



**CHALMERS**  
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# **Collaboration in Construction Project Delivery**

## **Strategic Implications for Technical Consultancy Firms**

Master's Thesis in the Master's Programme Design and Construction Project Management

CARL TÖRNEMAN



MASTER'S THESIS E2015:105

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Management*

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Department of Technology Management and Economics

*Division of Service Management*

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Göteborg, Sweden 2015

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*If everyone is moving forward together, then success takes care of itself*

- Henry Ford



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## ABSTRACT

Collaborative construction project delivery is becoming increasingly used within Swedish infrastructure sector. Despite this on-going development few studies have focused on the collaborative design phase of construction projects from the perspective of the technical consultant as a professional service firm. This thesis aims to investigate possible differences in the role of the technical consultant engaged in a collaborative project and how the consultancy firm could strategically adapt to this market development. Data was collected through an exploratory study and two case studies consisting of in total 21 interviews. The results show that collaboration reduces existing silos between the project parties as well as between technology areas within the technical consultant. Further, a higher extent of construction knowledge provided to the design team helps in reducing complexity of drawings. To be successful in collaborative projects, individual consultants should be flexible and open minded and led by a strong and proactive design leadership. In order to secure successful collaborative project teams over time, new resources should continuously be engaged and developed in collaborative project environments. It is important for the technical consultancy firm to have more resources working full time in the project both to develop relationships to other project participants and to obtain a holistic picture over the project process. The technical consultancy firm needs to prioritise collaborative projects from a human resource perspective and, finally, consider developing strategic relationships with suitable contractors to meet this market development.

Keywords: Professional service firm, strategy, technical consultancy firm, relational contracting, design collaboration

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## SAMMANFATTNING

Samverkansmodeller har i större utsträckning börjat tillämpas inom svensk anläggningssektor. Få studier har hittills behandlat samverkan i projekteringsfasen från teknikkonsultföretagets perspektiv. Detta examensarbete undersöker skillnader i den tekniska konsultrollen i ett samverkansprojekt och hur teknikkonsultföretaget strategiskt kan möta denna marknadsutveckling. Data har insamlats genom en explorativ studie samt två fallstudier om totalt 21 intervjuer. Resultaten visar på att samverkan minskar silos mellan de olika parterna i ett byggprojekt och även mellan teknikområden inom teknikkonsultföretaget. Vidare kan en ökad kunskap om produktionsförutsättningar i projekteringsfasen leda till minskad komplexitet i producerade handlingar. För att teknikkonsultteamet skall vara framgångsrikt i samverkansprojekt behöver de individuella konsulterna vara flexibla och öppna för samverkan med entreprenörer och andra parter. Dessutom krävs ett starkt och proaktivt teamledarskap. För att säkerställa framgångsrika samverkansteam över tid behöver nya resurser engageras kontinuerligt och kompetensutvecklas i en samverkansmiljö. Det är också viktigt att teknikkonsultföretaget allokerar en större andel av sin personal på heltid i sådana projekt. Detta är en förutsättning både för att skapa relationer med de andra projektparterna och en bättre helhetsbild av projektet. För att möta utvecklingen mot fler samverkansprojekt behöver teknikkonsultföretaget prioritera dessa projekt från ett HR-perspektiv och även överväga att utveckla strategiska relationer med utvalda entreprenörer.

Nyckelord: Tjänsteföretag, strategi, teknikkonsulter, samverkansprojekt, designsamverkan



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## Preface

This master thesis was conducted during six intensive months in the spring of 2015 at the Department of Technology Management and Economics at Chalmers University of Technology, in cooperation with Sweco Management AB in Gothenburg.

To my supervisor Anna Kadefors. Thank you for being my academic guiding star. Your knowledge, experience and patience have been invaluable in what has now been produced in this thesis.

To Julia Matwinska, Johan Sundh, David Källström and all other employees at Sweco Management in Gothenburg. Thank you for initiating this thesis from the start, for hosting me at the office and being a source of consulting experience and inspiration during this spring.

To all interviewees and participators in the study. Thank you for taking the time to share your valuable experiences and providing your honest answers to all my questions.

Working with this thesis has been an interesting experience, expanding my knowledge on collaboration in the construction industry and exploring the dynamics of a technical consultancy firm as well as new sides of myself.

Göteborg, August 2015

A handwritten signature in black ink, appearing to read 'CT', with a long horizontal flourish extending to the right.

Carl Törneman



# 1 Introduction

*This chapter provides an introduction to the background and research context of this master thesis. Some initial aspects on the development of collaborative construction project delivery in the infrastructure sector and the role of the consultant are introduced. Finally the purpose, research questions, scope and limitations of the thesis are presented.*

## 1.1 Background

In recent years the construction industry has experienced a development towards new collaborative project arrangements, driven by dissatisfaction with the inbuilt opportunism and adversarial relations in traditional project delivery forms like design-bid-build and design-build (Lahdenperä, 2012). Delivering construction projects with a design-bid-build approach creates a separation between the design and construction processes (Forbes and Ahmed, 2010). This separation is shown to hinder integration of knowledge between the technical consultant and the contractor, as well as diminishing the opportunity for contractors to have influence on the design decision (Song *et al.*, 2009). Introducing collaboration and engaging the different project parties at an earlier stage of the construction project process is one way to include this construction knowledge and create better relationships between the client, contractor and consultant (Mosey, 2009; Song *et al.*, 2009; Walker & Lloyd-Walker, 2015).

Planning and delivery of large infrastructure solutions is the most challenging and resource consuming projects in terms of time, money and human capital in the construction industry (Bundgaard *et al.*, 2011). Within Swedish infrastructure sector design-build contracts are uncommon and technical consultants are procured directly by the client through a traditional design-bid-build approach. If the technical consultant is not receiving enough input from the contractor on how a design can be implemented, it can reduce overall project performance and productivity (Arditi *et al.*, 2002; Song *et al.*, 2009; Baharuddin *et al.*, 2013). To overcome these challenges, several types of partnering and collaboration models have been developed to systematically involve the contractor's expertise in the early stages of complex construction projects (Rahman & Alhassan, 2012; Walker & Lloyd-Walker, 2015).

