disciplines. However, a change towards more DB contracts requires market development.

As of now; "*TRV has a lot of competences that the private market doesn't have*" (BK).

2. *Reward systems*

Traditionally, TRV has mostly used unit prices connected to a bill of quantities in their DBB-contracts. This is still the most common payment system in DBB-contracts, especially in the four railway specific disciplines. Unit prices are also used in projects with large uncertainties, that is, when it is difficult to forecast some of the work that has to be done, for instance when it comes to virgin soil.

Other payment alternatives are now explored and tested, especially in DB-contracts for civil engineering work and to some extent in the railway work. In such contracts fixed price has become more common. This is suitable in projects when it is possible for contractors to calculate their costs, that is, when projects are rather straight forward and not too complex and uncertain.

In more complex and uncertain projects, cost reimbursement coupled with incentives or bonus are sometimes used. Cost reimbursement is especially suitable when work is dependent on other ongoing traffic and cannot proceed independently. Even in cost reimbursement contracts, some parts are fixed, such as costs for management, site huts, cranes, etc., and the contractor's profit. Cost reimbursement is sometimes coupled with economic incentives that are connected to a target cost and involve pain/gain sharing when the actual costs are above/below the target. There is an ongoing discussion in TRV how the sharing mechanism should look like. 50/50 sharing of both gains and pains has been most common but this may result in constant renegotiations that are not adding value. "*If we have a 50/50 sharing, the contractors will pressure us to adjust the target cost upwards in every circumstance because it will hurt them very much if the actual costs exceed the target cost"* (PR). If a lower risk and benefit is allocated to the contractor (e.g., 80% to the client and 20% to the contractor) then the relationship may become more harmonious and less conflict prone. The target cost is either determined by the client in the tendering documents or through the contractors' competitive bids, or sometimes, when TRV strives for strong cooperation in early stages, it is decided jointly after the contract has been entered.

Bonuses are also used sometimes, although more seldom than the abovementioned target cost incentives. When bonuses are used, the criteria are tailored to the project and its requirements. Examples of such bonus

criteria (KPIs) are: timeliness, temporary traffic, cooperation, and environmental performance. A drawback with bonuses that are designed ex ante is that contractors may calculate to achieve them, and then they lose some of their positive driving forces. A bonus that is not achieved is then perceived as a loss. For this reason it is better to introduce bonuses ex post in certain situations when the client wants to encourage extraordinary performance. In addition, it may be counteractive to have too large bonuses. Compared to the total cost of the project, bonuses typically amount to about 1-2%, not more. When designing bonuses and incentives it is important to be careful so that appropriate drivers are created. Otherwise bonuses and incentives may encourage sub-optimizations, hidden agendas, and undesired behaviors.

The respondents believe that fixed price probably will be increasingly common in the future, as DB-contracts become more common. However, fixed price is inappropriate when there are uncertainties and unforeseeable risks that the contractor cannot handle. This may result in high bid prices due to risk premiums for the contractor In such complex and uncertain projects where many risks should be allocated to the client, cost reimbursement may become more common, but this will be coupled with incentives connected to target prices that are estimated by contractors in competitive tendering. Unit prices connected to quantities will become less common.

3. *Contractor selection*

TRV often use a two-stage approach where a limited number of contractors first are pre-qualified through an electronic system (TransQ). For small DBB-contracts pre-qualification is not very important, partly because these contracts don't require extraordinary competences, and partly because the Swedish market is rather small, i.e., there are only a limited number of contractors that will submit bids. TRV may then strive to invite 10-15 bidders but in the specialty disciplines the number of bidders is often significantly lower.

In large DB-contracts, pre-qualification is especially important to select competent and suitable contractors that are capable of executing the project. This pre-qualification also increases the chance for contractors to win the contract. Hence, pre-qualification can encourage contractors to put extra money and effort in preparing bids, which is especially important when TRV wants to obtain bids from large international contractors. Pre-qualification criteria can include: financial soundness, organizational capability and references, for example connected to experiences of working adjacent to

ongoing traffic and experiences of working with certain local geological circumstances in rock or clay. Pre-qualification is often limited so the 4-6 contractors that receive the highest score on these criteria are pre-qualified, in order to improve the chances of obtaining well prepared bids from capable contractors, without hampering competition too much. The pre-qualified contractors are then invited to prepare and submit bids.

When a pre-qualification has been conducted, bids are mostly evaluated based on a focus on lowest price. However, it differs a lot between projects and especially when it comes to large complex ones. There are different perceptions of the suitability of this trend. Some respondents pinpoint that after careful pre-qualification only capable contractors remain. Then they can compete mostly on price during bid evaluation. However, this requires that the pre-qualification is rather tough and so that only capable contractors remain, which is not always the case. Other respondents highlight that evaluating soft criteria involves more subjective assessment than evaluating lowest price, which increases the risk of appeals against the selection of a winning contractor. "*The trend towards a focus on lowest price stems from a fear of appeals when evaluating soft criteria, which is a shame* (BK). Accordingly, it requires more competence to formulate and evaluate multiple criteria according to the law of public procurement, in order to avoid appeals and subsequent delays of projects.

However, soft criteria are mostly evaluated to some extent too, often between 5-20 %. Common soft criteria are: management, organization, risk management model, collaboration model, realization plan, etc. In more complex and uncertain projects, especially when contractors are procured early and involved in defining and describing the project, soft criteria are given a larger weight in evaluation. In such cases it is also important to have contractors focusing a bit extra on preparing the technical solutions. If technical solutions are evaluated, contractors are encouraged to put extra effort in preparing them, compared to if they only are evaluated based on lowest price. Hence, putting some weight on soft criteria may result in higher quality of the bids and better prepared contractors. A drawback with soft criteria is that the organization and the resources described in the bids are not always the same that will perform the work in reality. "*Often, we don't get what we want; that organization and those names described in the bid, they were not here when we started working, then they were in another project somewhere else, so we never got those people that we were promised*" (LM). One way to prohibit behavior of this kind is to have economic penalties if the contractor changes key personnel that are not approved by the client.

In large DB-contracts it is also important to provide potential bidders with a long period of time for preparing bids and developing their technical solutions. To further encourage potential bidders to put extra effort in preparing bids and increase the chances of obtaining both more bids and better bids TRV sometimes pay pre-qualified contractors to submit bids. This payment covers at least some parts of contractors' costs for preparing bids.

Recently, the trend has been to use pre-qualifications more extensively and have a larger focus on lowest price and only a small weight on soft criteria. Hence, the focus on soft criteria is lower today than a few years ago. Evaluating bids for DB-contracts based on a mix of soft criteria and lowest price require a lot of competence. Hence, the existing competences for preparing tender documents for DBB-contracts need to be developed to competences for formulating and evaluating requirements in DB-contracts. In the future, the respondents believe that soft criteria may become a little more common but lowest price will continue to be the most important evaluation criteria. *"I believe that the pendulum will turn. Now it's too much juridical focus in procurement, you lose business focus. In this way, public procurement has its shortcomings; it is difficult to take into account the personal experience and expertise*" (BK).

4. *Collaboration model and partnering arrangements*

Traditionally, cooperation and partnering have not been used to a large extent in railway projects. Cooperation was often dependent on personal initiatives rather than on formal and general arrangements and policies. Furthermore, in the beginning of the change process towards a more professional client, many people within TRV perceived that the change meant that the client should take one step back and leave the work to the contractor, that is, less cooperation and more arm-length relationships (Sveriges Bygguniversitet, 2013; Statskontoret, 2015). However, this was not the strategic intent of the change process and in 2015 TRV implemented a formal policy that a basic collaboration model should be used in all contracts. Hence, the current strategy is explicitly based on formalized cooperation. The basic collaboration model includes a range of collaborative tools and activities such as: joint objectives, joint risk management, conflict resolution methods, follow-up workshops, and a partnering facilitator. The respondents are generally positive towards cooperation but it may be a bit costly to implement a formal collaboration model in small projects. The cost may then exceed the benefit.

TRV has also developed an extended collaboration model that should be used in more complex and uncertain projects. The extended model, which will be

implemented in 2016, includes similar collaborative tools and activities as the basic model, but also other procurement related components such as: early involvement of contractors in joint design work, bid evaluation based not only on lowest price but also on soft criteria, and reward systems based on cost reimbursement (sometimes including incentives or bonuses). When this model is implemented, the focus on cooperation will become much higher in challenging projects facing high complexity and uncertainty.

In large projects, with long contract duration, the series of workshops is especially important and serves as a vehicle for development of relationships as well as work methods. Workshops are then held with an external partnering facilitator 2-3 times a year. This extended cooperation model makes the contractors to take on more responsibility and adopt a more holistic perspective, enhancing all aspects of project performance, not only time and cost, but also safety, temporary traffic, and environmental concerns. Another key aspect is to sit together close on site, preferably in a joint project office. This is however difficult to implement in large projects where there is a large number of contractors involved. In such large projects it is also important to have workshops across contractual boundaries and let all key actors participate in top management workshops once a year. Cooperation is often limited to the client-contractor relationship, but some respondents also pinpoint the importance of involving design consultants in the partnering team.

In the future, the respondents believe that cooperation will become more important. However, it is important for the future to have a conscious idea on when to use cooperation and to what extent. Since TRV has implemented new policies in 2015 and 2016 that demands all projects to implement some kind of collaboration model (either basic or extended), the top management signals that cooperation will be increasingly important in future projects. Furthermore, since 2015 TRV demands the use of BIM (Building Modelling Information) in all of the construction projects, expecting large cost savings, (Trafikverket, 2015).

4.1.2. Procurement effects on project performance and the Swedish railway sector

Statskontoret (2015) criticizes TRV for neglecting innovation in their change process, which is more focused on productivity and short-term efficiency. Especially, the focus on lowest price may impede innovation, in terms of product developments (Statskontoret, 2015). However, the respondents believe that the increased use of DB-contracts and cooperation will probably

drive innovation and efficiency in the long run, when the supply market actors have adapted to the new requirements and developed their design and innovation capabilities. Also the increasingly common use of early involvement of contractors in collaborative DBB-contracts drives both innovation and efficiency, based on joint problem solving and knowledge sharing. "*In our collaborative DBB-contracts the main purpose has been to identify and develop innovative solutions, they have really enhanced innovation. In this way, the collaboration model drives innovation more than the delivery system*" (BK). From a short-term perspective, the respondents believe that the current procurement strategies have produced somewhat better time and cost performance with equally good quality.

4.1.3. Strengths and weaknesses of TRV

TRV perceive one of their strengths to be competent project managers that have a lot of experience from managing many different types of projects. "*It is a strength to be able to manage all stages in large and long projects*" (JB). Although this is a core capability, it is also a major challenge since many people in TRV will retire within the coming years and many new project managers need to be recruited and trained. However, also the project managers that are hired consultants are very competent and represent TRV very well.

Another strength mentioned by one respondent is that TRV has developed good communication and relationships with the supply side, both with the supply market in general, and with specific suppliers in particular projects. This is a core capability that is important for the collaborative procurement strategies.

Another strength that is mentioned is that there is a strong will within TRV to perform and develop. In this way, the respondents perceive TRV as an organization with focus on learning. This positive attitude towards change and development has been strengthened the last few years during the organizational change effort towards a more professional client.

Obtaining a suitable balance between centralization and decentralization is a key challenge for STA. Since the merger of the road and railway administrations, some respondents believe that TRV has become somewhat more decentralized, whereas others believe that TRV has become more centralized. The centralization has resulted in that purchasers that support smaller projects are employed centrally. This creates a geographical and mental distance between project managers and purchasers, which is negative. Another key aspect of this balance is the degree of standardization of

organizational routines. Here, some respondents believe that standards and policies increase efficiency and serve as guides for project managers and other decision makers, whereas others believe that such standards restrict and constrain decentralized decision making. Statskontoret (2015), however, pinpoints that TRV is not too centralized, although there are a lot of guidelines and policies to guide and direct project managers in their work. In fact, some respondents argue that, in spite of these central standards, another strength of TRV is the flexibility and authority of the project managers. They have competence and mandate to adapt and form procurement strategies and management practices to the local circumstances for the benefit of the local project.

4.1.4. Summary of Trafikverket's procurement strategies

Trafikverket is currently changing their procurement strategies and although this transition is proceeding more slowly in the railway sector than in the road sector, also railway procurement is significantly affected. Traditionally, railway procurements have been based on thoroughly specified DBB contracts evaluated based on lowest price. The last couple of years also DB contracts have been procured, especially concerning large and complex projects along with civil engineering work and work on the tracks. This change process will continue and DB contracts will probably become increasingly common in the upcoming years. The extended collaboration model that is implemented 2016 will also mean that ECI based on consultancy contracts will be tested in some projects. The most common reward system has been fixed unit prices but due to the trend towards more DB contracts also fixed price and to some extent incentive-based payment have become more common. When it comes to contractor selection, pre-qualification is mostly utilized together with a high focus on lowest price during bid evaluation. In more complex projects, especially in DB contracts, also softer criteria are evaluated and these are perceived to become more common in the future. Traditionally, the level of formal cooperation has been low in railway projects, but this is currently changing. TRV has adopted a new policy that all projects should implement a basic collaboration model including a few collaborative tools and activities such as joint objectives, joint risk management, and partnering facilitator. Complex and uncertain projects that will implement the new extended collaboration model will utilize a broader range of collaborative tools and activities.

The procurement strategies of TRV are summarized in Table 3, where the most common alternatives are marked in dark green and alternatives that are

used less frequently are marked in light green. Alternatives that are white are seldom or never used.

Table 3. Trafikverket's procurement strategies and their influence on competition and cooperation.

	Competition	Coopetition	Cooperation
Delivery system	Design by contractor (DB)	Early involvement in joint design, contractor responsible (DB)	Joint design with shared responsibilities. ECI based on consultant contract
	Design by client (DBB)	Early involvement in joint design, client responsible (DBB)	
Reward system	Fixed price (lump sum)	Cost reimbursement with incentives and target cost	Cost reimbursement with bonuses
	Fixed unit price		
Contractor selection (invitation+evaluation)	Open invitation	Pre-qualification	Direct negotiation
	High focus on lowest price	Lowest price and soft criteria	High focus on soft criteria
Collaborative tools and activities	No collaborative tools/activities	A few collaborative tools/activities	Many collaborative tools/activities

4.2. Jernbaneverket and the Norwegian railway sector

In 1996, Norges Statsbaner (NSB) was divided into two separate organizations; the National Rail Administration called Jernbaneverket (JBV) became responsible for the infrastructure and NSB BA became responsible for operating the transports. JBV is responsible for maintaining the existing railway system including approximately 4000 km rail, but also for governing the development and construction of new railway. The organization of the Norwegian railway sector has been stable since 1996, but now the Norwegian government and its Samferdselsdepartement require reformation and change due to increased investments. The Norwegian government wants to develop the railway sector so that it becomes more attractive for suppliers (Samferdselsdepartementet, 2015).

Furthermore, the Ministry of Transport and Communications has put together an efficiency program including all costs that the agency can influence. One way pointed out by the agency is to use the resources in a more efficient way through more efficient planning (Norwegian Ministry of Transport and Communication, 2013). There is a need for faster and more effective planning processes since the planning process for major rail projects is on average 10 years. The aim is cut this time in half by e.g., early involvement by the Government in planning, indicative deadlines for the planning process and

clarification of main principles and standards (Norwegian Ministry of Transport and Communication, 2013). New policies for infrastructure projects are adopted to provide more efficient implementation. In this way projects will be completed faster, have lower development costs and attract contractors to invest in long-term productivity improvements and organizational development (Norwegian Ministry of Transport and Communication, 2013).

Investments in new railway infrastructure are at the core of the reform of the railway sector. JVB will increase the investment level for railways to 9.2 billion NOK per year, that is, an increase with more than 50 % compared to the 2013 budget. This also includes a 100 % increase of investment in large projects (Norwegian Ministry of Transport and Communication, 2013). The overall procurement strategy of JBV is to reduce the total costs while at the same time include precision, flexibility and speed (JVB, 2015). Precision is taken into account by delivering at the right time, place, and customer with the right documentation. An ability to be flexible is obtained by handling fluctuation in demand and by procuring goods/services from a range of suppliers. Finally, JBV aims for an ability to quickly respond to customer requirements, meaning the time between identification of a need to delivery of infrastructure to meet the need.

At an organizational level, JBV has initiated a change process where they are changing from primarily using Design-Bid-Build contracts to an approach where more responsibilities are given to the contractors using Design-Build contracts. One major reason for this change is that JBV is enlarging their project portfolio 5-10 times, but they can’t enlarge their client organization accordingly. Hence, they must allocate more work to contractors. As part of the change, JBV wants to improve on legal aspects and reduce conflicts. JBV should be transparent and predictable so that contractors know where JBV stands. This type of change toward increased supplier involvement and responsibility is already common in many other large industrial investment projects, such as in the Oil & Gas industry. Hence, many lessons learned and experiences can be brought in from external actors that have been part of similar change processes in other industries. To further facilitate the general change process within JBV there is a strong need of change champions that can support the various change initiatives. Due to the down turn in the Oil & Gas industry, there is now many competent experts in project management available.

JBV wants to increase the number of tenders and has set a goal within the National plan to have at least three tenders in most (in at least 75 %) of the procured contracts. Following political requirements seeking to avoid

inflation and work overload among domestic companies, JBV therefore strives to obtain international competition in their new projects. To attract large international companies JBV has marketed themselves in other countries by informing foreign supply markets about their upcoming plans and projects. Furthermore, JBV has increased their contract sizes and seeks to avoid allocating all risks to the contractors. Some risks, for example caused by geology and ongoing business or traffic related to third parties, are better managed by JBV. Otherwise, contractors may add large risk premiums to their contracts, resulting in unnecessary high project costs. These changes are in line with the goals of making the Norwegian railway sector more attractive for suppliers, partly by increasing the monetary size of contracts (Samferdselsdepartementet, 2015). Larger contracts functioned well in Vestfold/Telemark in 2012 and are now tried in the Follo line project in Oslo.

The Follo line project

To further improve the possibilities for foreign suppliers to take part in large projects, JBV needed to translate all contractual documents and requirements to English. This has been a major undertaking in the Follo line project that took approximately a year, but now there are general and standard versions of all parts, except bridges, which are possible to reuse in future projects.

The Follo line project, which is the largest railway project measured in monetary value in Norway in modern times, has been mandated to implement change. Below is the mandate for change given to the Follo line project by JBV top management in line with policies given in Nasjonal transportplan 2014-2023 (Samferdselsdepartementet, 2013):

- Tasks that can be done by the market shall not be performed by JBV.
- Use of fewer (=larger) contracts that gives less interfaces, more effective follow-up and more holistic facilities.
- Ensure good and fair competition both nationally and internationally through use of language (english), larger contract values and more use of EPC contracts.
- Strong focus on quality and the operations phase (low LCC).
- Experience, competence and policy regarding HES (SHA/HMS) shall be adequately weighted when selecting contractors.

The Follo line project thereby serves as an icebreaker and forerunner in JBV's change process. The intent is to drive a change in the entire client

organization through this large project, that is, the temporary project will initiate a change in the permanent organization. In the Follo line project there are several change agents with prior experience from other capital intensive industries, such as Oil & Gas.

4.2.1. Procurement of railway investment projects in Norway

1. *Delivery systems*

Traditionally JBV has mostly used DBB-contracts divided by discipline, that is, 5 different DBB-contracts for civil engineering, electrical engineering, signal systems, telecommunications, and the railway, respectively. These DBB-contracts were procured based on detailed design that was prepared by JBV and their consultants. The respondents pinpoint that a drawback with this type of contract is that JBV serves as a sub-contractor to their own main contractors since JBV were responsible for the delivery of design drawings, etc. Another drawback mentioned by the respondents is that JBV takes the responsibility for the development work and the drawings, since the consultants that are doing much of the design work don't take this type of responsibility. The main idea with the change process from DBB to DB is that tasks that can be performed by the market shall not be done by JBV. Accordingly, JBV now utilizes DB-contracts based on NTK 07 (Norsk Totalkontrakt 07), which is an Engineering Procurement Construction (EPC) contract, originating from the Oil & Gas industry and heavily used in several industries (e.g., by Statoil, Hydro, Norske skog, etc.). This EPC-contract has now been adapted to fit the infrastructure context. The traditional standard for DB-contracts in the Norwegian construction and infrastructure sectors (NS 8407) was perceived to drive conflicts rather than cooperation and not being sufficiently client friendly. JBV also strives for larger contracts that integrate several different disciplines. The use of fewer and larger contracts results in fewer interfaces, more effective coordination and follow-up, and more holistic facilities. Hence, civil engineering, electrical engineering, telecommunications and the railway work is packaged together in one and the same DB-contract. Only the signal system is allocated as a separate DB-contract and procured based on an existing framework agreement. Large international contractor companies are used to coordinate these different disciplines. Hence, by letting a main contractor manage several disciplines, JBV can avoid several contractual interfaces where responsibilities are unclear.

Although the delivery systems are at the core of the change process, DBB-contracts may still be used in some circumstances. Generally, this may apply

to preparatory work “on the critical path” in the time schedule as well as towards the end of the project for finalizing work.

Traditionally, contractors are procured late and are not involved in the design work, as JBV has used internal resources that together with consultants prepare the design and tendering documents for DBB-contracts. As a result of the change process, contractors are now procured earlier and are responsible for the design work in DB-contracts. Large international contractor companies have a lot of experience and competence that are valuable during the design stage.

The respondents highlight the importance of letting the contractors be responsible for the design. One benefit with DB-contracts is that the client then can focus on controlling aspects related to safety, quality, and schedule, instead of controlling and coordinating design work and production of drawings. This does however not mean that JBV are not involved in the design and development stage. On the contrary, it is perceived very important to collaborate closely with the contractors. *“All of our staff has one main task, to follow the contractor”* (JV). JBV follow and control the design and development work closely and they have an active dialog with contractors about important choices regarding for example technical solutions. This active dialog is especially important when foreign actors are involved. They often need help to understand the Norwegian context and characteristics. For example, the rock is very hard in Norway compared to most other places. Although the contractors are responsible for the design it is important to not just stand aside and wait for them to fail. Hence, JBV must help the contractors to complete the work according to the contract: ”i*f the contractor succeeds, we succeed*” (JV).

Furthermore, it is important to note that the technical requirements mandated by JBV’s technical rules and regulations apply to any type of contract. Hence, although the degree of client led specification differs, there is no difference in quality requirements between DB and DBB contracts.

In the future, the respondents believe that larger DB-contracts will become more common, as a result of the Follo project. DB contracts are also very well received by contractor companies both in Norway and abroad as this type of contract is a vehicle for improvements in the construction industry. However, in some circumstances DBB-contracts will also be used. It is important to have different alternatives, not only one option. The size of the client organization, the size of the project portfolio, and the nature of the supplier market, are important factors to assess when choosing delivery system.

2. *Reward systems*

Traditionally, JBV has mostly used unit prices connected to a bill of quantities. This reward system enhances flexibility when there are uncertainties in the quantities of different types of material.

In the Follo line project, JBV mostly use fixed price (lump sum), which is related to a predetermined base line situation. That is, JBV has predetermined a probable situation, for example an interval regarding probable rock quality, for which the fixed price applies. If the quality is better, any savings goes to the contractor, and if the quality is worse the contractor is reimbursed at a competitive rate for any increased costs. Fixed price is used for the parts of the scope where risks are predictable and can be managed by the contractor. For other parts of the scope, unit prices are used when there are uncertainties regarding quantities. Then the contractors only take risks for their efficiency problems, while JBV takes the risk for the quantities. Cost reimbursement is used where there are uncertainties of when work can be executed, for example when working near ongoing train operations that will require stopping construction work. "*If the contractor should be responsible for this type of risk the price will become too high, it is better that we take this risk"* (JV). In cost reimbursement contracts, JBV is heavily involved in and closely monitors the work of the contractor to assure that time and resources are spent efficiently and effectively.

Incentives and bonuses are typically not used. One reason for this is that it is difficult to design and implement incentives/bonuses that drive the desired behaviors. Bonuses often result in sub-optimizations, where contractors focus only on those activities that are connected to bonuses and ignore other important activities. Other reasons are that it is difficult to objectively assess when bonus criteria are fulfilled and that some contractors may take contractual bonuses into account in their bidding process and lower their bids accordingly. A more suitable approach, which is sometimes used, is therefore to introduce bonuses later in a project to strengthen the focus on a particularly important aspect that needs to be improved. Furthermore, penalties are often used, mostly connected to delivery time, but also to other aspects such as work safety, child labor, etc.

In the future, the respondents believe that fixed price will become more common than unit prices, especially when risks are low or at least predictable.

3. *Contractor selection*

JBV typically prequalify a limited number (e.g., 5-6) of contractors that are invited to submit bids. This procedure is used partly to attract contractors to submit bids, due to higher chance of winning the contract after being prequalified, and partly to reduce the costs and time needed to evaluate bids. Requirements for bidders are to comply with a high safety standard, ability to execute the work based on experience and organization, and ability to cooperate with client. If many contractors pass the requirements, the 5 or 6 best ones are invited to submit bids.

In bid evaluation, JBV has traditionally mostly focused on lowest price in their DBB-contracts. Approximately 90-95% of the weight is given to lowest price and with soft criteria correspondingly at approximately 5-10%.

Today, when most contracts are DB/EPC, lowest price may be given a weight of 80% and soft criteria 20% in a normal bid evaluation. If the scope of the contract is very complex and uncertain, which require extraordinary competences and resources, then soft criteria may be given a stronger focus, up to 50%. It is however important to motivate why such balance is required. In large contracts, such strong focus on soft criteria is typically avoided since it may result in awarding a significantly higher bid price if the bid is very strong regarding the soft criteria. In general, JBV avoids a high focus on soft criteria since the value of soft criteria has to be defended both internally and towards any losing bidder. Before deciding the balance between lowest price and soft criteria, JBV staff discusses this extensively and evaluate different models and their potential outcomes.

Due to the public procurement act, the bid evaluation process is very challenging and the evaluating team must be aware of the risks of appeals from losing bidders if the lowest bid doesn't win. Appeals may result in severe delays, which must be avoided. When soft criteria are evaluated, important criteria are: organization and resources, project planning and execution, earlier relevant experiences and references, safety, political risks, etc.

The prequalified contractors that didn't win the contract may get paid to cover some of their costs of preparing the bids. This approach is used to encourage contractors to submit bids that are thoroughly prepared, and thereby obtain a higher number of bids and better bids.

In the future, the respondents believe that the trend towards using more soft criteria in bid evaluation will continue. Hence, evaluating multiple criteria will be important in future projects to select capable contractors.

4. *Collaboration model and partnering arrangements*

In general, JBV doesn't use any formal overall collaboration arrangement, such as partnering. However, on several projects JBV has conducted a cooperation phase at the start of the contract to ensure well prepared and coordinated teams.

The recently initiated change process doesn't include any formalized collaborative arrangement, such as partnering. However, JBV perceive cooperation very important and strives to obtain good relationships and cooperation with contractors in informal ways. JBV aims to help contractors to achieve their best. *"Good project management includes cooperation"* (HS). Hence, JBV doesn't perceive that cooperation need to be dealt with separately in any formal written contract arrangement. Informally, it is important that JBV facilitates good cooperation and helps contractors to develop their competences and technologies. JBV may even provide contractors with expertise in terms of allocating specialized human resources to develop contractors' competence within certain areas. Furthermore, informal cooperation is based on trust and transparency: "*We should be predictable and transparent, the contractor should never be uncertain of how we will behave"* (JV).

Some collaborative tools and activities are used, such as teambuilding activities and workshops to align contractual understanding and cultural awareness, in order to enhance cooperation among different project actors. In addition, joint IT-tools in terms of common documents exchange systems are often used.

In the Follo line project, a joint steering group has been formed for each DB-contract. Each group has 4-6 meetings per year during project duration to discuss project execution in a collaborative way. The participants in these steering groups consist of contract managers and/or project directors one hierarchical level above project managers, from JBV as well as contractors.

The respondents don't foresee any strong trend towards partnering in JBV. In fact, partnering arrangements are not intensively discussed in Norway and JBV doesn't perceive any strong need to formalize cooperation. It is important to facilitate development through competition, especially in public procurement that involves tax payers' money. A trend towards earlier

involvement of contractors in the development of projects is however coming also in infrastructure projects. This type of early involvement has been common in industry and has driven technology development and productivity.

4.2.2. Procurement effects on project performance and the Norwegian railway sector

The "new" procurement strategies based on larger DB-contracts that integrate several different disciplines improve coordination and save time compared with the traditional strategies. In addition, the client's project organizations can be smaller, which saves money internally. It also enables JBV's team to focus on quality, safety, and schedule instead of chasing drawings from engineering consultants and discussing contractor claims as are common activities in many DBB-contracts.

Furthermore, people develop and grow when they are working in new ways. For contractors, the new procurement strategies enhance a desired development towards greater responsibilities and better utilization of their skill and experiences. "*The industry will never develop if we only use DBB-contracts*" (HS). In the long run, DB-contracts will enhance a restructuring of the civil engineering sector where contractors sell competencies instead of man hours and machine hours. This change will strengthen their competitiveness and make it possible for more Scandinavian contractors to be successful internationally. However, this is a difficult change process that takes time and requires help and support from JBV.

4.2.3. Strengths and weaknesses of JBV

In Norway there is a long tradition of executing very large engineering projects in various industries, especially in Oil & Gas. For comparison the Oil & Gas industry in Norway invested more than 230 billion NOK in 2013, whereas the entire InterCity infrastructure project in Norway involves investments of approximately 100 billion NOK with less than 10 billion NOK/year. Hence, there is a lot of competence and experience connected to managing Megaprojects. These competences can be utilized in the infrastructure sector now when Oil & Gas investments are decreasing.

The respondents perceive that a major challenge for JBV is to change the culture to continue the initiated change process and avoid going back to the same old rut. This requires leadership and change agents that can champion and support the change process. At a more detailed level, JBV wants to develop their skill in using 3D-modelling tools (e.g., BIM) to improve both

the speed and quality of their projects. In this process JBV makes use of competence and experience in other industries to develop this skill.

4.2.4. Summary of Jernbaneverket's procurement strategies

The type of delivery system chosen is based on the level of complexity as well as the size of the project. JBV has traditionally mostly used DBB but has recently started a major change process similar to the transition that TRV is going through. As such, JBV has now started to use DB contracts for large infrastructure projects. This means that the contractors are now procured earlier and are responsible for the design. However, there is close collaboration between client and contractor, which is important and has provided valuable input in the design phase. There is an ambition to achieve large contracts that integrates several disciplines, since this implies fewer interfaces as well as more effective coordination and follow-up. However, the type of delivery system chosen is based on the level of complexity as well as the size of the project. DB contracts have been well received in Norway and they are therefore predicted to be more common in the future.