Despite the goal of bridging the gap between project stages and move the project parties closer to each other, few studies have focused on the collaborative design phase of construction projects (Koutsikouri *et al.*, 2008). Regarding the role of the consultant as a professional service supplier in collaborative projects, some benefits like improvement of design through contractor expertise and improved risk management have been identified (Eadie & Graham, 2014; Sødal, 2014). Also challenges such as difficulties in establishing trust and mutual understanding between the contractor and consultant are known (Sødal, 2014). Due to this limited amount of research and the on-going development of collaborative construction project delivery methods within the Swedish infrastructure sector, this thesis will try to clarify some of the aspects that a technical consultancy firm need to consider to meet future demands and remain competitive on the market.

## 1.2 Purpose & research questions

Introducing collaborative project delivery methods will imply several changes in the dynamics of the infrastructure construction sector. This means a new market environment for the client, contractor and consultant. The purpose of this thesis is therefore to investigate possible differences in the role of the technical consultant engaged in a collaborative project and how the consultancy firm could strategically adapt to this market development.

The focus of this thesis will thus be on dynamics of the interaction between project parties when the contractor is engaged in the design stage of a construction project. Furthermore the thesis will try to examine how this affects the work and role of the consultant, on individual, team as well as the firm level. In other words, what internal competences, resources and processes the consultant team need to have to be successful in collaborative project with early involvement of the contractor, what approach to the project mission the consultant should have and finally what possible implications that can be seen on the produced output.

Consequently, in order to fulfil the purpose of this thesis the two following research questions will be answered:

- *What differences in the role of the consultant can be seen in a collaborative project compared to traditional project delivery forms?*
- *How shall the technical consultancy firm adapt in order to maintain a competitive market position with an increased number of collaborative projects?*

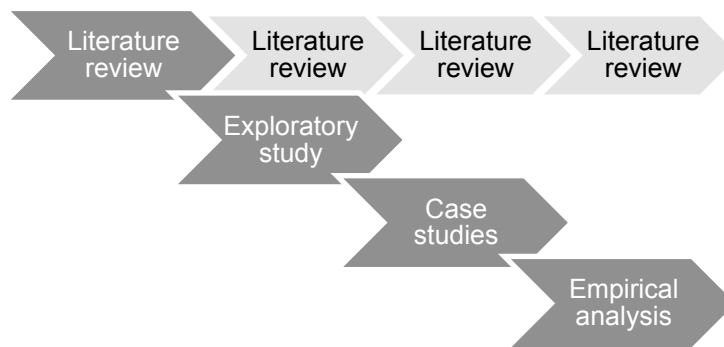
## 1.3 Scope & limitations

This thesis has been conducted in cooperation between Chalmers University of Technology and the infrastructure division of Sweco Management in Gothenburg. The thesis draws upon literature of strategic management of professional service firms and principles and requirements for collaborative construction project delivery with focus on the design phase. Empirical data is collected through a set of explorative interviews, primarily with consultants, and case studies of two large railway projects in Sweden, both delivered with a collaborative approach.

The thesis is limited to examine the role of the consultant in the design stages of large infrastructure projects in Sweden. However, the thesis will just briefly touch upon contract and remuneration forms but not go deeper into any details of contracting practices or remuneration models. Instead the focus is centred on how the technical consultant should manage the distribution of its firm resources in the most efficient way when engaged in a collaborative project.

## 1.4 Methodology

The work with this thesis was divided into four stages as shown in Figure 1. An initial literature review was conducted to scope the thesis and create an understanding of the subject. This literature review continued throughout the thesis as the work developed and forms the Frame of reference presented in Chapter 2. Alongside the literature review an exploratory study was performed to prepare for the two main case studies.



**Figure 1** Overview of the data collection and analysis process

The literature review was conducted through searching scientific databases such as Summon, Google Scholar and ScienceDirect, accessed through Chalmers University of Technology. In addition some articles were provided through the thesis supervisor. In order to find relevant literature in the databases a number of keywords such as *strategic management*, *professional service firms*, *professional identity*, *relational contracting*, *early contractor involvement*, *ECI*, *design collaboration* and *integrated teams* were used. Abstracts, keywords, conclusions and citations were examined to assess the relevance for the thesis and find more related literature.

## 2 Frame of reference

*This chapter presents a literature review on technical consultants as professional service firms, aspects on collaborative delivery forms and finally the latest research on success factors, challenges and implications on individuals, teams and firms engaged in design collaboration. A summary at the end of the chapter presents the key findings from the literature review.*

### 2.1 The professional service firm

Technical consultants can be labelled as *Professional Service Firms (PSF's)*, sharing business sector with, among others, management consultants, lawyers and accounting firms. Løwendahl (2005) defines a professional service as highly knowledge intensive, delivered by people with higher education with close links to the scientific knowledge development within the given area. Furthermore, a professional service is said to involve a high degree of customization and autonomous judgement by the experts involved, as well as significant interaction with the client representatives.

Despite the strong client focus, a PSF does not solely operate under economical market conditions. It is rather so that the product of a PSF is heavily dependent on the multiple professions present within the firm (Løwendahl, 2005). This means less competition on classical financial terms like price. Instead a portfolio of unique and diversifying services, together with a well-established network of client relations is of high importance (Koch, 2004). As PSFs mainly work in project related environments, three major activities in the delivery of a professional service can be defined: client relations, project management and performance of the detailed task (Maister, 1982).