Traditionally, fixed unit prices were used but in large DB contracts, such as in the Follo project, fixed price is used for parts of the scope where risks are predictable and can be managed by the contractor. Incentives and bonuses are typically not used since these are perceived to result in sub-optimizations. It is considered difficult to objectively assess when bonus criteria are fulfilled. Penalties are on the other hand often used.

JBV normally pre-qualify a number of capable contractors that are invited to submit bids. In bid evaluation, lowest price has traditionally been the main contractor selection criteria while soft criteria corresponded to 5-10 %. For DB contracts the soft criteria represents 20 % or more for a complex and uncertain project. JBV avoids a large weight on soft criteria in the evaluation phase since the value of soft criteria has to be defended both internally and towards any losing bidder. However, the share of soft criteria is considered to increase in the future.

There are no formal collaboration agreements but a cooperation phase in the beginning of the project is regularly used to ensure coordinated teams and joint involvement in design. Cooperation is however seen as very important and JBV strives to have good relationships with contractors in informal ways. A few collaborative tools are used such as teambuilding activities and workshops.

The procurement strategies of JBV are summarized in Table 4, where the most common alternatives are marked in dark green and alternatives that are used less frequently are marked in light green. Alternatives that are white are seldom or never used.

Table 4. Jernbaneverket's procurement strategies and their influence on competition/cooperation.

	Competition	**Coopetition**	**Cooperation**
Delivery system	Design by contractor (DB)	Early involvement in joint design, contractor responsible (DB)	Joint design with shared responsibilities. ECI based on consultant contract
	Design by client (DBB)	Early involvement in joint design, client responsible (DBB)	
Reward system	Fixed price (lump sum)	Cost reimbursement with incentives and target cost	Cost reimbursement with bonuses
	Fixed unit price		
Contractor selection (invitation+evaluation)	Open invitation	Pre-qualification	Direct negotiation
	High focus on lowest price	Lowest price and soft criteria	High focus on soft criteria
Collaborative tools and activities	No collaborative tools/activities	A few collaborative tools/activities	Many collaborative tools/activities

4.3. ProRail and the Dutch railway sector

ProRail is a public company, under The Ministry of Transport, Public Works and Water Management and 100% owned by the State of The Netherlands. According to The Federal Railways act, The Ministry of Transport, Public Works and Water Management has the responsibility for railway infrastructure in The Netherlands. The execution of construction, management and maintenance of the infrastructure and stations lies with ProRail as a long-term concession of the Ministry of Transport, Public Works and Water Management (Correia et al., 2013). In 1995, NS Railinfratrust Ltd (RIT) was founded as a result of the separation of tracks and trains and was funded to maintain, extend, allocate, and control tracks and railway infrastructure, i.e., a management focused organisation (Boes & Dorée, 2011). NS Railinfratrust is a holding company of NS Railinfrabeheer, Railned and NS Verkeersleidering. Since 2005, NS Railinfratrust goes under the trading name of ProRail. From being a large organisation with engineers and contractors employed in-house, today 80-90 % of the yearly turnover is outsourced. Initially, the focus was to start the shift from traditional contracting to DB contracting with the civil engineering constructions but during the last 5-6 years the same strategy has

been applied to railway controlling systems, etc. This means that many every projects are procured in an early stage and based on early involvement of the contractor. The change also led to a transfer in the responsibility of the design phase and project risk, from client responsibility to contractor responsibility. However, in turn the contractor has been given the possibility to influence the development and design of projects and their systems to a larger extent than before. It has also resulted in an increased responsibility of the total performance, i.e., money and time. "*The problem we saw was that the engineering companies didn't have the incentives to assure that the quality of the project was sufficient. They have an incentive to do as much engineering as possible when they are paid by the hour, and if they don't get paid by the hours spent they have lump sum payment contracts where every change is a change in their own benefit. That is why we changed our strategy*" (MvdP).

4.3.1. Procurement of railway investment projects in the Netherlands

1. *Delivery systems*

Since the organisational change, ProRail procures all operations and activities that can be performed by supply markets. ProRail has a history of DBB contracts but have gradually changed over the years (Boes & Dorée, 2011). In general, performance based contracts are used as delivery systems and DB contracts are the most common type of contract when civil engineering, electrical engineering, signal systems, telecommunications, and the railway infrastructure network are to be procured.

However, for the last 15 years, the Dutch procurement strategies have been based on using a set of project delivery systems. For each project ProRail decides which delivery system that would be the most suitable for the particular requirements of the project. As a result, ProRail also uses the traditional DBB contracts, but these contracts are gradually fading out as the use of DB contracts has increased for new construction. The drawback with using DB contracts is the limited influence ProRail automatically have on the design of the construction. Hence, DBB contracts have particularly been used for constructing station buildings because of the influence ProRail can have on the architectural design, but also for renovations and renewals.

As mentioned earlier, ProRail have outsourced almost all their project specific business areas which also has resulted in a procurement strategy for maintenance. Four maintenance contractors have the main responsibility for maintaining the Dutch railway infrastructure. These maintenance contracts

also affect procurement of investment projects to some extent, since it often is suboptimal to bundle investment and maintenance in one larger contract. Technical components of the railway system (i.e., supplies, not works) can be procured as a bundled design-build-maintain (DBM) contract. However, because of the railway maintenance contracts mentioned above, DBM contracts for works are not very common for Dutch railway investments.

The contractors' involvement differs between projects and is related to which delivery system that is the most suitable for the specific project. For new tunnels, the majority of the new tracks, and more straight forward civil engineering projects, ProRail only defines what they want and then go to the market and procures the contractors, i.e., in DB contracts. In these contracts the contractors are rather early involved in the projects. However, early involvement is not standardised in any documents at ProRail and the degrees of early involvement vary between projects.

Several categories of projects are still procured mainly as DBB contracts. This however concerns the minority of annual spend and is often related to technical niches or to architectural requirements of stakeholders. Here, as ProRail already know what they want and how they want it, they write the tendering documentations based on their demands, even though some degrees of freedom can be present even for this type of contracts.

Depending on the contract type, ProRail's involvement in design, monitoring on site, etc. varies between projects. For DBB contracts, ProRail monitors the contractors and provides a helping hand if something goes wrong. In projects procured as DB contracts, the responsibility of the managing role has been transferred to the contractor. The control of the contractors also differs between DBB contracts and DB contracts, but has some common parameters that always are executed. ProRail always has inspections, on site, independent of what type of contract or contractor that has been procured. In the first inspections they are verifying, on a general level, whether or not the contractor is following the agreed process. If any of the actors have failed in their ability to follow the contract, then an inspector go a little bit deeper in their inspection. It is also important for ProRail to monitor the work done on the tracks, as the safety in those specific circumstances is aligned with rigorous safety instructions.

The respondents express that the delivery systems will remain as they are today for the near future. This means that ProRail will continue to act as construction clients and have focus on procuring DB contracts. "*I don't think that we will change, what we have to do is to do this more professionally*"

(MvdP). However, DBB contracts are thought to maintain as a delivery system available for those projects in which ProRail considers it necessary to keep a strong influence on how to design and the construction.

2. *Reward systems*

According to ProRail, the contractors get payed for what is delivered; it general fixed prices for DB contracts as well as for DBB contracts. They get 90 % of the money for work done (usually payment is related to the project scope being decomposed into work packages) and get the final 10% when they have finished all paperwork. This allocation of the compensation creates an incentive for the contractors to close the projects on behalf of ProRail.

Over the years a new model for DB contracts has been discussed. The suggestion was to exclude all calculations due to the functional specification and put the payment in relation to time. However, the discussion ended up in the already well-established fixed price. The obstacle with fixed price payments was the difficulties related to necessary changes in a signed contract, but to shift it to a payment related to time only transferred the risk to ProRail, something that was tried to be avoided when starting to implement DB contracts.

In ProRail the discussions about incentives, in terms of bonuses, are on the table. The difficulty, however, with bonus systems is to know what will be achieved with the use of such a system, i.e., if it will lead to any improvements. However, DB contracts have two standard but optional paragraphs containing incentives inspired by alliancing principles. The first paragraph is saying that in case of complex risks, i.e., a risk that could be better managed by the contractor together with the client, rather than solely by the contractor or the client, the actors should set a fund for that risk together and share that risk. The second paragraph is regulating optimisations in the project. For ProRail, the most important parameter when working on the tracks is the optimisation of the work done in terms of time, i.e., to minimise the amount of time a specific section of the track is closed for traffic. The importance of the time schedule has generated a malus clause in DB contracts for works done on the tracks. The clause ensures that ProRail gets compensated for deficient performance that results in additional time that the tracks are shut down. *"We use a lot of incentive systems and the incentives are based on safety and reliability. For instance for us the extension of a train free period is bad news, so we want to have an agreement with the contractor that the work will be done in 52 hours for instance during a weekend. Then on*

Monday morning the trains have to be rolling. If there is a delay and there is an extension of the train free period, it is bad news" (BS).

There are no key performance indicators (KPIs) in the standard contracts used by ProRail, except for the time parameter when it comes to railway shut downs. ProRail doesn't see any direct changes in this area in the future. The general attitude at ProRail is that the contractor receives the payment of a good outcome, which is already agreed upon. There is no logic behind an extra payment, a bonus, in such a situation. Hence, incentives and bonuses will probably not become more common in the future; fixed price payment will remain as the main reward system.

3. *Contractor selection*

According to the European public procurement directive there are four procedures that can be used when inviting contractors to submit bids. In the Netherland, prequalification and negotiation are the most utilised procedures. ProRail always uses some form of prequalification when it comes to construction projects and next to that the 'qualification system' in article 77, directive 2014/25/EU for railway specific activities. The qualification system allows the selection of contractors for a period of time and a certain scope of work, instead of pre-qualifying them at every single tendering procedure. To be a part of the tendering process at ProRail, contractors have to be qualified for the accurate categories, one or several. This means that for every part that belongs to the tracks they use qualified contractors and consultants. An authorisation of qualification is valid for 3 years after approval, after that a new application have to be approved.

For the majority of the projects, the most important bid evaluation criteria when selecting a contractor is price. However, since 2010 the Dutch procurement law prescribes the economically most advantageous tender (Boes and Dorée, 2011). The weight given to softer criteria depends on the particularities of the project. ProRail applies a spectre of quality-to-price ratio's, ranging from 10% soft criteria and 90% price to 90% soft criteria and 10% price, but the former category is much more utilized than the latter (i.e., the price-component is mostly dominant in the ratio). This implies that there are more criteria, except lowest price, that may be evaluated, such as the contractors' project solutions, experience and capabilities, and that the whole construction process should be climate friendly.

However, ProRail has implemented a system called ''CO_2 Performance ladder'' connected to the tendering phase. The objective of the system is to

decrease the CO_2 emissions, and the firms certified by this system could get an advantage in the biding process (see e.g., Stichting Klimaatvriendelijk Aanbesteden & Ondernemen). According to the certified level in the ladder system, the firm has an advantage towards other competitors and gets an award in percent of the total price in relation to the other bids (Correia et al., 2013). As an example: If a contractor's bid is 100 in some monetary unit and they as a firm has received level 5 (the highest level) in the ladder system then their bid price is reduced by 10% and is evaluated as if they have a bid of 90. If they win the contract, their payment will be the unreduced bid price of 100. The certificate is valid for a certain period of time and as long as you are on the certified step on the ladder the firm gets their bid price reduced in each tender evaluation process.

ProRail has also developed framework agreements for procurement of e.g., tunnels under the railways for pedestrians and other more common and simpler works that are procured more continuously. The projects that are put in such a framework agreements are small and many in numbers, hence, they take a lot of capacity in the tendering phase and lead to high cost if they are treated separately. The objective of the framework agreements is to reduce the required tendering resources.

In the future the respondents believe that ProRail will move towards maximum quality criteria in the selection system. ProRail has already started the process by implementing criteria such as the climate friendly system, but not taken it to its full extent. *"I think there is a growing trend in moving away from lowest bids towards maximum quality criteria. So let's say, in 10 years we really have to convince our tender board that we should use like 50% quality criteria and 50% price"* (HP).

4. *Collaboration model and partnering arrangements*

Partnering is not something that ProRail works with at the moment even though workshops with e.g., the Swedish Transport Administration have been utilised for inspiration and information purposes. The step towards partnering for the future is not clear. However, since 1998 project alliances have been used 'from time to time', with great success in the specific cases and something that they continuously are working with.

Collaborative tools and activities such as joint IT-tools and workshops are not something that ProRail has utilised to a larger extent in their projects. Steps have however been taken internally by implementing internal systems. Also applications to control the amount and the progress of different projects have

been implemented, this to better monitor and control the process of the project. In addition, Building Information Modelling (BIM) has been initiated and experimented with to a small extent, mainly in small scale projects, but never implemented or tested on projects in a bigger scale. The general problem at ProRail is that there is a big amount of different IT-tools used, and with that comes the difficulties with collaborating through joint IT-tools.

For ProRail, collaborative arrangements may become more common in the future. *"I do think that collaborative agreements will become more common, but it's also a bit of a hope in my case"* (HP). It is important to learn from others and by cooperation and knowledge sharing, the projects may become more efficient.

4.3.2. Procurement effects on project performance and the Dutch railway sector

The traffic on the Dutch railways is very dense and it is a complex issue with subsequent effects to close down parts of the system and cancel traffic. It is necessary to make the preparations and create a detailed plan with margins, so the work is efficient and the traffic and track can be re-opened quickly. In the tendering phase ProRail demands optimisations of the projects in terms of time. The aim is to keep the railway shutdowns to a minimum of hours. Here DB contracts have advantages where ProRail only has to stipulate the functional requirements for the project, and the contractors have to come up with the most time efficient solution. When tendering with DBB contracts this is not possible to the same extent, because of the detailed specification of the design.

The procurement strategies are not encouraging innovations to a large extent. ProRail wants the techniques to be well tested and approved by ProRail before implementing them in projects. This is important for safety reasons. On the other hand, innovations are good for firm performance, so the last few years ProRail has initiated a procurement instrument, an innovation program, to stimulate innovation in design optimisations or process innovations. The so called Unsolicited Proposal (USP) program makes it possible to develop innovations and discuss innovations with ProRail without having a contract for a specific project. Previously, the normal process for a firm with an innovation was to wait until a project was announced, be a part of the tendering process and hope to win the bid evaluation and that the innovation would be approved. However, with USP, firms can discuss innovations with ProRail and even get approvals of the innovation in advance. This makes

ProRail accessible for innovative projects and it opens up for initiatives from the firms.

4.3.3. Strengths and weaknesses of ProRail

The respondents believe that ProRail has a creative culture and the procurement department is of big value for the company. The working environment stimulates the employees to think about procurements. Furthermore, they have developed a standardised procedure for procurement; hence everything is backed up in policies and in standardised contracts. The procurement procedures are reliable in that sense. However, the other side of the coin is that with standardisations come more strict rules and thinking outside the box is restricted and to some extent innovation will suffer from this. ProRail performs really well, the trains are good, the tracks are ok, and there are no real disasters. ProRail is working together with universities, but it is important to implement the research results in the infrastructure sector. For ProRail, cooperating with universities around the country is also a good way to invest in innovations and research projects. Recently the R&D department at ProRail also appointed a professor and funded a whole group of about 10 PhDs. ProRail has also initiated a scientific program called xProRail together with Dutch science foundation.

One aspect that can be improved is the knowledge sharing among other companies regarding their procurement strategies. By benchmarking colleagues in other countries and within the nation it becomes possible to reflect on good and less good things within the own organisation, which may inspire organisational development.

4.3.4. Summary of ProRail's procurement strategies

Since the organizational change, ProRail procures all operations and activities that can be performed by supply markets. ProRail has a history of DBB contracts but have gradually changed over the years. In general, performance based delivery systems based on DB contracts are the most common type of contract for new investments. For particular railway components (e.g., signaling systems) DBM contracts are procured, but for multi-disciplinary projects DBM is an exception. The most common reward system has been fixed prices when procuring DBB contracts as well as for DB contracts. When it comes to contractor selection for activities that relate to the core of the railway system, ProRail applies the 'qualification system' according to the 77th article in the European directive 2014/25/EU. For non-core activities (e.g., civil works), this qualification system does not apply. The restricted procedure and negotiated procedure are mostly utilized together with a high

focus on price during bid evaluation. However, ProRail has implemented a so called ‘‘CO2 Performance ladder’’ connected to the tendering phase. The objective of the system is to decrease the CO_2 emissions, and the firms certified by this system could get an advantage in the bidding process. Traditionally, the level of formal cooperation can be neglected in railway projects in the Netherlands. However, ProRail has initiated and experimented with BIM to a small extent, mainly in small scale projects, but never implemented or tested on projects in a bigger scale. For ProRail, collaborative arrangements may become more common in the future.

The procurement strategies of ProRail are summarized in Table 5, where the most common alternatives are marked in dark green and alternatives that are used less frequently are marked in light green. Alternatives that are white are seldom or never used.

Table 5. ProRail’s procurement strategies and their influence on competition and cooperation.

	Competition	**Coopetition**	**Cooperation**
Delivery system	Design by contractor (DB)	Early involvement in joint design, contractor responsible (DB)	Joint design with shared responsibilities. ECI based on consultant contract
	Design by client (DBB)	Early involvement in joint design, client responsible (DBB)	
Reward system	Fixed price (lump sum)	Cost reimbursement with incentives and target cost	Cost reimbursement with bonuses
	Fixed unit price		
Contractor selection (invitation+evaluation)	Open invitation	Pre-qualification	Direct negotiation
	High focus on lowest price	Lowest price and soft criteria	High focus on soft criteria
Collaborative tools and activities	No collaborative tools/activities	A few collaborative tools/activities	Many collaborative tools/activities

4.4. Deutsche Bahn and the German railway sector

In 1994, Deutsche Bahn AG was founded as a public company during a big railway reform. The aim of this reform was to liberalise the railway sector, induce competition, increase railway traffic and relieve the federal government’s budget (Hunold & Wolf, 2012; Schwilling & Bunge, 2014). The railway reform was a response to both political changes (the reunification of East and West Germany) as well as economical dilemma (for both the former state owned Reichsbahn and Bundesbahn). The holding company Deutsche Bahn AG is 100% publicly owned, meaning that 100% of the shares

are owned by the government and the politicians are represented in the board, but the organisational structure looks and Deutsche Bahn runs as a private company.

When it comes to infrastructure procurement the system is vertically integrated, which means that the infrastructure and operation/traffic are separate entities under the holding of Deutsche Bahn, although the units are not separate companies (Hunold & Wolf, 2012). The operating units are divided into long distance, regional, and freight operator, and there are network operators for the tracks, for the stations and for the energy system, all separate legal entities, but they all belong to the same mother company. For infrastructure the procurement is conducted by a central procurement organisation at Deutsche Bahn AG and conducts procurements for all infrastructure units.

Deutsche Bahn Netze as a subsidiary of Deutsche Bahn has the operation, maintenance and repair responsibility of tracks, stations and energy networks for the Deutsche Bahn through the business unit of DB Netz AG, DB Station&Service AG and DB Energie GmbH. Their main mission is to guarantee safe, reliable and efficient railway infrastructure. Maintenance is performed in-house without procurement from the supply market.

In terms of financing, different types of work are financed in different ways. Every railway operator has to pay track access fee, like a toll, to the infrastructure owner. The access fee is then used and should cover maintenance of the network. Reinvestment and modernisation of the network is however covered by public funding related to budgeting on a 5 year bases. Furthermore, completely new infrastructure, which means new lines and stations, is funded by the federal government, i.e., the ministry of infrastructure. In general, the ministry of infrastructure has a budget plan and they allocate suitable budgets to specific projects and when a project has complete financing the new line can be built. There are some new lines in the pipeline, e.g., a high speed link between Munich and Berlin and one from Stuttgart to Wendlingen/Ulm, which then goes to Munich, including a new underground station in Stuttgart. There is also a big project, the Fehmarn Belt, to connect the Island of Fehrman in northern Germany with Denmark and all the way to Copenhagen. However, most of the projects are smaller in terms of closing gaps in the already existing network.

4.4.1. Procurement of railway investment projects in Germany

1. *Delivery systems*

In general, the planning and the design phases are done in-house by the Deutsche Bahn engineering staff, which in turn also will do rough cost estimates of the project and prepare the tendering documents. The contracts are rather detailed and standardised; Deutsche Bahn provides the detailed design and location of the project, that is, how and where it should be built (i.e., DBB contracts). The different parts within the construction project are separately procured, i.e., the civil engineering work will be tendered and procured separately from e.g., installations, tracks, signal systems and the energy system. When the planning, design, and building permit from the local or central authorities and a financing plan are set, then the tendering process will start and the construction firms will be procured. "*The main reason for this is that construction costs are publicly financed while Deutsche Bahn has a certain amount allocated for planning costs and design, depending on the size of the project*" (TL). All other expenses have to be covered by operating profits of Deutsche Bahn. So there is a life cycle cost approach, basically the planning unit has the obligation to choose the best cost solution in a life cycle perspective, but it is not a contract criteria.

The construction firms are basically not involved in specification or development work in DBB contracts and Deutsche Bahn see contractors more as the final construction firm rather than an engineering firm. *"It's difficult to get the planning and building permissions in Germany. So we don't want to give the risk for the planning and the planning permission to the contractor"* (TS). However, the contractor can suggest alternative solutions – if the solution is technically equal to the solution in the tendering documents and the alternative solution is more economically favourable, Deutsche Bahn can decide to procure with that solution instead.

During the construction, Deutsche Bahn do the supervision and project management of the construction, sometimes it is outscored but the project leaders are always working on behalf of Deutsche Bahn. In Germany there are very strict rules; signatures are needed for every change that deviates from the agreed contract. This means that whenever the contractor wants to deviate from an agreed contract, permission from the project management team in Deutsche Bahn is needed. Furthermore, supervisors will not approve the changes if the design engineers and experts have not approved and signed the changes in their documents. The reason for this is that Deutsche Bahn has to make sure that the changes are technically verified and covered by the public financing plan; otherwise it will need to come from Deutsche Bahn's operating profits.

The respondents believe that the basic structure of the delivery system for Deutsche Bahn will remain the same for the coming years. To change the system means to change the regulations and rules in connection to procurement contracts and tendering, which in turn will lead to a lot of lobbying from all involved groups. For the large mass of projects not much will change. However, for large infrastructure projects more flexibility will come. It seems that the plan is to go more into early contractor involvement and contract models influenced by the UK and the US. Today, early involvement is basically not used in Germany. The reason for the belief of these changes is that the German government has initiated working groups that will evaluate how large infrastructure projects are delivered and also look at project delays and budget overruns.

2. *Reward systems*

In general, Deutsche Bahn uses fixed unit prices connected to a bill of quantities. The most economic project will be awarded. So whenever changes have to be made during construction, the changes will be priced as the agreed pricing per unit for the contract. This agreement works the other way around as well, which means that if Deutsche Bahn has changes that will affect the already agreed contracts, then the risk is in hands of the Deutsche Bahn and the contract is corrected for the cost, higher as well as lower. The system is constructed to protect the public money and the government wants to make sure that the money is responsibly used but also that the risk allocation is transparent. Construction projects are high risk projects and as the client, Deutsche Bahn, rather than the construction firm, takes most of the risk.

Basically, the invoices are based on unit price payment for quantities, or for hours worked. However, other alternatives are available, for instance full function requirements for train control systems are used as it is important that the functions for these types of systems are fulfilled and works faultlessly. There are no incentive based payments or bonus criteria. If an incentive is created in the contract, the money has to come from the government. However, using the government's money is the same as using the tax payers' money on things that the contracts originally should cover. Hence, incentives are generally avoided.

The German philosophy on reward system in construction is that the client describes the project and the detailed design they want to procure. Then they formulate the project in the tendering documents. In the tendering process, bids from contractors are received by Deutsche Bahn and weighted by in-house staff. *"The general scheme is that we have a design plan and cost*

estimates, and based on that we do the tendering" (TL). The basic principal for Deutsche Bahn and the German government is that the contractor will not be able to perform better than the design in the contract because the goal for the contractor is to deliver according to the design documents. "*So there is no reward for adhering to a contract*" (TL). Another obstacle with offering bonuses for early delivery is that there is no possibility to take railway into service earlier than planned, so there is no benefit for the client to offer such incentives.

The respondents at Deutsche Bahn don't see any direct changes in this area in the future. The main reason for this is that every reward system needs to be approved by the finance department of the Government or the local states. However, a trend is seen towards more Key Performance Indictor (KPI) measurements in projects, but not a reward system on top of KPI. One way could be to change the view on the relationship between the actors. As it is today the client and the contractor are not working like partners, they are in a conflict situation and this is not good for neither of them.

3. *Contractor selection*

The government alongside with the federal state wants to achieve a transparent, non-discriminating awarding procedures and competitive bidding process (Peter, 2008). The majority of the project volume, approximately 80%, in Deutsche Bahn is tendered through prequalification and Germany is following the European tendering laws and regulations for the sector. This means that if there are fewer firms or only one firm that are certified or prequalified to deliver a certain product then negotiation procedures are used, but that is an exception from the prequalification with open tender system. The certificate is mandatory for all firms who want to work for Deutsche Bahn. Once a firm has received a certificate in terms of an authorisation of prequalification they are approved to submit bids for the next three to five years.

During bid evaluation, the overall economy of the project is the most important evaluation criteria, except from the prequalification system. The traditional way of selecting contractors is 100% focus on lowest price, but Deutsche Bahn is among the forerunners to use qualitative or soft criteria. Accordingly, selection criteria are mostly weighted 70% price, 15% logistics and 15% time planning, or 80% price and 20% logistics or 20% time planning. *"At the moment we are discussing other qualitative selection criteria, e.g., environmental aspects such as noise emissions or air pollution"* (CH).

On the other hand, in practice there is nothing that shows that the ranking between the tenders will change through the soft criteria compared to the pure price criterion. In general the firm that is most qualified with best performance and quality constructions they also have the best planning and logistics and are most efficient. "*In most cases the lowest price comes from the firm which has the best time planning and logistics*" (TL).

The balance between lowest price and the other more soft criteria are evaluated through point systems. The system is created in the way that points are given for the pricing separate from the points received for the time planning and the points for the logistics and sometimes other environmental factors. The firm with the highest points will be awarded the contract.

In the future, strengthening the work for non-pricing criteria like quality and delivery performance are in the pipeline of investigation, all this to strengthen the life cycle cost aspects. *"This must be the future"* (HE). Hence, the focus on lowest bid price may become lower in the future.

4. *Collaboration model and partnering arrangements*

Because of the public tendering law and the anti-cartel management there are no collaborative arrangements between Deutsche Bahn and supply side firms when the project is federally financed. Procurements are based on contract by contract relationships. However, there are construction firms that have been contracted for many years and for those contracts they are working in a collaborative way in terms of regular meetings, performance reviews, and supply evaluations, discussions, giving and receiving feedback, etc. In these informal long-term relationships, whenever a change in the contract is needed, a negotiation in a collaborative manner is to be preferred from both parts, as a good relationship is needed also in the future. But Deutsche Bahn will not put some suppliers in favour of others or have any strategic supplier contracts.

Internal cooperation within Deutsche Bahn, in terms of various workshops for the project managers and the design engineers, is carried out in a systematic and good way. On the other hand collaborative workshops with the contractors are scarce, but the respondents think that this has to change. Deutsche Bahn has worked together with universities and selected projects for collaborative arrangements, but the public financing department said no. Public financing chose road construction projects as pilot tests for those mechanisms, but not railway infrastructure projects. They may select a railway project in future tests, but it will be one project out of many.

What will change the way how to conduct projects will be the implementation of building information modelling (BIM) that has been initiated by the supply market. Deutsche Bahn has selected pilot projects in different phases of delivery e.g., bridges and tunnels, basically to learn. In this way Deutsche Bahn supports this type of initiative coming from associations of construction firms. "*We support the initiative from the association of construction companies that wants to implement BIM in Germany. We support it actively. We believe that it will change the way work is done, from planning to completed infrastructure*" (TL). The idea is that the phases of design planning and execution planning will merge so a more detailed and proven planning will be used for tendering in the future. It will also allow certain collaborative ways of how to work with the construction firm and much more transparency in all project stages. One further step could also be to go from 3D to 5D BIM, which means to also connect it to the time schedule in relation to costs, or even 6D, by connecting it to life-cycle management. By implementing BIM models it is almost required that solutions for early contract involvement are found. However, this will take time; probably five years or longer, according to the respondents.

4.4.2. Procurement effects on project performance and the German railway sector

Deutsche Bahn has very standardised contracts so the respondents believe that the procurement strategies are well optimised for the situation today. Public regulations of how to get building permission has an effect but for Deutsche Bahn that is something uncontrollable, so to handle efficiency the focus is on the procurement strategies. This is the effect of more than 10 years of work and intensive cooperation with Deutsche Bahn's legal department. Hence, the respondents perceive that the efficiency is high in their projects.

The procurement organisation at Deutsche Bahn has 8 competence centres that are service or technology oriented. The 8 competence centres are focusing on: civil engineering works (e.g., tunnels and bridges); tracks; stations and buildings; safety; architectural and engineering services; telecommunications; train control systems; and finally one competence centre for electrical appliances, e.g., transformers and cables. These competence centres work together with the client organizations in each project or the technology department of Deutsche Bahn's network operator and together they make procurement strategies in terms of what technology needs to be developed or changed, how to setup the future projects to optimise delivery of projects, and what innovative technologies can be implemented in the future. These constellations are the driving force of innovation and sustainable

development. When it comes to a tendering process then the tender conditions are set in advance by the competence centres. This means that the conditions of innovation and sustainability are already set when the tendering process starts.

It is very difficult for a firm to innovate or to develop a new product or process innovation and then sell it to Deutsche Bahn. The process of implementing new technologies is not a tendering condition. However, innovative ideas are shared and discussed with the technology department at Deutsche Bahn, who will test it under strict rules. Once a new technology is approved by the technology department, very often the safety criteria is the most critical part in the process, a homologation is mandatory to receive. This process is long, costly and demanding for Deutsche Bahn as well as for any firm that wants to innovate. Once the homologation is received then the new technology or innovation could be in a tender document. But innovation in the construction industry is not as quick as in other areas.

4.4.3. Strengths and weaknesses of Deutsche Bahn

Deutsche Bahn has achieved a very high level of standardisation in the contracts and procedures they are working with. They are very compliant with the regulations they have on public procurement, contracts, and financing conditions. This has led to basically no fines have to be paid from their operating profits. Deutsche Bahn is very compliant in their legal position and sees that this creates efficiency. A strength that Deutsche Bahn has is the cross-functional work, with technology departments within the network operators or with the clients.