#### 2.1.1 Managing knowledge and resources

Building and maintaining core competences is crucial for sustaining competitive advantage for a firm (Prahalad & Hamel, 1990). PSF's are specialized in delivering knowledge services and a key strategic resource of such firms is the knowledge and experience of its staff (Huang *et al.*, 2007; Løwendahl, 2005; Stroe, 2013). Operating in a complex and specialised environment with highly customized products, professional services are difficult to substitute and thus highly dependent on the knowledge and experience of the firm professionals. Thus, there is often an informational asymmetry between the PSF and the customer, which has to do with the intangibility of the output of the professional workers within the firm (Løwendahl, 2005).

Being so dependent on human capital, one of the most fundamental strategic challenges of a PSF is the management of a resource that are only partially controlled by the firm (Løwendahl, 2005). Competence resources are to a high extent controlled by the professionals themselves, which makes the organization highly vulnerable to their exit. Stroe (2013) argues that this creates a high bargaining power of suppliers. The suppliers are in this case the qualified professionals present on the labour market holding the knowledge needed for the production of the firm's services. It is therefore possible to say that a PSF compete in two markets simultaneously: an "output market" for the firm's services but also a so called "input market" for attracting, developing/motivating and keeping its professional workforce.



To retain individuals within a firm, active human resource development programmes, together with high employee motivation, is crucial (Yisa & Edwards, 2002). In a well-run professional service firm, junior resources are increasingly provided with manager tasks in order both to test and develop their competence and worthiness for promotion (Maister, 1982). Junior resources also perceive a supportive environment as more important, while senior levels focus more on having the right people in the team and managing conflicting project demands, rather than playing with new ideas (Koutsikouri *et al.*, 2008). The need for a well-functioning system for continuous knowledge sharing and development is supported by Huang *et al.* (2007) and would ultimately lead to increased business performance for the firm.

### **2.1.2 Characteristics of professional services in the construction industry**

Construction projects depend upon several competences from the technical consultants. That means being responsible for knowledge production at different levels within the construction industry (Koch, 2004). Stroe (2013) defines services by a technical consultant as “*highly specialized activities of intellectual nature, which identify, select, organize and apply technological engineering knowledge for purposes of investments and production*”. Swedish Federation of Consulting Engineers and Architects (2013) further outlines the core competences of technical consultants to:

- Multidisciplinary engineering
- Architecture services
- Project management
- Construction management
- Civil/Structural engineering
- Electrical, mechanical/HEVAC and industry engineering
- Environment and energy engineering

Technical consultants can provide all of these services from more management consultancy tasks to pure engineering, or a specific type of service depending on the nature of the firm or in which stage of the project the consultant firm is engaged (Stroe, 2013). Despite type of service and time of involvement, the business of technical consultants consists of creative, complex and customized problem solving. Stroe (2013) therefore stresses the need for buyers of consultancy services to change the perception of consultants as commodity suppliers towards being seen as customized solution providers based on high knowledge resources.

Because of the dynamics of the construction industry, the demand for services by technical consultants is often characterized by uncertainty, unpredictability and fluctuations over time (Stroe, 2013). This has to do with economic cycles and related investment strategies of customers. In addition, the professional competencies of technical consultants are known to overlap with those of the client and the contractor. Public clients and large contractors often have their own engineering departments, fully or partially integrating backward to perform similar tasks as external consulting firms, but in-house (Koch, 2004; Stroe, 2013).

### 2.1.3 Professional identity of technical consultants

Defining roles and identities among professionals is becoming increasingly important within the construction industry. Von Nordenflycht (2010) defines a professional workforce as knowledge intensive individuals with a combination of a strong ideology and self-regulation. A certain set of norms, ethical codes and internalized preferences forms the ideology, which is then enforced through the control professionals have over the practice of their occupation; their inbuilt self-regulation. Here Løwendahl (2005) and von Nordenflycht (2010) argue that strong professional norms can be an inhibitor for commercial competitiveness, setting client satisfaction and trust higher than profit. For example, the preference for autonomy present among many PSF's (von Nordenflycht, 2010). To challenge these norms Hughes and Hughes (2013) argues that professionals within the construction industry need to work across professions, involving more stakeholders and move away from claiming exclusive ownership of a specific body of knowledge. This is supported by Nalewaik and Mills (2014), calling for more 'modern' professionals with a birds-eye perspective on construction projects, not hesitating to improve internal processes and adding new services to their product portfolio.

The trend of more diversified service firms within the construction industry raises questions about firm professionalism, accountability and code of ethics (Nalewaik & Mills, 2014). Thornton *et al.* (2005) discusses the need of understanding the specific dynamics present among designers, the 'design versus technology' approach. Some smaller practitioners still keep a strong focus on the aesthetic logics of the profession, while others, mostly large engineering and design firms, move towards an efficiency approach driven by the needs of the corporation. A study by Burr and Jones (2010) concludes that the designer has to take back the role as 'vision maker' and 'conductor' of the project, by acquiring broader knowledge base and skills and working more proactively with the contractors. These business development initiatives can however be challenge in an environment where the human and financial resources are becoming scarce at the same time as the projects become more complex (Nalewaik & Mills, 2014; Lieftink *et al.*, 2014). In addition, design professionals are known for often keep any type of innovation strongly linked to what they perceive as their 'professional logic' i.e. what is viewed as appropriate within the industry (Lieftink *et al.*, 2014)

## 2.2 Collaborative project delivery forms

The development of collaborative project delivery in the construction industry is an on-going process. Several different terms exist, for example *partnering* (Bygballe *et al.*, 2010), *relational contracting* (Lahdenperä, 2012), *collaborative project procurement arrangements* and *relationship-based procurement* (Walker & Lloyd-Walker, 2015).

Within the infrastructure construction sector, initiatives such as *increased co-operation* in Sweden (Utökad samverkan, FIA, 2006), *Early Contractor Involvement (ECI)* in United Kingdom, Australia and The Netherlands (Rahmani *et al.*, 2013) and *Integrated Project Delivery (IPD)* in the US (Kadefors & Eriksson, 2015) have been developed and increasingly used in recent years.