Deutsche Bahn believes that they should gain a lot if they were faster when it comes to implementation of new ideas, innovations, processes and products. Other improvement for Deutsche Bahn is to be better in expanding the countries from where they procure. Of course construction needs to be delivered locally but there are always parts that can be produced outside of Germany. Rails for example are no longer procured in Germany, the production plants for rails are located in other countries and the procurement are made outside Germany.

Germany is generally known for high level of quality, good control, and strict regulations. By introducing 5D or 6D BIM and early contractor involvement there will be big steps of innovation in Germany. *”If we start with the BIM models then we have to find solutions that the contractor starts earlier in entering to the project. This will result in big changes for the entire construction industry here in Germany. If it comes here in Germany, I think it*

will have an influence also at a European level" (HE). Deutsche Bahn is working together with excellent universities with good research results. The importance for Deutsche Bahn and Germany is to bring these results from these universities to the infrastructure sector. The biggest step further, when speaking about railway infrastructure, is in the organisational aspect.

4.4.4. Summary of Deutsche Bahn's procurement strategies

For the most part, Deutsche Bahn executes the planning and design phase in-house, which also includes rough cost estimates of the project and preparation of the rather detailed and standardized tendering documents. This means that railway procurements have been based on thoroughly specified DBB contracts. The most common reward system is fixed unit prices connected to a bill of quantities. When it comes to contractor selection, pre-qualification is mostly utilized together with a high focus on lowest price during bid evaluation. However, Deutsche Bahn is among the forerunners to use multiple criteria that also include softer aspects. These are perceived to become more common in the future. Traditionally, the level of formal cooperation, in terms of collaborative arrangements, can be neglected in railway projects in Germany even though internal workshops are conducted. However, Deutsche Bahn has started to implement BIM in some test projects, which will change how to conduct projects in the future. By developing and implementing BIM will together with early contractor involvement involve significant innovation and change in Germany.

The procurement strategies of Deutsche Bahn are summarized in Table 6, where the most common alternatives are marked in dark green and alternatives that are used less frequently are marked in light green. Alternatives that are white are seldom or never used.

Table 6. Deutsche Bahn's procurement strategies and their influence on competition/cooperation.

	Competition	Coopetition	Cooperation
Delivery system	Design by contractor (DB)	Early involvement in joint design, contractor responsible (DB)	Joint design with shared responsibilities. ECI based on consultant contract
	Design by client (DBB)	Early involvement in joint design, client responsible (DBB)	
Reward system	Fixed price (lump sum)	Cost reimbursement with incentives and target cost	Cost reimbursement with bonuses
	Fixed unit price		
Contractor selection (invitation+evaluation)	Open invitation	Pre-qualification	Direct negotiation
	High focus on lowest price	Lowest price and soft criteria	High focus on soft criteria
Collaborative tools and activities	No collaborative tools/activities	A few collaborative tools/activities	Many collaborative tools/activities

4.5. Network Rail, Cross Rail, and the railway sector in the UK

The railway sector in the UK started its journey to privatization in 1994. Railway infrastructure became one company, train operators became a multiple of companies but still with a regulator deciding the charges for ticket prices. The national infrastructure owner was granted an expenditure profile and an income trading relationship with the train operators deciding how much they were allowed to charge the train operators for running on their railway. This was and is heavily regulated.

In 2002, Network Rail (NR) took over as owner and operator of Britain's railway infrastructure. It became a not-for-dividend company that owned and maintained the rail infrastructure. The company is also responsible for timetabling, access to the network and projects on the infrastructure throughout England, Scotland and Wales. Most projects are controlled by NR and then they seek suppliers in the market place for different aspects of the project. Consultancy support is used to define and manage the projects.

NR was earlier a heavily regulated private company but became a government body in 2014. The Department for Transport oversees NR and has much more control over the decisions that NR makes, as stipulated in the Framework Agreement between them. There is currently a major review about the future of NR regarding more devolvement of power and how NR will work with train operators.

NR has got its own national supply chain part of the business, which supplies a lot of the resources to major projects. The National Supply Chain is a national organization that provides most of the significant materials such as rail, sleepers and ballast and also on-track plant and freight trains to get materials and small plant to site. Historically, the client has set standards for materials and components that the supply chain uses even though efforts have been made to avoid being too prescriptive about components to enable market forces to play their part in trying to achieve better components. The Infrastructure Projects Division provides the project management for major projects, whilst smaller maintenance types of work are delivered by route based teams.

Crossrail

Crossrail is a large infrastructure project in London established in 2008. It is a 50/50 joint venture company between the Department for Transport and Transport for London. The whole Crossrail construction includes 21 km of tunnels under central London and will increase rail-based transport network capacity by 10%. The project is in the middle of the city of London and is a massive construction project all of which is underground making it very complex; technically and in terms of relationships with stakeholders and the existing operational railway.

The budget is £ 16 billion, whereof the stations program run by London Underground is £ 5 billion. One of the stations is the Bank station with a construction investment of £ 600 million, which just started and will be completed by 2021.

4.5.1. Procurement of railway investment projects in the UK

1. *Delivery Systems*

There is a wide range of delivery systems used. Projects below 10 million are likely to be covered by some type of framework contract. NR has also set up frameworks for ongoing renewals to encourage supplier investment and efficiencies. Similar arrangements are in place for maintenance type works, but these will normally include extensive schedules of rates as opposed to target cost or lump sum type arrangements. Depending on scale, importance to the operations of the railway and political importance, projects are treated as standalone projects. These projects are typically 100 million pounds (over approximately 1 billion SEK) or more. The delivery types for construction work are Design Build (DB) and Design Bid Build (DBB). DB contracts have become most common but one respondent believes the term is mis-used. The

term DB is used but often the client knows exactly what it wants and the contractor is just invited to do the last details (see e.g., Nyström et al., 2016 for similar reasoning in TRV in Sweden). In practice it is DBB in such cases. In projects where DBB contracts are used NR retains the control and then seeks suppliers in the market place for different aspects of the project. This implies a different supplier for physical construction, tracks, signaling, etc., and therefore NR normally performs the project integration itself.

Design Build Maintain (DBM) is not used beyond the defects period which is typically a year after the completion of the work. The infrastructure is thereafter the responsibility of the maintenance division at NR, and it is unusual to expect the contractor to provide the maintenance.

Network Rail has very hands-on project teams (planning and implementing) and very demanding (many contractors say they are intrusive). NR makes sure everything works since it is NR who receives all the criticism if anything goes wrong. There have been a number of cases where the safety record of a contractor was unacceptable to the point where they had to be stopped and removed. The monitoring is asset specific e.g., for signaling the testing and commissioning is heavily supervised but for structures the supervision and approvals are much lighter. NR has looked into increasing the amount of self-certification but no significant changes have been made yet.

NR is increasingly aiming for earlier contractor involvement. To be able to identify the best value for money and the required outcome, early supplier involvement is essential. However, the client's representatives in general feel uncomfortable assessing a company and not a design since it would be too subjective in their eyes. It is difficult to select contractors on soft criteria early enough for them to have an impact on the value created. Clients have to be better at describing performance outcomes instead of technical outputs and solutions. One example of this is the Bank station project within Crossrail where the contractors' ideas for solving the operational problem were discussed in the tendering phase in a very controlled process which protected their intellectual property. During the contract the supply chain had a clear understanding of value for the client, resulting in a focus around trying to get a really valuable outcome. "*There is a better relationship and less commercial tension than would ordinarily be found in one of these major undertakings*", according to the Programme Director of London Underground Crossrail and Stations.

Moving forward, the respondents believe that the client has to take back more risk; budgetary risk, technical risk and design risk, if the aim is to get the sort of levels of collaboration that is needed to achieve the best outcomes.

2. *Reward Systems*

Complex building and civil engineering projects are procured using cost reimbursement with economic incentives connected to a target cost when there is a greater risk sharing involved and/or if a start is needed prior to design completion. This is true for projects with or without contractor's design.

The majority of the larger contracts in the railway sector are target cost, supporting collaborative working. The mega project Crossrail uses target cost in the contracts procured as well as incentives based around the relationship with the buyer as well as the benefits and cost outcome for the buyer. Target cost has a good argument for larger projects but for smaller projects it is recommended to avoid it unless there is a good specific reason to use it, and that the right people and resources are available. Hence, smaller contracts are normally lump sum as target cost contracts require more contract management.

Target cost payment is especially common for DB contracts since it allows a little bit more room for collaboration. Hundreds and hundreds of standards are part of the design process and this is dealt with in a collaborative way to achieve the best solution. The gain and pain is shared. If the cost end up under the target the benefits are typically split 50/50, while if the actual cost is over the target cost the split depends on the contract. Sometimes there are standalone payment milestones connected to e.g., a deadline. The target cost can be adjusted during the contract and the reason for not using a fixed price is that there is not truly a fixed price project. *"For existing infrastructure nothing is what you assume it to be*", says one respondent.

For target cost arrangement one of the downsides is that contractors can spend too much time trying to drive up the target costs rather than drive down the actual cost as it's a lot easier to make the price target go up than it is to come up with clever ideas to drive the cost down.

The contractors are paid on a measurement of the works they have done. That is e.g., how many linear meters of this or how many tons of that against an agreed rate. However, this depends on the form of contract. For target cost invoicing/applications for payment are four weekly based on actual costs plus

accruals. For non-target cost contracts payments based on quantities completed or percent of a priced activity completed.

There have been cases where performance measures or KPIs have been used to influence what a contractor receives but most often the KPIs are just used as a performance discussion tool to highlight the fact that a contractor is doing well or not in an area. Furthermore, the KPIs are used to compare with the performance of other contractors and to encourage better performance. Sometimes the KPIs have been used as an influence or a multiplier on top of incentives or even on top of a fee. In addition, there may be penalties that are often connected to delays. One respondent highlights the importance of timely delivery: *"time and completion of the job on time is sometimes more important on a busy railway than price. So time based penalties may be quite significant*".

For future reward systems, factors such as customer satisfaction during a project (e.g., passengers on a station that is rebuilt), the attitude towards buyer, passengers, neighbors and train operators are discussed. These factors ought to influence how profitable the contractor is but today this is very uncommon. At the moment there is not a clear understanding of how to incentivize sustainability outcomes. Another trend is greater online collaboration and data capture, such as BIM (Building Information Modelling), which could encourage more reward sharing.

3. *Contractor Selection*

Usually the contractor selection process starts with a pre-qualification questionnaire being published. The trigger level for advertising is £345k for goods and services and £4.3m for works. Then the client selects the preferred bidders from the prequalification short list. Sometimes when the client is looking for suppliers that are not on the list, the process for European Interactive Digital Advertising Alliance is used. This is the case when the client is looking for worldwide solutions. However, the majority of the suppliers are found through the accreditation system. After prequalification, the tender documents are sent out. For larger projects, negotiation occurs during the tender process if the specifications need adjustments or if the client wants to make changes.

NR has gone through several phases regarding evaluation criteria. Currently, there is an enormous amount of tension around the increase from the bid prices. This means the price in the tender is not the actual building price but a price to win the contract. The contractors focus on raising the target cost

during the contract rather than driving down the cost of the work. Typically there is a 10% spread on bid price and comparing the bid price to the outcome cost there is normally an increase between 25 % and 40 %.

The assessment criteria typically have a technical component and a commercial component. These are assessed in a precise un-subjective way to minimize the chances of a challenge from a disappointed unsuccessful contractor. The criteria are weighted around 60 % price and the rest is 25 % technical aspects, 10 % safety, and 5 % sustainability. The technical aspects consist of methodologies, programs and people in the project. Apart from the price, the commercial part includes a fee, which is a percentage of the price, to avoid underpriced work. The fee is also evaluated since some contractors have been known to underprice the works and add a fee of 20 %, where a normal fee is around 8 %. Other criteria are the financial standing of the company and the parent company in particular. Sometimes behavior assessments are used.

In the Crossrail project the bidders were prequalified around their ability to innovate and the relationships that they had with clients and their ability to bring value to the business. Price was not the key component and the bidder got much more traction on winning that bid after enhancing benefits than by reducing price. The winning bid was in value terms 50% better than the baseline solution. The most important weightings were the passenger journey time through the station, the handling capacity for the station and disruption during the process of building the station.

There is a large discussion going on in the UK regarding what selection criteria to use in the future. Performance outcomes instead of technical outputs in the contract is a key feature. The client is also trying to develop measures for sustainability. As for now it is still a subjective word about sustainability policies. However, a standard 5 % weight on criteria for sustainability in tenders is a way to integrate and develop sustainability into all what Network Rail does.

4. *Collaboration model and partnering arrangements*

"*In many ways, the transactional relationships are leading us to procurement approaches which historically, broadly, have not worked in producing us certainty of outcome, efficiency of outcome, nor sustainability of the supply chain*", says one of the respondents. This can be seen in the financial results of the main contractors in the UK and a need to ensure a move towards more relational rather than transactional arrangements has been identified.

Furthermore, the government wants to transfer all the risks to the contractor, which can be a problem according to one of the respondents.

Alliances are used to generate the best ideas and to get early contractor involvement to decide what the best way forward is. On very large projects with a design that is hard to define, such as electrification, alliances are used to help drive the project forward and save money early on the scope decisions. The alliance has a board that makes the decision regarding the mixture of different contractors and consultants. The alliances have their own specific reward mechanisms. Up until now all alliances have been bespoken and of different character. Currently Network Rail is trying to standardize their alliance agreement.

An alliance typically has two to three contractors of multi-disciplinary companies and the client. In mega project market segment regarding e.g., the amount of track works and civil engineering has been determined before procuring. Sometimes the ventures are formed after the tendering process when contractors have realized that it would be better if they bring in another supplier in their team. This means there is flexibility on the structure depending on how that whole tendering process went. In the Bank project in Crossrail, a non-contractual partnering agreement is in place. There is a board between the various organizations which is independent, as well as standard tools for partnering. This is driven by a lack of resources for projects in the London area.

Regarding the future, there is a move towards longer term relationships for the major works. With specialist contractors the idea is to form separate but direct relationships and the aim is to have alliancing relationships over several years for a number of projects. Another trend is greater online cooperation and data capture, such as BIM, which could encourage more reward sharing.

4.5.2. Procurement effects on project performance and the railway sector

Some parts of the UK rail system is heavily used making it difficult to get access for maintenance and reinvestments. Therefore, criteria such as traffic availability are included in the contract.

There is a general recognition within the industry that there is a move to new configurations and new delivery models. There is also a belief that the industry needs to find better ways of encouraging cooperative working and a way to define win/win for the client and all the contractors involved. Therefore more collaborative approaches are tried and Network Rail is aiming

for early contractor involvement to achieve more value for money. This has been tested in mega projects such as Crossrail.

Target cost is the main pricing for large complex projects. This has resulted in contractors trying to raise the target cost during the project instead of focusing on lowering the actual cost. This is a result of the fact that the original tender is often too low. This issue has caused friction between the client and the contractors. Within the mega project Crossrail a different approach was used resulting in a focus on creating valuable outcome.

There is a move towards longer term relationships for the major works. With specialist contractors the idea is to form separate but direct relationships and the aim is to have that alliancing relationship lasting over a number of years and over a number of projects. Also, it is believed that moving forward the client has to take back more risk both budgetary risk, technical risk and design risk if the aim is to get the sort of levels of collaboration that they need to get the best outcomes.

Sustainability, in economic, environmental and social terms, is talked about in the UK. "*With any government or public funded works there is an expectation that you've got a good story to tell there*". Sustainability is started to be used as a criteria (5 %) for tendering but it is yet not known how to measure it. One example of this is life-cycle cost.