### 2.2.1 Partnering

Partnering is a general approach to collaboration in the construction industry that is widely applied and discussed, but where no real consensus on the meaning of the term yet exists (Bygballe *et al.*, 2012). With regard to the overall development in the construction industry, partnering can be seen as an all-encompassing concept from where close to all collaborative construction delivery forms can be related (Kadefors & Eriksson, 2015).

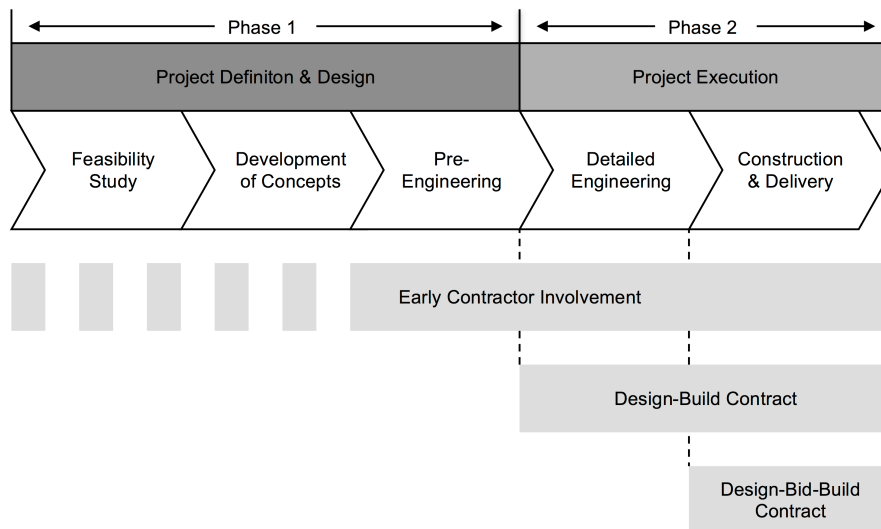
The basics of partnering can be associated to a number of hard elements such as formal integrative mechanisms like workshops for teambuilding and common goals, financial incentive systems, dispute resolutions procedures and continuous improvements programmes (Bresnen & Marshall, 2000, Nyström, 2005; Eriksson, 2010; Bygballe *et al.*, 2010). In addition, as both a prerequisite and result of these integrative mechanisms trust and mutual understanding has an important place in partnering arrangements (Bresnen & Marshall, 2000; Nyström, 2005). As a complement, optional procedures like early involvement of contractors in concurrent engineering, joint project office and joint IT-tools can be adopted for increased partnering in a specific project (Eriksson, 2010).

Two more distinct partnering approaches can be defined, namely *project partnering* and *strategic partnering*. In project partnering the different project parties agree on working collaboratively in a specific project (Rigby *et al.*, 2009). The agreement and mutual goals are often expressed in a partnering charter (Kadefors & Eriksson, 2015). Strategic partnering, on the other hand, is when a client (or contractor in that sense) works with a limited set of suppliers through a number of projects, with an intention to improve relations and performance over time (Rigby *et al.*, 2009).

### 2.2.2 Relational contracting with early contractor involvement

Early contractor involvement (ECI) is collaboration form that originates from the ideas of partnering but with the goal to involve the contractor at an earlier stage through formal contractual mechanisms (Mosey, 2009). ECI is a two-stage project delivery approach where the contractor is procured for two separate phases with open books. In Phase 1 the contractor scopes, prices and initially designs the project together with the consultant team to the point where a target price for the whole project can be set. In Phase 2 the contractor is awarded the contract for the construction works based on the, in Phase 1, agreed design (Mosey, 2009; Rahmani *et al.*, 2013).

At what point of time the contractor is awarded in an ECI project can vary depending on the project. The time of involvement ranges from the initial idea phase to the pre-engineering phase (Walker & Lloyd-Walker, 2015). The scope of work for the contractor, and the consultants, therefore depends on the time of involvement of the contractor. Figure 2 presents an overview of ECI compared to design-build and design-bid-build delivery forms from a construction project life-cycle perspective.



**Figure 2** Construction project delivery activities in relation to different contract forms (adapted from Walker & Lloyd-Walker, 2015)

It is important to recognize that ECI is not a ‘one way fits all’ approach but rather a set of principles forming a framework of collaboration, including a two-stage approach. As such, the contractual arrangements can vary in terms of remuneration models, incentive structure and whether or not there will be a second procurement between the two stages (Mosey, 2009). Often the client has the possibility to include a go/no-go clause in the contract, giving both parties the possibility to exit the collaboration before Phase 2 (Walker and Lloyd-walker, 2015). To achieve full benefits of the ECI approach, it is however desirable that the same contractor performs both Phase 1 and Phase 2. The client can therefore, to create stronger commitment for the final product, apply contractual targets in Phase 1 giving the contractor certain requirements to fulfil to be awarded Phase 2 (Mosey, 2009).

### 2.2.3 Relational contracting in Sweden

Within the Swedish infrastructure sector the initiative FIA was deployed by the General Directors of former Swedish National Rail Administration and former Swedish National Road Administration in 2003, now Trafikverket (FIA, 2012). The goal with FIA was to gather the main stakeholders within the Swedish infrastructure construction sector and initiate a change towards increased productivity and profitability. As a part of the work within FIA a model for increased co-operation<sup>1</sup> was developed. The model was intended to act as a complementing instrument to existing procurement-, delivery- and remuneration forms already present in the industry. That means being independent and used in combination with Swedish standard contracts to drive collaboration and increase productivity for each project (Utökad samverkan, FIA, 2006).

The model of increased co-operation is based on the concepts of project partnering and strategic partnering. Instead of using the partnering notion, the increased co-

<sup>1</sup> In Swedish named ”Utökad samverkan”

operation model is built upon three building blocks, Level 1, Level 2 and Level 3. Level 1 includes all compulsory activities required by the project team to be classified as an increased co-operation project. Level 2 includes optional activities for more complicated and/or large civil works project, or any project aiming to amplify their intra-project collaboration (Utökad samverkan, FIA, 2006). Project partnering concepts applies for Level 1 and 2, while strategic partnering translates into Level 3. The different actions within Level 1 and 2 are described in Table 1 below.