Although DB contracts are used, they are often rather detailed and specified in terms of design and technical solutions, leaving little room for contractors to innovate and come up with new solutions. In fact, one of the respondents believes that contractors should not be encouraged to innovate. *"Innovation has been the root of a lot of evil in projects and a lot of disasters have been caused by innovative signal design, electrical equipment, etc., and actually I would say innovation should be a project within itself and then when it is totally reliable then we should implement it in projects. I have seen so many projects completely destroyed either by money or time scale through inappropriate innovation" says one of the respondents*. Instead of promoting innovation in each construction project, NR has specific funds for Innovation and Strategic research and development. These are used to support the industry to development and to introduce new technologies and innovations in separate innovation projects. Separating construction and innovation projects is especially critical due to the heavy traffic and the severe consequences of malfunctions. "*We do tend to be conservative in the use of innovation, but realistically I think it's the only thing we can do*" according to a respondent.

4.5.3. Strengths and weaknesses of Network Rail

The respondents believe that the substantial funds for innovation and strategic developments are a strength of Network Rail. In the Crossrail project an innovation programme was formed when realizing there were several hubs of innovation within the mega project. Furthermore, innovation is supported by an increased focus on early contractor involvement. A client infrastructure group has been formed in the UK to discuss the need to specify outcomes and to procure suppliers who will then work with the client to deliver those outcomes. This shows a will to develop the delivery forms to achieve more value for money.

However, the client finds it difficult to select contractors on criteria early enough for them to have an impact on the value created. The client has to be better at describing outcomes and not outputs. Some examples are starting to come where the clients are becoming mature enough to be wanting to procure outcomes but it is not the norm.

The friction between client and contractor regarding too low bids and a focus on raising the target cost in the projects is a weakness for Network Rail. There is a tendency to use target cost even for small projects which has not been successful, which is why "the bar" for when to use target cost is re-evaluated.

4.5.4. Summary of Network Rail's procurement strategies

Network Rail mostly uses DB contracts and is increasingly aiming for earlier contractor involvement. To be able to identify the best value for money and the required outcome, early supplier involvement is essential. However, Network Rail finds it difficult to select contractors on criteria early enough for them to have an impact on the value created. Clients have to be better at describing outcomes and not outputs. This has been successfully done in the large Crossrail project.

Cost reimbursement connected to a target cost is the main pricing for large complex projects. Smaller contracts are normally lump sum as target cost contracts require more contract management. Target cost payments are often used in DB contracts since this payment provides a little bit more room for collaboration. For future reward systems, factors such as customer satisfaction during a project (e.g., passengers on a station that is rebuilt), the attitude towards buyer, passengers, neighbors and train operators are discussed.

A pre-qualification is used for contractor selection and the assessment criteria typically have a technical component and a commercial component. During bid evaluation, the criteria are weighted around 60 % price and the rest is

spread 25 % technical aspects, 10 % safety, and 5 % sustainability. Currently, there is an enormous amount of tension around the increase from the bid prices and there is a large discussion going on in the UK regarding what selection criteria to use in the future. Outcome instead of outputs in the contract is a key feature.

Alliances are used to generate ideas and to get early contractor involvement to decide what the way forward is. Up until now all alliances have been bespoken and of different character. Currently Network Rail is trying to standardize their alliance agreement. There is a move towards longer term relationships for the major works and to have alliancing relationships lasting over a number of years and over a number of projects.

The procurement strategies of Network Rail are summarized in Table 7, where the most common alternatives are marked in dark green and alternatives that are used less frequently are marked in light green. Alternatives that are white are seldom or never used.

Table 7. Network Rail's procurement strategies and their influence on competition and cooperation.

<table>
<tr><th></th><th>Competition</th><th>Coopetition</th><th>Cooperation</th></tr>
<tr><td rowspan="2">Delivery system</td><td>Design by contractor (DB)</td><td>Early involvement in joint design, contractor responsible (DB)</td><td rowspan="2">Joint design with shared responsibilities. ECI based on consultant contract</td></tr>
<tr><td>Design by client (DBB)</td><td>Early involvement in joint design, client responsible (DBB)</td></tr>
<tr><td rowspan="2">Reward system</td><td>Fixed price (lump sum)</td><td rowspan="2">Cost reimbursement with incentives and target cost</td><td rowspan="2">Cost reimbursement with bonuses</td></tr>
<tr><td>Fixed unit price</td></tr>
<tr><td rowspan="2">Contractor selection (invitation+evaluation)</td><td>Open invitation</td><td>Pre-qualification</td><td>Direct negotiation</td></tr>
<tr><td>High focus on lowest price</td><td>Lowest price and soft criteria</td><td>High focus on soft criteria</td></tr>
<tr><td>Collaborative tools and activities</td><td>No collaborative tools/activities</td><td>A few collaborative tools/activities</td><td>Many collaborative tools/activities</td></tr>
</table>

4.6. Swiss Federal Railway and the railway sector in Switzerland

In the beginning of the 20th century, the Swiss Federal railway (SBB) was founded as a public company. For the Swiss railway, as well as for many other Europeans countries, the EU directives (Dir.91/440/EEG) have been important for the separation of the national railways into different

organisations; one which deals with the infrastructure and another that deals with the transport activities. In 1999 this separation was conducted for SBB with the aim to liberalise the railway sector, induce competition, and increase rail traffic. In the same year SBB was excluded from the Federal Administration and became a fully public limited company under public law, meaning that 100% of the shares are owned by the government. SBB is divided into four divisions; Passenger, Freight, Infrastructure, and Real Estate. In addition are the Control and Service functions and Personnel. In turn SBB Infrastructure is divided into seven units: Timetable and Network Design; Installations and Technology; Projects; Maintenance; Operations; Purchasing, Supply Chain and Production; and Energy, Telecom and Electrical Systems. The main goal for the Infrastructure unit is to help the Passenger and Cargo units by operating, maintaining and developing the railway and installation systems.

4.6.1. Procurement of railway investment projects in Switzerland

1. *Delivery system*

In general, SBB first describes the project they want and the needs they have. Subsequently, the planning and design are then conducted in-house by SBB engineering staff in collaboration with external specialists. This work also involves rough cost estimates of the project and preparation of the tendering documents. The projects are based on DBB contracts and the contractors have no influence on the design and are not involved in specifications or development work. *"In fact they come in very, very late in the project"* (MJ). However, occasionally SBB can accept and procure alternative solutions from a contractor as long as the new solution is not in conflict with the construction permit.

Often, SBB procures a general contractor that together with their subcontractors executes the project. During the construction, SBB is generally not monitoring the contractor. However, for any project an in-house project leader supervises the contractors, has an overall discussion with the contractors, and conducts meetings with them on regular bases. This informal working environment is created due to a long and trustful relationship between SBB and the contractors, but also among the contractors themselves.

The respondent believes that in the future the basic structure of the delivery systems will remain as they are today, which means that SBB will continue with in-house planning and design staff. *"For the large mass of projects not much will change"* (MJ). However, it seems that the plan is to go more into

early contractor involvement and contract models influenced by the UK and the US. Today, early involvement is basically not used by SBB but might be an exception even in the future.

2. *Reward system*

In the main, fixed unit prices connected to a bill of quantities are used by SBB. This reward system enhances flexibility compared to other reward systems in terms of adjusted reimbursement. Whenever necessary changes, e.g., due to contingent uncertainties, have to be made during construction, changes will be priced as the agreed pricing per unit and the contract is corrected for the cost. This agreement works the other way around as well. SBB is not using any sort of incentive based payments or bonus criteria for their projects.

3. *Contractors selection*

In Switzerland, open tendering with negotiation and without prequalification is the most utilized bid invitation procedure. The trustful working environment among SBB and domestic contractors has spurred a tendering system without formal prequalification, due to SBB´s great knowledge of the contractors on the market. However, the contractor has to prove in advance that they have the capability to successfully execute the project, e.g., the right knowledge and persons, the financial conditions, machines, references projects etc. Formal prequalification is something that SBB doesn't think is applicable to the Swiss tendering phase. They have discussed this strategy with Deutsche Bahn, but were not convinced. SBB's view on prequalification is based on their view that every project is unique.

For the majority of the projects, the most important bid evaluation criterion is the overall economy of the project. The old fashion way of selecting contractors is 100% focus on lowest price, but the respondent believes that SBB is among the forerunners to also evaluate soft parameters. Accordingly, selection criteria are mostly weighted on price, quality, security and logistics. Before SBB starts the tendering phase they together with the project managers decide the weight price will have for the specific project. In general 40-60% of the criteria weight is price, and the residuals are allocated among the more soft criteria. This weighting system is rather new for SBB. A couple of years ago the balance between lowest price and the other more soft criteria was evaluated through a point system. The system is created in the way that the price is separate from the points received for the time planning and the points for the logistics and sometimes other environmental factors. The firm with the

lowest price and the highest points over 300 out of 500 point was the awarded the contract. In the future, SBB will continue using the selection criteria in its current form, due to the rather recently implemented system.

4. *Collaboration model and partnering arrangements*

Internal collaboration is considered important during the design phase. As such, various workshops for the project managers and the design engineers are carried out within SBB but there are no collaborative arrangements between SBB and supply side firms as the common view is that procurements are based on contract by contract relationships. This idea also influences the exclusion of collaborative tools and activities such as joint IT-tools and workshops during the production phase. For SBB, it seems that no collaborative activities or tools will be used in the future.

4.6.2. Procurement effects on project performance and the railway sector

Optimization in the design phase does, to a big extent, affect efficiency in terms of cost. The traffic on the Swiss railways is one of the densest systems in Europe and it is very tricky to close down parts of the system and cancel traffic. It is necessary to make the preparations and create a very detailed plan with good margins, so the work is efficient and the traffic and track can be re-opened quickly. In the tendering phase, SBB demands optimizations of the projects in terms of time. The aim is to keep the railway shutdowns to a minimum of hours.

Knowledge sharing across projects is something SBB is continuously working with. However, SBB sees the projects as unique and the sector as a "people based business" so the greatest challenge for SBB is to create a working environment that encourages this sharing of knowledge.

The procurement strategies do not encourage innovations to a large extent. However, innovations are good for performance and before a project starts, SBB is trying to look for innovative solutions. They have also created room for contractors to propose innovative solutions or materials in the tendering phase. Then it is up to SBB to evaluate, discuss and finally approve a change from the tendering documents. The aim for SBB is to open up for innovation or better solutions for a specific project, and not necessarily enhance developments that will become standards in future projects.

4.6.3. Strengths and weaknesses of the Swiss Federal Railway

SBB is very pleased with the way they are working and believes that their strategies create good projects. The dense railway system in Switzerland puts pressure on every actor to deliver at the highest level and the fact is that there are not many delays in the execution of projects.

The key as SBB sees it is to have exceptionally competent civil engineers, who deliver robust and faultless projects. As the most important aspect for SBB is the time schedule, they include a malus clause in many contracts for works done on the tracks. The clause ensures that SBB gets compensated for deficient performance that results in additional time that the tracks are shut down. This is however not a standard, but it is added to strategically important or big projects were time is exceptionally critical. SBB is very compliant in their position and sees that this creates efficiency. A strength that SBB has is the cross-functional work, with technology departments within the network operators or with the clients.

In general, SBB is very confident in their partners and that is also something that they believe have created robustness of infrastructure deliveries. *"We agree on a contract, we pay and they deliver. Not more difficult than that"* (MJ). Another important aspect for success, as SBB sees it, is that if SBB observes a problem or they get indication of problem, they will not initially stop the work during error search. This means that the contractor continue the work until the end of the contracted project, or until SBB waves the flag for a stop in the construction. It is also important to know that SBB never goes to court with problems; they are continuously working to find solutions to the problem and having a discussion with the contractors in an open dialog.

4.6.4. Summary of Swiss Federal Railway procurement strategies

In general, SBB executes the planning and the design in-house, which also involves cost estimates of the project and preparation of the rather detailed and standardized tendering documents. Traditionally, railway procurements are therefore based on thoroughly specified DBB contracts. The most common reward system is fixed unit prices connected to a bill of quantities, even though fixed price payments are used in projects when needed. When it comes to contractor selection, the trustful working environment that has been created in Switzerland has created a tendering system without prequalification, due to SBB´s great knowledge of the contractors on the market. Contractors are mostly evaluated based on lowest price but SBB is among the forerunners to also use soft criteria. This will be increasingly common in the upcoming years. Traditionally, the level of formal cooperation

with contractors is negligible in Swiss railway projects even though internal workshops are conducted within SBB. The dense railway system in Switzerland puts pressure on every actor to deliver at the highest level and the fact is that there are not many delays in the execution of projects. SBB perceive it important to have exceptionally competent civil engineers and a good and confident relationship with all actors on the market.

The procurement strategies of SBB are summarized in Table 8, where the most common alternatives are marked in dark green and alternatives that are used less frequently are marked in light green. Alternatives that are white are seldom or never used.

Table 8. SBB's procurement strategies and their influence on competition and cooperation.

	Competition	**Coopetition**	**Cooperation**
Delivery system	Design by contractor (DB)	Early involvement in joint design, contractor responsible (DB)	Joint design with shared responsibilities. ECI based on consultant contract
	Design by client (DBB)	Early involvement in joint design, client responsible (DBB)	
Reward system	Fixed price (lump sum)	Cost reimbursement with incentives and target cost	Cost reimbursement with bonuses
	Fixed unit price		
Contractor selection (invitation+evaluation)	Open invitation	Pre-qualification	Direct negotiation
	High focus on lowest price	Lowest price and soft criteria	High focus on soft criteria
Collaborative tools and activities	No collaborative tools/activities	A few collaborative tools/activities	Many collaborative tools/activities

5. Comparison of the procurement strategies in the six countries

The procurement strategies in the six countries vary significantly, as illustrated above in Tables 3-8. The competitive focus in Germany and Switzerland is in in line with findings in many prior studies, which show that procurement strategies traditionally have been based on detailed DBB-contracts and competitive tendering focusing on lowest price (Korczynski 1996; Kadefors, 2004). However, these competitive strategies are also in stark contrast to the more recent trend towards an increased use of cooperation and partnering arrangements in the construction industry in many countries during last decade (e.g., Bygballe et al., 2010; Kadefors & Eriksson, 2015). Coopetitive and cooperative strategies are adopted by TRV, JBV, ProRail,

and Network rail. These actors have one important thing in common: they try to increase the suppliers' responsibilities and freedom through the use of DB contracts. By getting involved and supporting the contractors in the design work, the clients can achieve sufficient extent of direction of the process and customization of the end product anyway.

The comparisons among the six studied countries are summarized in Table 9 below. When the organizations' abbreviations are marked in bold it illustrates common strategies and abbreviations marked in italics illustrate strategies that are used less frequently.