**Table 1** Levels and actions of Swedish increased co-operation model (Utökad samverkan, FIA, 2006)

<b>Level 1</b>	<ul style="list-style-type: none"> <li>• Establishment of organisation form</li> <li>• Joint management by objectives</li> <li>• Joint risk management</li> <li>• Conflict-solving methods</li> <li>• Continuous follow-up and improvement</li> <li>• Transparency on common issues</li> </ul>
<b>Level 2</b>	<ul style="list-style-type: none"> <li>• Extended work on group development</li> <li>• Advanced management by objectives</li> <li>• Benchmarking</li> <li>• Greater involvement for other players</li> <li>• Systematic competence development</li> <li>• Active Design</li> <li>• External communication</li> </ul>
<b>Level 3</b>	<ul style="list-style-type: none"> <li>• Strategic co-operation</li> </ul>

## 2.3 Success factors and challenges in collaborative project relationships

Moving towards collaborative approaches in construction project relationships and delivery methods, a holistic change in structures, processes and attitudes is required (Eriksson and Pesämaa, 2007). Through contract terms and project organisation, together with a strong best-for-project mind-set, high performance in the project delivery can be achieved while opportunistic behaviour is avoided (Mosey, 2009; Walker & Lloyd Walker, 2015).

### 2.3.1 Contractual arrangement

The contract represents the steering mechanism and sets the frame for the project. It is thus of high importance that a common contractual base for the whole project process is set at the early stage of a collaboration project (Mosey, 2009). In the contract it must be stated who is in charge of the project and what level of authority this implies in terms of who does what, who calls meetings and who is entitled to decision-making. Walker & Lloyd Walker (2012) argues that the level of commitment in the project depends on the chosen collaboration form, where contractual agreements enforces project parties to work together sharing both pain and gain. Mosey (2009)

finally stresses the need for contractual specifications on meeting procedures and circumstances, decision-making processes and communication routines to support collaborative working.

### **2.3.2 Construction knowledge and constructability**

A contractor possesses by nature a high level of knowledge of the construction process. Song *et al.* (2009) suggests that such knowledge provided to the design team in the initial project phases can improve both information flow and quality of drawings and consequently better schedule performance. A higher level of integration in the design stage can thus help to establish effective design development, efficient management of time and costs, increased flexibility, improved design quality, reduced rework, less conflicts and changes, and optimal project costs (Jørgensen & Emmitt, 2009; Ping *et al.*, 2011). In all a higher extent of constructability can be obtained in the project (Song *et al.*, 2009).

Construction Industry Institute (1986) defines constructability as the way to achieve overall project objectives through optimum usage of construction knowledge and experience in planning, engineering and procurement. Arditi *et al.* (2002) argues that the extent of which constructability is obtained depends on how the project delivery system is set up and the resulting interface between the constructor and the designer. Still it is seen that many designers struggle with understanding the design process as a part of the entire building process with traditional project delivery methods like design-bid-build. Extensive research by Eriksson and Westerberg (2011) shows that an increased level of collaboration between the designers and contractors during the design phase, in combination with joint objectives, has the possibility to significantly improve the overall project performance. Contractor expertise on how to manage building processes can thus be very valuable in the work of for the design team (Senescu et al, 2014).

### **2.3.3 Leadership, communication and culture**

Efficient project management and leadership are crucial for successful collaborative project delivery (Koutsikouri, 2008; Mosey, 2009; Kent & Becerik-Gerber, 2010; Walker & Lloyd-Walker, 2015). Having a good project management from the early stage of a project helps linking the team together and ensures that everyone is working towards a same goal. The management of a project is also responsible for securing that enough time is allowed for the individuals in the team to get to know each other in the initial phases, to be able to form mutual agreed goals before the actual work begins (Baiden *et al.*, 2006; Manley & Chen, 2015).

Developing a strong communication culture helps avoiding misunderstandings, increases commitment, mutual respect and trust and sets the base for effective decision making within the common project organisation (Kent & Becerik-Gerber, 2010; Walker & Lloyd-Walker, 2015). As a support, information and communication technology (ICT) tools can be used to enhance such continuous communication and information exchange between project parties in addition to contractual obligations (Lahdenperä, 2012). This is particularly important in the infrastructure sector, where geographical distance between the project and the corporate organisation can create communication barriers and delays in delivery processes (Manley & Chen, 2015).

A way to integrate project members further is to opt for effective knowledge sharing and a 'no-blame culture' through a system of KPI's and an open-book model (Walker & Lloyd Walker, 2012). This would ultimately lead to a higher degree of transparency, helping foreseeing and managing risks and creating greater possibilities for innovative ideas in the project process by dismantling any inbuilt hesitance normally present among many consultants (Bundgaard *et al.*, 2011). The temporary nature of construction projects and changing composition of project teams over the project life can however form significant barriers to creating a collaborative project culture (Baiden *et al.*, 2006).

### **2.3.4 Individual mind-set and attitudes**

Moore and Dainty (2001) suggest that professionals within the construction industry to a high extent perceive themselves as members of their individual disciplines, rather than as members of a project team with a common goal. Researchers however conclude that successful collaborative project delivery depends upon the individual behaviour of the team members conducting the project, creating a need for everyone to adopt a best-for-project mind-set at all levels of the project organisation (Baiden *et al.*, 2006; Walker & Lloyd-Walker, 2015). Obtaining a best-for-project mind-set implies moving from a focus on home-base performance interest to the project interest (Walker & Lloyd-Walker, 2012). This requires a fundamental change in how the different parties perceive their role within the overall project. Complementing traditional project drivers like time, cost and quality, known for creating adversarial relations, with drivers related to behavioural culture and attitudes, is therefore a key challenge for project teams engaged in collaboration (Moore and Dainty, 2001; Baiden *et al.*, 2006; Eriksson & Westerberg, 2011).

## **2.4 Design collaboration and the role of the consultant**

Applying a collaborative delivery approach to a construction project helps reducing separation between the technical consultant and the contractor in the design phase. Through increased contractor input the technical consultant will have to be more flexible towards new information, which creates a need for project team members to change their usual ways of working to enable effective collaboration (Jørgensen & Emmitt, 2009; Chiochio *et al.*, 2011).

In a study on 38 newly graduated construction industry professionals, Chiochio *et al.* (2011) examined how trust, collaboration and conflict evolve over time to affect performance of integrated design teams. The results of the study showed that a member of an integrated design team must overcome traditional power structures and mind-sets present within the industry. One way to achieve this is through a general change in attitudes and problem-solving approach, to both old and new types of problems. According to Chiochio *et al.* (2011), it is also important that the team members really learn how to trust, how to manage conflicts and how to collaborate effectively. In a study on a multi-disciplinary technical consultancy firm in UK, Koutsikouri *et al.* (2008) concludes that obtaining a supportive work environment, in addition to formal project management methods and the availability of skilled resources, is a key factor for successful outcomes of collaborative design.

In a study on integration of design and construction activities in three housing projects in USA and Denmark, Jørgensen and Emmitt (2009) found that it is important that the

project parties, including the design team, understand the specific project context. This to be able to judge the appropriate level of detail of the preliminary design provided to the contractor for feedback. As design iteration can create a lot of waste through drafting, reviews and rework it is important for the design managers to ensure a balance between fixing design parameters sufficiently early to achieve progress and still maintain a possibility for continuous improvement. Furthermore, a specific challenge in the cases was to achieve efficient cost feedback from the contractors at the early design stage. It was seen that in one of the cases, where design to target cost principles were applied, a greater level of detail in the design was needed. This required considerably more work in the early design phase compared to the other cases.

The few previous studies on design collaboration generally focus on the perspective of the team and individuals, but lack the firm level perspective. However, based on a study on 15 completed ECI-project in UK and Ireland, Eadie and Graham (2014) conclude that a collaborative approach in the early design phase can help the consultancy firm to work more efficiently with resourcing, reducing internal fluctuations in resource demand. Also, such design collaboration can result in stronger confidence in pre-construction estimates and programmes, reduced commercial tension between project parties as well as better understanding of design relevant construction and logistics issues leading to more cost efficient output. Thus, the firm achieves an improved capability for future collaboration projects (Eadie & Graham, 2014).

Finally, technical consultancy firms will have to put more focus on creating stronger relationships with the other organisations present in the industry. Though extensive research on partnering literature, Bygballe *et al.* (2010) conclude that by creating a strategic supplier network, the contractor will have greater possibility to coordinate and integrate resources of different firms. As more responsibility is shifted from the client to the contractor by applying collaborative delivery in complex projects, prime contractors will require special capabilities and knowledge not belonging to their core competences, which consequently need to be acquired from suppliers (Bemelmans *et al.*, 2012). In the best case this would lead to increased business opportunities for the technical consultants, requiring addition of new services, targeting new markets and increased collaboration efforts of the firm (Liefink *et al.*, 2014).



## 2.5 Summary

Through the literature review a number of aspects that technical consultancy firms have to consider when engaged in design collaboration and relational contracting have been identified. The findings can be summarized in the following bullet points:

- Technical consultancy firms belong to the category of professional service firms (PSF's), delivering specialized products through high knowledge resources and strong client focus and professional norms
- Securing the right balance of human capital in terms of knowledge, experience and motivation for the specific project setup is crucial for obtaining high business performance of a PSF
- Increased level of collaboration between consultant and contractor can help to increase constructability and overall project performance
- Engaging in design collaboration requires an holistic perspective on the project processes as well as trust and mutual understanding between the technical consultancy firm and the other project parties
- It is important to establish a strong culture of communication between project parties and leadership paving way for a best-for-project mind-set among individuals in the project teams
- Strategic relationships between technical consultancy firms and contractors are potentially important to bridge knowledge and obtain effective collaboration in the design phase of construction project

### **3 Methodology**

*In this chapter the methodology of the thesis is presented. First the research strategy and research design are outlined. In the research design section the data gathering process is further described, including the different data collection stages and data sources. The chapter ends with a discussion regarding the results credibility.*

#### **3.1 Research design**

This thesis is based on a qualitative research strategy encompassing three different research methods forming the overall research design. Bryman and Bell (2011) define a research design as a framework for the collection and analysis of data and research methods as techniques for collecting the data. Three research methods were used in this thesis: a literature review, an exploratory interview study and case studies of two railway projects. Furthermore, as these research methods have been conducted in parallel, weaving back and forth between data collection and theory, the research design can be considered as iterative (Bryman & Bell, 2011). The method for the literature review is presented in Chapter 1.

#### **3.2 Exploratory study**

Due to the limited amount of existing research on the collaborative design phase of construction projects (Koutsikouri, 2008) and the role of the consultant in this process, empirical data had to be gathered at an early stage of the thesis work. In parallel with the literature review an exploratory study was for this reason performed to further understand the context of the thesis and identify important aspects for the coming case study. In total eight interviews were conducted with construction sector professionals representing different fields of expertise, see Table 2 below. Most of the respondents in the exploratory study represented the consultancy sector, with the exception of one university professor and one lawyer.

As the goal of the exploratory study was to complement the literature review with industry practice, the respondents were asked open-ended questions and encouraged to share their personal experience on collaborative construction project delivery. As only a few questions were prepared for the exploratory study, the interviews can be classified as unstructured or semi-structured (Bryman & Bell, 2011). The interviews were not recorded but extensive notes were taken and transcribed at the same day.