Table 9: Summary of comparisons among the six countries

	Competition	**Coopetition**	**Cooperation**
Delivery system	Design by contractor (D-B) **TRV***, JBV,* **PR, NR**	Early involvement in joint design, contractor responsible (D-B) **JBV***, PR*, **NR**	Joint design with shared responsibilities. ECI based on consultant contract *NR*
	Design by client (D-B-B) **TRV, JBV, PR, DB***, NR*, **SBB**	Early involvement in joint design, client responsible (D-B-B) *TRV*	
Reward system	Fixed price (lump sum) **TRV***,* **JBV, PR***, DB, SBB*	Cost reimbursement with incentives and target cost *TRV*, **NR**	Cost reimbursement with bonuses
	Fixed unit price **TRV, JBV, PR, DB***, NR*, **SBB**		
Contractor selection	Open invitation **SBB**	Pre-qualification **TRV, JBV, PR, DB, NR**	Direct negotiation
	High focus on lowest price **TRV, JBV, PR, DB***, NR*, **SBB**	Lowest price and soft criteria *TRV, JBV, PR, DB*, **NR, SBB**	High focus on soft criteria
Collaborative tools & activities	No collaborative tools/activities **JBV, PR, DB, SBB**	A few collaborative tools/activities **TRV,** *JBV, PR, DB*, **NR**	Many collaborative tools/activities **NR,** *TRV*

5.1. Delivery system

In many countries, contracts regarding infrastructure investments have become increasingly performance-based to trigger innovative activities that are less likely to occur under conditions of the traditionally highly specified contracts (Geyer & Davies, 2000). The traditional delivery system for all investigated countries is DBB, and while some of the countries have moved away from this type of contract others are still using it for the majority of the construction projects. In general there is a trend towards decreasing the use of DBB contracts and trying to incorporate more DB contracts for large infrastructure projects. Project complexity is an essential factor affecting the choice of delivery system, and the greater complexity the more likely it seems to be to use DB. The size of the project is also of importance for this decision. Large DB contracts are perceived to encourage international contractor companies to enter smaller Scandinavian markets in Norway and Sweden.

In Switzerland and Germany, DBB is the main delivery system and the respondents believe that this type of contract will remain most common. In

Sweden, TRV has started a change process towards increased use of DB contracts, but DBB contracts are still common in some regions. In Sweden, bridges are mainly procured by DB contracts, but there are now several examples of DB contracts used for other parts of railway construction as well. In the future, DB may be used more frequently in large scale complex projects. Norway is also using DB contracts to an increasing extent, and here as well a change process is taking place within the railway sector where DB contracts have been well received and are now becoming more common.

In the Netherlands and the UK the most common delivery system for large construction projects is DB, and thereby DBB is becoming less and less used. However, in the Netherlands, DBB is still used for reinvestments and in the UK the DB contracts are in practice sometimes equal to DBB since they may be rather detailed and specified. A similar situation has been identified in Sweden, especially in the beginning of the change process where detailed DBB contracts were rebranded DB contracts. It is important to point out that, at least in Sweden, highly specified DB contracts are very similar to DBB contracts, both in practice and from a legal point of view, since the client has to take responsibilities for the specified solutions in DB contracts (Eriksson & Hane, 2014). This type of hybrid approach may be counterproductive, by hindering contractors to improve both innovation and efficiency.

DB implies more involvement of the contractor in design work. In Sweden however, using DBB for so long has resulted in inexperience among many contractors regarding the market for consultancy services and how to manage the design stage. Furthermore, the large set of rules regarding railway construction limits the freedom in design for DB compared to the road sector. When the degrees of freedom are very limited, it may be better to use DBB contracts. This seems to be the case in Germany and Switzerland, where DBB contracts are still most common.

In Norway the contractors are now procured earlier and the design is the result of an informal collaboration between client and contractor. To have a dialog in an early stage is especially important for JBV when working with foreign contractors. Furthermore, it is especially important in complex construction projects for knowledgeable clients to get involved and contribute to joint development work (Jacobsson & Roth, 2014). Close collaboration in the design stage in DB contracts can thereby be an alternative to DBB contracts when clients want to get involved in design work and affect technical solutions (Eriksson & Hane, 2014).

The contractors in the Netherlands are involved early in DB contracts, but exactly how early is not standardized and depends on the project. In the UK, early contractor involvement (ECI) has been identified as essential to identify best value for money and required outcome. This is in line with the literature where early contractor involvement is identified as supporting innovation and development (Caldwell et al., 2009). Network Rail is striving for early contractor involvement but finds it difficult to select the contractors based on soft criteria in early stages. ECI based on consultancy contracts has also recently been tested in Sweden to some extent. These approaches based on early involvement of contractors are in stark contrast to the strategies in Germany and Switzerland. There, DBB is the delivery system used and where all planning and design is done in-house. The contractors are seen as a construction firm, rather than a provider of competence.

Integrated contracts such as Design-Build-Maintain (DBM) are not common in the studied countries but have to some extent been used for small complex project in the Netherlands (Lenferink et al., 2013). However, obtaining the benefits of such integrated contracts is challenging. In their study of the restructured UK and German markets, Geyer and Davies (2000) found that valuable experiences from performing maintenance services are often not fed back to design and construction phases of new railway investments. Lack of vertical integration and/or cooperation among different actors and their activities therefore results in missed opportunities for continuous improvements and innovation (Sveriges Bygguniversitet, 2013). Another barrier to integrated contracts seems to be the division of investment and maintenance departments/organizations with separate budgets in the client organizations, resulting in separate rather than integrated procurements.

5.2. Reward system

DBB contracts with unit prices connected to a bill of quantities are used in all the studied countries. However, DBB contracts are most common in Germany and Switzerland. For DB contracts and for projects where the uncertainty is low, fixed prices are generally used in Sweden, Norway, the Netherlands and the UK. In the Follo project in Norway, a fixed price is determined for a baseline situation, a price that is then adjusted in the case of exceptional ground conditions. In Sweden, fixed price is explored and tested for DB contracts but only when it is possible for contractors to calculate their costs with sufficient accuracy, that is, when projects are rather straight forward and not too complex and uncertain. Then, the risk premium does not become too high.

In the UK, the majority of the larger contracts in the railway sector are target cost, supporting collaborative working. The gain and pain is shared, typically split 50/50. The target cost can be adjusted during the contract and the reason for not using a fixed price is that it seldom becomes the final price. In reality there are no truly fixed prices since they are adjusted due to changes. A related challenge when using target cost is that contractors can spend too much time trying to drive up the target rather than drive down the actual costs. This has caused a lot of friction in the UK between the client and contractors. A known disadvantage for incentive-based payment is that adjusting the target cost often gives rise to discussions or even disputes similar to those of adjusting a fixed price (Kadefors, 2004; Badenfelt, 2008; Boukendour & Hughes, 2014). This is also the reason for why this type of reward system is not used in Norway. In the Swedish discussion regarding target cost this drawback has been acknowledged and a split 80/20 to the client is now suggested as a possible way to reduce contractors' risks and thereby conflicts.

Bonus opportunities linked to other soft aspects are not used to a large extent among the investigated countries. In the UK, KPIs are mostly used as performance discussion tools to highlight the fact that a contractor is doing well or not in an area, instead of as a basis for economic rewards. However, there are a few cases where KPIs have been used to influence what a contractor gets paid. Future reward system factors such as customer satisfaction during the project, attitudes towards passengers and sustainability are discussed. Linking bonuses to such non-economic aspects is a more collaborative way of using bonuses (Tam & Tam, 2008; Eriksson & Westerberg, 2011; Love et al., 2011), and Network Rail is aiming for increased collaboration with the contractors. In Sweden bonuses have been used in some occasions. Examples of bonus criteria are: timeliness, temporary traffic, cooperation, and environmental performance. In the Netherlands, bonuses are seen as a mechanism that often causes sub-optimizations and it is found difficult to objectively assess when bonus criteria are fulfilled. Therefore, incentives and bonus criteria are typically not used, except for the time parameter to minimize the time a section is shut down due to work. However, the discussion in the Netherlands regarding bonuses is still on the table. In Germany, bonuses for early delivery are not on the agenda since it is not possible to take railway into service earlier than planned. In Germany there is a trend towards more KPI measurements in projects but not linked to a reward system. It is believed that tax payers' money should not be used to reward performance covered by the original contract.

5.3. Contractor selection

Pre-qualification is used in all countries in the study (except in Switzerland where the domestic market is small and the amount of bidders is rather low) to receive well prepared bids from capable contractors. As such, the purpose of prequalification seems to be twofold: 1) to increase the chance of selecting contractors with strong capabilities and avoid poorly performing contractors, and 2) to motivate capable contractors to dedicate sufficient time and resources to prepare bids with high quality. All client organizations seem to adopt a view that it is better to receive a few strong bids than a larger amount of bids with highly varying quality. To facilitate this, it is however important that pre-qualifications are tough and demanding so that not all contractors get pre-qualified, then this strategy loses its purpose.

As for bid evaluation, lowest price is still the most important evaluation criteria but all countries include soft criteria as well to some degree, see Table 10. This is also supported by the literature, stating that lowest price is often the most important bid evaluation criterion, especially among public clients (Eriksson, 2008b). One major reason for this focus on price competition is that public clients fear appeals from the contractors not winning the contract, stating that the evaluation has not been performed in a transparent and objective way (Eriksson & Hane, 2014). However, although lowest price selections have been dominant, this is starting to change and many respondents across the studied countries believe that soft criteria will become more important in the future.

Table 10: Soft criteria in bid evaluation.

Country	**Soft criteria (weight)**
Sweden	5-20 %
Norway	DBB 5-10%, DB 15-20 %, complex project 50 %
Netherlands	10-30%
Germany	30-40 %
UK	~ 40 %
Switzerland	40-60%

In terms of soft criteria, the focus in Sweden is on organization and management as well as risk management, collaboration and realization plan.

Organization and planning is included in Norway too, as well as criteria such as experience and safety. In the Netherlands, the main focus is on a climate friendly solution and reduction of CO2 emissions. The "CO2-ladder" developed by ProRail is one way to make soft criteria less subjective and easier to evaluate in transparent and objective ways. In the UK, a sustainability factor is included but the suitable measurements for this criterion are under development. Methodologies and organizations are also included. In Germany and Switzerland, logistics and planning are included to complement the price criteria.

Some respondents discussed the ambiguous importance of soft criteria. One the one hand, soft criteria often don't affect which contractor is selected. That is, even when soft criteria are evaluated the contract is often awarded to the contractor with the lowest price. However, the inclusion of soft criteria is argued to improve the quality of the bids since soft criteria make contractors really think through and plan the project more thoroughly during the bid preparation phase.

Soft criteria seem to be more important depending on the complexity and uncertainty of the project, especially if the contractor is procured early in the project. In Norway the soft criteria can constitute up to 50 % of the total criteria if needed, although it is unusual. It is especially vital that tender evaluation focuses on soft criteria in complex projects or when the contractor is expected to contribute to innovation in the design stage (Bosch Sijtsema & Postma, 2009).

A challenge using soft criteria is that the evaluation is more subjective and therefore can lead to appeals from losing contractors. This was highlighted by Sweden, Norway and the UK. In Norway, a large focus on soft criteria is therefore avoided. In the UK, the mega project Crossrail managed to use soft criteria such as the passenger journey time through the station, the handling capacity for the station and disruption during the process of building the station, successfully without any appeals. The reason given was that the contractors were invited early in the process and participated in a dialog phase. The contractors in the Crossrail projects were compensated for their tenders. This is sometimes the case in Sweden and Norway as well.

In construction projects, selecting capable contractors is a critical task for clients (Kumaraswamy & Anvuur, 2008; Caldwell et al., 2009). This is confirmed by the interviews where all respondents talk about ongoing development of criteria and coming changes. Several respondents also highlight the importance for public clients to develop more knowledge

regarding how to select contractors based on soft criteria in very early project stages.

5.4. Collaboration model and partnering arrangements

In general, formal partnering agreements are not commonly used in the studied countries except for Sweden and the UK. TRV has traditionally not used cooperation and partnering to a large extent in railway projects. However, since 2015 a formal policy is in place stating that a basic collaboration model should be used in all contracts. Hence, the current strategy is explicitly based on formalized cooperation. Furthermore, an extended collaboration model will be implemented in 2016 for more complex and uncertain projects. In the UK, there is a clear collaborative approach, due to a perceived need to move towards more relational rather than transactional arrangements. Alliances are used to generate the best ideas and to get early contractor involvement to decide the best way forward. Joint objectives enhance the development of a win–win situation in which all project participants together strive to improve project performance as formulated in objectives (Swan & Khalfan, 2007; Eriksson, 2015). Currently, Network Rail is trying to standardize their alliance agreement. For Crossrail, a non-contractual partnering agreement is used and an independent board between the various organizations is in place as well as standard tools for partnering.

In some of the other countries there is an emphasis on more informal collaboration. In Norway, there are no formal collaborative arrangements but some of the contracts have a cooperation phase in the beginning to ensure well-prepared and coordinated teams. Furthermore, cooperation is seen as very important and JBV strives to obtain good relationships and cooperation with contractors in informal ways. Some collaborative tools and activities are used, such as teambuilding activities and workshops to align contractual understanding and cultural awareness. Collaborative arrangements are not used by ProRail in the Netherlands, apart from a light form of project alliance. The risk is however not fully shared due to safety restrictions. Switzerland and Germany do not focus on any formal collaborative arrangements, but due to the small market in Switzerland, informal collaboration among client and contractors is still developed to some extent. In Germany, public tendering law and the anti-cartel management are the reasons stated for not using collaborative arrangements between Deutsche Bahn and contractors. However, some collaborative activities may be used for construction firms that have been contracted for many years. Activities are e.g., regular meetings, performance reviews, and supply evaluations.

Respondents in all countries mention IT-tools, especially in terms of BIM. In the Netherlands, BIM has been initiated and experimented with to a small extent. In Sweden, TRV started to use BIM in 2015 in all the projects with the aim of making large cost savings. Joint IT-tools, in terms of common documents exchange systems, are already often used in Norway. Both Germany and the UK believe BIM to be a growing trend for improved collaborative behavior. Joint IT-systems facilitate integration and communication among project actors and can thus improve time, cost, and quality performance (Woksepp & Olofsson, 2008).

In the UK and in Sweden, which are the countries that focus most on cooperation, there is an outspoken belief that collaboration will become even more important in the future, especially in Sweden due to the newly developed collaboration models and policies. In Norway the respondents do not foresee any strong trend towards partnering and in the Netherlands partnering is not seen as an obvious path to take even though collaborative arrangements are perceived by several respondents as likely to become more common in the future. In Germany, BIM is believed to allow certain collaborative ways of working and more transparency. However, implementing BIM and more collaborative arrangements based on early contractor involvement will take many years.

6. Conclusions and recommendations

6.1. Change processes in the six countries

Traditionally, clients from the six studies countries have focused on enhancing competition in their procurement strategies regarding construction work. This focus stems from in-house production, which gradually has been outsourced. In a second step, apart from construction also design and development work have been outsourced in some countries, but then mainly to consultancy companies. However, during recent years there is a discernible trend in Sweden, Norway, the Netherlands and the UK towards allocating more degrees of freedom and responsibilities to contractor companies and increasing the strategic focus on cooperation. This may be seen as a third step in the trend towards using the supply market, where also design and/or development work is outsourced to contractors instead of consultancy companies. Hence, the use of DB contracts has increased and many relationships can now be characterized as coopetition, rather than pure competition. The UK and the Netherlands are forerunners in this trend,

although with somewhat different approaches, whereas Norway and Sweden are in the middle of this transition. Germany and Switzerland have not yet initiated this change but respondents believe that collaboration will become more common in the future. In fact, most respondents in this study believe that their client organizations will become more cooperative in the future and that contractors will be involved earlier and given greater freedom and responsibilities. As such, the third step of the market oriented trend seems to focus on two main dimensions: degree of cooperation and degree of contractor freedom.