**Table 2**      Participants in the exploratory study

<b>Participant</b>	<b>Company</b>	<b>Date interviewed</b>
<b>Region Manager</b>	Sweco Civil AB	2015-01-21 & 2015-03-06
<b>Project Manager</b>	Sweco Management AB	2015-02-27
<b>Project Manager</b>	Sweco Management AB	2015-03-05
<b>Professor</b>	RMIT University, Australia	2015-03-18
<b>Business Area Manager</b>	Sweco Civil AB	2015-03-25
<b>Region Manager</b>	Sweco Rail AB	2015-04-15
<b>Business Area Manager</b>	Tyréns AB	2015-04-27
<b>Lawyer</b>	FOYEN Advokatbyrå	2015-04-27

### 3.3 Case studies

To collect empirical data from hands-on experience on the role of the consultant in collaborative construction projects, case studies were performed on two railway projects: *Project Mälarbanan* and *Citybanan/Project Norrströmstunneln*. Conducting case studies is a good way to gain knowledge on individual, team and firm level (Yin, 2014).

Within the Swedish infrastructure sector there is a limited number of on-going and finished collaborative projects. The two cases in this thesis are among the few in progress and were chosen due to their similar size in terms of contract sum and collaborative approach applied by the client. The nature of the projects is however different, as Project Mälarbanan is a railway extension and Citybanan/Project Norrströmstunneln is an underground railway tunnel including a station. More information about the cases can be found in Chapter 5 and 6.

Through the results from the exploratory study in combination with the initial literature review a number of focus areas were derived. These focus areas served as a basis for the interview guides used in the case studies. In the case study of Project Mälarbanan, six people were interviewed, representing the consultant, the contractor and the client organisation. In the case study of Citybanan/Project Norrströmstunneln, three people were interviewed, representing the consultant, the contractor and the client organisation. See Table 3 and 4 for additional details.

**Table 3** Participators in case study of Project Mälarbanan

<b>Participant</b>	<b>Position</b>	<b>Date interviewed</b>
<b>Client Representative A</b>	Project Manager	2015-05-05 (by phone)
<b>Client Representative B</b>	Design Leader	2015-04-28
<b>Consultant Representative A</b>	Design Leader	2015-04-27
<b>Consultant Representative B</b>	Design Leader	2015-04-29
<b>Consultant Representative C</b>	Ass. Design Leader	2015-04-29
<b>Contractor Representative A</b>	Production Manager	2015-04-28

**Table 4** Participators in case study Citybanan/Project Norrströmstunneln

<b>Participant</b>	<b>Position</b>	<b>Date interviewed</b>
<b>Client Representative</b>	Design Leader	2015-05-06 (by phone)
<b>Consultant Representative</b>	Design Leader	2015-04-06 (by phone)
<b>Contractor Representative</b>	Design Process developer	2015-04-28

The interviews lasted between 1 hour and 1 hour and 30 minutes and were conducted at the respective project offices on site in Stockholm, or by phone. An interview-guide with 21 open-ended questions was used for all interviews, to ensure that similar data could be collected from each respondent. This classifies the interviews as semi-structured (Bryman & Bell, 2011). The interview guide was divided into four parts, covering project specifications, aspects of working in collaboration, aspects on the role of the consultant and finally thoughts on future development. The interviews were recorded and backed up with notes. All respondents were informed about the recording before the interview and gave their permission.

### **3.4 Analysis of empirical data**

Upon completion, all case study-interviews were transcribed to gather the empirical data. Thereafter, the transcribed data was structured in an Excel-file to create an overview and help the author to sort out common concepts and emerging patterns. The collected data could then be compiled and related to the theoretical findings from the literature review through a discussion, forming the final conclusions fulfilling the research purpose. This systematic approach of categorizing the data can be defined as a cross-case synthesis (Yin, 2014). All interviews were conducted in Swedish, why the transcribed data including citations have been translated into English for the thesis report.

### **3.5 Credibility of results**

The empirical data for the thesis was gathered through eight interviews in the exploratory study, combined with two separate case studies including in total nine interviews. The case studies, as mentioned above, were chosen from the few available collaboration projects within the Swedish infrastructure sector. It is therefore important to acknowledge that these projects might not be representative for collaboration projects in general. It could also have been desirable with more than two case studies to obtain empirical data from additional perspectives and more respondents.

The results from the exploratory study and the case studies are based on the information collected through the interviews, if not stated otherwise. Thus it is important to acknowledge that personal opinions can be present and might not reflect the common understanding by the other respondents or the industry in general. The author has however to the highest extent possible tried to separate obvious personal opinions from case project related experiences among the respondents. Moreover, only three respondents were interviewed for Citybanan/Project Norrströmstunneln, while six respondents were interviewed for Project Mälarbanan. It is therefore a risk that the width of the empirical data can differ between the two cases.

Even though the respondents were interviewed separately, they were aware of each other's participation in the study. It is therefore important to recognize the risk that the answers can have been influenced by this knowledge, making the respondents not expressing what they could have felt as a challenge with the other party in the project or with the collaborative setting in general. It is also possible that the interviewer consciously or unconsciously avoided certain leading questions due to the answers from the respondents throughout the interviews.

## 4 Exploratory study results

*In this chapter the results from the exploratory interviews with different industry professionals is presented. Two main areas were derived from the interviews, namely aspects on the role of the consultant and project governance and contractor relations. A summary at the end of the chapter states the main findings. The results of the pre-study together with the literature study served as basis for the case study.*

### 4.1 Role of the consultant

In traditional construction project delivery, like design-bid-build, the client procures consultants for a focused design task. A common understanding among all respondents is that the consultant team must have a much more holistic perspective of the project process when engaged in collaboration. A consultant business area manager with experience from a recently conducted collaboration project further argues for the need for a consultant with integrity who can have a constructive discussion with the contractor, which in turn requires strong and experienced individuals with experience from working in collaboration. The lawyer, who has experienced the problem with many consultants having the belief that it is only the client-contractor relationship that matters, supports this argument. Instead it is important for the collaborative project as a whole to engage all parties on equal terms, working alongside each other towards the common goals of the project.