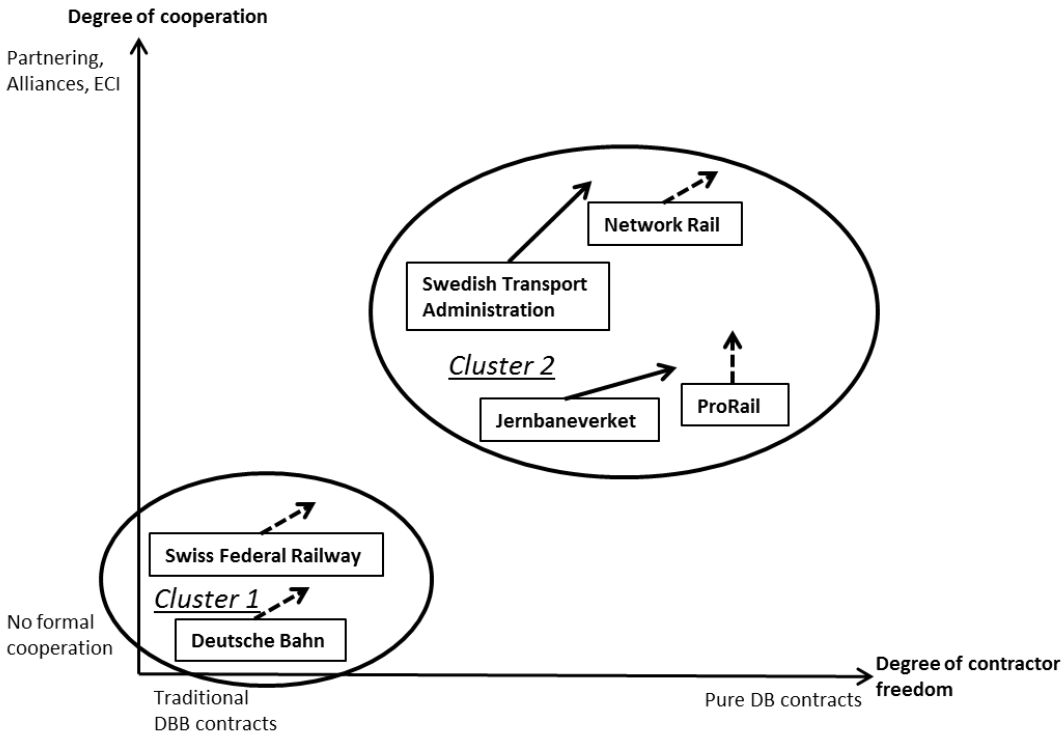

Figure 2: Change processes in the six countries.

Figure 2 illustrates two clusters among the six countries. The first cluster is constituted by Germany and Switzerland, which both have rather low degrees of both cooperation and contractor freedom. However, the respondents believe that both these dimensions may be increased somewhat in the future (illustrated by short dotted arrows). The second cluster is formed by the four other countries that have moved away from the first cluster the last decade. The Netherlands and the UK were first to initiate this change but while ProRail has mainly focused on increasing the degrees of freedom for the contractors, Network Rail has also focused on strengthening the cooperation. The respondents believe that these changes will continue but ProRail will

probably focus on strengthening the cooperation, whereas Network Rail will probably try to increase both dimensions. Sweden and Norway are in the midst of this transition and both TRV and JBV anticipate significant changes in the near future in the same direction (illustrated by long bold arrows). However, TRV will probably focus equally on both dimensions while JBV seems to focus more on increasing the contractor freedom and involvement. If the anticipated changes play out in the six countries it seems that the two clusters will remain but move upwards and to the right in Figure 2.

6.2. Tailoring procurement strategies to project characteristics

Prior research has not provided empirical evidence that there is one best way to procure construction projects. Instead procurement strategies must be tailored to the project characteristics at hand to fit the purpose (Eriksson & Hane, 2014). According to this theoretical perspective that underpins the procurement model in Table 1, a high focus on competition is suitable in simple projects with low uncertainty, where the client either has low customization requirements (DB contracts) or has the possibility and capability to design the project according to stable requirements in DBB contracts. Coopetition is suitable when complexity and uncertainty becomes somewhat higher and cooperation is required when project characteristics are very challenging, see Figure 1 and Table 1 in the theory section. The clients within Cluster 2 that have moved towards increased cooperation and contractor freedom seem to have adopted such a perspective. The respondents in Norway, Sweden, The Netherlands, and the UK pinpoint the need of tailoring the procurement strategies to the project characteristics at hand. Hence, they use a lot of different alternatives for different projects, although the general trend is towards more cooperation and DB contracts.

Another perspective when choosing procurement strategies is to tailor them to the client characteristics, that is, to choose strategies that reap the most benefits of current strengths and weaknesses of the client organization and its capabilities. This approach was adopted by all countries in the first step of the transition from in- house production to DBB contracts, that is, to change as little as possible and utilize the strong design capabilities of the client organization while outsourcing construction through DBB contracts. This approach may enhance short-term efficiency by utilizing strong client capabilities, but it may hamper long-term innovation due to lack of possibilities and incentives for the supply market to develop new competencies and technologies. Accordingly, Germany and Switzerland that still adopt this rationale when choosing procurement strategies may need to be

especially aware of the risk of missing innovation opportunities. As such, they need to invest more resources in internal R&D and search the external environment for product and process innovations that can improve production, operation, and maintenance solutions. Furthermore, as client characteristics are more static than project characteristics this approach results in less variety. Hence, these client organizations don't utilize all possible alternatives of different procurement strategies; thereby missing the opportunities to reap some of the benefits of the neglected procurement strategies. From a long-term perspective, it therefore seems more relevant to tailor procurement strategies to project characteristics than to the characteristics of the client organization, although the first approach may require managing difficult change processes, as illustrated among the clients in Cluster 2, which have transformed both their internal capabilities and their procurement strategies.

It is noteworthy to discuss the different views on innovation among the clients. In Sweden, an explicit reason for changing towards more DB contracts is to improve the contractors' possibilities to innovate and develop their products and processes in infrastructure projects. In Norway, a similar but more implicit reasoning highlights that contractors will develop their competences and become more innovative in the long run if JBV utilizes DB contracts more instead of DBB contracts. In the other countries, contractor innovation is not really demanded in railway projects. Instead, there are internal funds and/or human resources to initiate separate development projects. Accordingly, this approach clearly separates the "normal" business projects, focusing on efficiency, and development projects, focusing on innovation. Eriksson (2013) argues that such structural separation may be suitable but requires sufficient funding of separate development projects, which is often not the case in the construction industry. Hence, there is a risk that the structural separation of efficiency focus in business projects and innovation in development projects result in stagnation and lack of innovation in the infrastructure sector (Eriksson, 2013). To enhance innovation, it is thus important to allocate sufficient funds to separate development projects where new technologies, products, and processes can be developed and tested, before they are implemented in the business projects. Another challenge regarding innovation is diffusion of innovation, in terms of spreading, transferring, and/or sharing new technology and knowledge across projects. Clients need to develop competences and routines that enable re-using and spreading innovations that have been developed in a certain project across their project portfolio.

Another noteworthy aspect is that the choice of delivery system is perceived to be a core mechanism in the transition towards more freedom to the supply market and more collaboration. However, it is not only the delivery system that matters, also the timing of the procurement. Early involved contractors in DBB contracts may be more creative and innovative than late procured contractors in restrained DB contracts. ECI based on consultancy contracts during the design stage may be an even more radical mechanism for facilitating innovation. Since many innovations are of systemic nature and require joint problem solving among project actors, the timing of the involvement and the collaboration model may affect innovation more than the choice of delivery system and type of contract (e.g., DB vs DBB contracts).

6.3 Concluding remark – the need of a systemic procurement perspective

To enhance both efficiency and innovation, clients need to adopt a system perspective when designing the procurement strategies, since all four strategy components are central and interact. The *delivery system* is often key when deciding procurement strategy. In projects where project characteristics are challenging and the client wants to involve a competent contractor early in the design work, coopetitive and cooperative approaches are more suitable than purely competitive strategies. *Rewards systems* may then be based on cost reimbursement coupled with incentives/bonuses and the *contractor selection* may include a significant weight of soft criteria. To enhance cooperation further, some sort of *collaboration model* may also be implemented. In projects that are not very challenging (in terms of complexity, uncertainty, customization, etc.) and the client has the competence to perform the design work in-house or manage consultants to do the design, competitive procurement strategies may be suitable. The client may then use highly specified DBB contracts with fixed price that are procured based on competitive tendering with a high focus on lowest price.

Both these diametrically different approaches are used in the studied countries. These differences, however, seem to hinge on differences in culture, tradition, and capabilities in client organizations together with national laws and regulations, rather than on differences in project characteristics. Hence, the procurement strategies in some countries are not mainly tailored to the circumstances of the particular project, but to the existing capabilities of the client, consultant, and contractor organizations. While this enhances efficiency and success in the short-term it may not be an optimal approach to enhance innovation and sustainable development in the long-term. On the other hand, tailoring procurement strategies to project

characteristics may require changes in client, consultant, and contractor organizations, which may decrease efficiency in the short-term but improve innovation and sustainable development in the long-term.

The change processes that several of the clients are currently going through call for systemic and purposeful follow-up investigations that can improve our understanding of the consequences of the changes. Due to the complex interconnections between the four procurement strategy components, it seems urgent for railway clients to test different combinations and investigate how different components interact and how various combinations work in practice in different types of projects. These tests require systemic follow-up investigations that can serve as input to further improvements and change of procurement strategies.

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Respondents

Sweden

Johan Bill (JB) is head of the department for large projects in TRV since 2014. Johan has long and broad experience from the civil engineering sector, both from contractor and consultant organizations where he has been regional director at Skanska and Peab and CEO at Bjerking.

Per Rydberg (PR) started working at TRV 1977. He has long and broad experience from the infrastructure sector and has been project director for several mega projects such as Hallandsåsen 2008-2014 and now Marieholmsförbindelsen.

Lars Malthe (LM) started working as a procurement officer at TRV in 2011. He has been procurement manager in several large infrastructure projects such as Öresundsförbindelsen, Citytunneln, Tvärbanan, and now Förbifart Stockholm.

Björn Kruse (BK) started working with procurement in the Railway administration in 1999, and he has been Procurement Manager in the Citybanan project since 2007. He has also a lot of procurement experience from other industries, such as corporate head of procurement at Linjebuss 1996-1999, and purchasing manager in the JAS project at SAAB 1990-1996.

Norway

Jan Vormeland (JV) is Procurement manager in Jernbaneverket's Follo line project. Jan has more than 30 years of project management experience with megaprojects (Capex > 1BUSD) in the fields of Infrastructure, Renewable Energy and Oil & Gas. He has experience from both client and contractor organizations, private and public sectors, and from countries in Asia, USA, Middle East and Europe. Jan's specialties are: Project management, risk management, procurement and contract management in large engineering projects. Jan has worked with the Follo line project since the end of 2012.

Håvard Skaldebo (HS) is Project control manager in Jernbaneverket's Follo line project. Håvard has more than 40 years of experience in major projects and project related industry in Norway and abroad (Europe, North America, Middle East and Asia). He held the position Senior Project Control Manager in the Borouge 2 Project (Abu Dhabi Polymers Company Ltd. www.borouge.com), which received the 2011 MECW Project of The Year Award. Håvard has held positions, primarily in Norsk Hydro, as Vice President, Project Director, Project Manager, etc. He has performed quality

assurance of major Norwegian public projects according the Guidelines from the Norwegian Ministry of Finance, also contributing to the development of new Guidelines. Håvard's specialties are: Project management, risk management and project control of large engineering projects. Håvard has worked with the Follo line project since mid-2011.

Nils Olsson (NO) is professor at Norges teknisk-naturvitenskapelige universitet (NTNU) in Trondheim. Nils has conducted research and consulting in the areas of project management and railway traffic. His research has focused on project management and productivity improvements, while his industry experience includes: transportation, offshore, construction, IT, nuclear industry, hospitals and shipping.

The Netherlands

Mr Henrico Plantinga (HP) has been working at ProRail for 13 years and started with the design-build development, mostly for civil engineering projects. He has also experience from train singling projects. He is nog working as a tendering manager.

Mr Bart Smolders (BS) has worked at ProRail since 2006, first as an operation manager and later as the director of the asset management department, focusing on safety, reliability and cost control in maintenance of the Dutch railway network and its stations. Since 2014 Bart is the director of Project Management department at ProRail, which is responsible for the preparation and execution of all projects in the railway system and stations in The Netherlands. Before coming to ProRail, Bart worked as an consultant within the infrastructure sector.

Mr Menno van der Ploeg (MvdP) has been working at ProRail since 2000 and since 2010 acts as the director of Rail infrastructure projects. He has experience as a designer but also contract management, tendering procedures, project management and contract management for large scale projects.

Peter Dijk (PD) is the General Director of the Amsterdam Metro since 2012. Peter has extensive experiences of mega projects. Since September 2008, he is responsible for the project delivery of the North South metroline in Amsterdam and from 2012, he is also responsible for all the other rail projects in Amsterdam. This includes the refurbishment of the tunnel of the Eastline, the renovation of the underground stations, the start up for the renewal of the Amstelveenline and the ownership and asset management of the Amsterdam rail infrastructure and stations.

Leentje Volker (LV) is an Assistant Professor at TU Delft and also the secretary of the Dutch Forum of Public Commissioning Clients in Construction (Het Opdrachtgeversforum in de bouw). In both these assignments, Leentje works with project management and contracting/procurement in the construction industry, especially focusing on the infrastructure sector.

Germany

Dr Torsten Latz (TL) is head of the department of procurement infrastructure at Deutsche Bahn since 2014. Dr Latz has a PhD in Physics and has nine years' experience as a consultant at McKinsey & Company. Further he has worked with long distance operator and procurement of railway spare parts at Deutsche Bahn.

Mr Heinz Ehrbar (HE) has worked at Deutsche Bahn Netze since 2013 and is now head of major projects management. Mr Ehrbar has a master of science in Civil Engineering and has long experience as project manager for hydropower plant construction in Switzerland and foreign countries, tunnels and other major infrastructure projects, for instance the Gotthard Base Tunnel in Switzerland.

Dr Thomas Schriek (TS) has worked at Deutsche Bahn since 2002 and is head of the division of Architectural-, Engineering and Service, Region Southeast. Dr Schriek has also experience from construction companies.

Mr Christoph Herzog (CH) has worked at the department of procurement infrastructure at Deutsche Bahn since 1999 and is head of the division of Construction Engineering, region south.

The UK

Ian Wright (IW) runs the Network rail suite of contracts for procuring works and services from the supply chain. Controlling and updating the standard contracts for buying goods, services and frameworks is part of his work as well as to control and update as required with new requirements.

Andy Mitchell (AM) is Chief Executive Officer at the Thames Tideway Tunnel Ltd. Andy was previously employed at Network Rail as the Crossrail Programme Director between 2009-2014. He has 18 years of experience in railway infrastructure from both buyer and contractor perspectives. Furthermore, he is the Chairman of the Infrastructure Client Group. Andy works close to the government treasury.

Miles Ashley (MA) is the Programme Director at Network Rail. He runs the Crossrail & Stations Capital Programme at London Underground with a number of major station developments such as Tottenham Court Road, Bond Street, Victoria and Bank.

Stuart Baker (SB) is the Deputy Director of National Rail Projects at the Department for Transport in the UK.

Switzerland

Mr Michael Jutzi (MJ) has a master degree in business administration and has worked at SBB since 1998, first as a project controller and then as head of the department of procurement and contracts. Since 2008 he is head of the department of construction project procurement.

TRAFIKVERKET

Trafikverket, 781 89 Borlänge. Besöksadress: Röda vägen 1.
Telefon: 0771-921 921, Texttelefon: 010-123 99 97

www.trafikverket.se