“For the consultant, working in collaboration is not like riding in the back seat of a taxi, driven by the client [...]. It is about moving to the front seat and be a part in controlling the outcome of the project”

Lawyer

A consultant business area manager with extensive experience from working in collaborative settings and with development initiatives stresses the need for mutual understanding of the role of the respective project party. It is important to move away from the culture of blaming each other for the upcoming problems and rather create an understanding for everyone’s contribution. Furthermore, it is crucial for the consultant to be aware of the responsibility for all drawings and technical solutions and to secure this in the collaboration with a contractor demanding a certain quality. According to several respondents, the consultant needs a proactive leadership of the team that understands what the contractor requires in a collaborative project in this situation. This applies for everything from the initial concept, to final drawings and project management. According to the consultant business area manager it is important for a design or project leader to be competent to successfully manage a collaborative project. This is because he consultant will have a more significant role for the contractor, requiring flexible, structured and completely open-minded resources who understand the dynamics of collaboration.

“A contractor is much more governed by needs, they require less documents and much more pin-pointed material from the consultant”

Consultant Region Manager

A project manager with experience from a large railway collaboration project recognized that several new and customized types of technical specifications had to be produced by the consultant to serve the contractors requirements, compared to a traditional design-bid-build project. Furthermore, he saw a challenge with project parties not fully understanding the collaborative setting. This was due to both insufficient time in the initial project stages as well as lack of understanding of and the right attitude towards the collaborative principles among the individual project participants. A particular problem was to make the contractor calculate their risk premium as a part of the overall project and not as separate risks for each project stage. The consultant project manager believes that this is a cultural problem, as the contractor traditionally makes their profit on this risk premium.

When the contractor is engaged at an earlier stage it is a common understanding among all respondents that it will require more specialist knowledge from the consultant. A consultant region manager believes that this need for increased specialist knowledge can be a source of revenue. Instead of contracting a technical consultancy firm for the whole design task, as clients do today, the contractor will probably handpick consultants for smaller work packages, based on their specific knowledge and experience. Finally, a consultant business area manager stresses the need for strategic staffing of projects from certain predefined criteria. These criteria could in such case be both social skills and more quantitative aspects like the amount of production knowledge and experience.

## **4.2 Project governance and contractor relationships**

To secure efficient and successful collaboration the contractual framework has a central role according to all respondents. A good contract with low initial price focus is basic for avoiding conflicts and enhancing effective collaboration. In the meantime it is acknowledged by all respondents that this is more of a matter for the client and contractor to secure, as the consultant is still dependent on the procuring party. According to the lawyer, the variety of collaboration forms developing within the industry at the moment creates confusion for the consultant. Therefore, the recommendation for the consultant is to have one contract with the contractor, leaving the collaborative setup to be solved between the client and the contractor. According to the design leader, an approach with early contractor involvement creates an open and transparent environment around the contract, which increases the possibility to reach mutual agreements, while still maintaining a single contract between the contractor and consultant compared to a regular design-build arrangement.

“Collaboration is not the same thing as ‘together’ [...]. These are two different concepts that are often mixed up within the construction industry in these days”

Consultant Business Area Manager

Working in collaboration puts high demand on the governance of the project. The consultant business area manager stresses the need for an overall steering group with top management representatives from all project parties, including the technical consultant. This group should be in charge for the overall master time plan that clearly states who should be doing what at and what time. Here the steering group should work with clear milestones, part-time goals and other means for securing continuous

progress in the project. According to the consultant region manager, this steering group should also ensure that everyone works according to the mutual goals defined in the beginning of the project. In addition the steering group should act as a support function for the operational project management, securing that all systems and roles are set when beginning the collaborative work. Finally, the steering group should actively work against industry norms like consultants being solely interested in charging hours and contractors looking for any opportunity to find claims. An approach acknowledged by all respondents.

“With the current development on the market, it is important for us consultants to ‘show our muscles’ [...]. The contractor needs to understand that we have the internal resources required to support them in these types of large and complex collaboration projects”

Consultant Project Manager

The professional relation between the contractor and consultant is recognized as an increasingly important factor to consider. As the contractor will have more power to choose their consultants if involved earlier in the project, the consultant becomes much more vulnerable according to the consultant region manager. Therefore strategic relationships with the contractor will be important for the consultant to consider on a market with more collaboration projects. The consultant business area manager and regional manager see a need for an active investment in these relations, while still maintaining flexibility towards the choice of contractor and projects from what is best for the local organisation. The consultant project manager argues for the importance of alliancing with certain contractors to be able to win the growing number of large and complex infrastructure projects, as such market of alliances is still in its infancy. In that case experience of either working with the specific contractor or general experience of working in collaboration with contractors will become very valuable, according to several respondents.



### **4.3 Summary of exploratory study results**

The pre-study is based on exploratory unstructured interviews on a somewhat unstudied and developing topic. All parties mention the great amount of insecurity on what will be the final result of this development towards stronger collaboration, which creates a room for expectations rather than solely experience-based arguments. The pre-study however sheds light on some specific aspects regarding consultants in collaborative projects:

- The consultant team needs to have a more holistic picture over the project process when engaged in a collaborative project due to increased communication with the contractor
- The technical consultant should provide flexible, structured and open-minded team-members fully understanding the collaborative setting when engaging in collaborative projects
- Working in close collaboration with the contractor demands more specialist knowledge and adapted drawings by the technical consultant
- There is an increased need for a suitable contract frame and strong governance mechanisms through top-management steering groups
- Developing long-term relations with contractors becoming an more important factor for the technical consulting firms to consider

## **5 Case study – Project Mälarbanan**

*In this chapter the case study of Project Mälarbanan is presented. First an introduction to the project, describing its overall characteristics is presented. Then the organisational arrangements are covered, followed by a more in-depth analysis of the role of the consultant based on the interviews conducted. Finally, the main findings are summarised.*

### **5.1 Introduction**

Project Mälarbanan is a railway extension project between Tomtebodavägen and Kalhäll northwest of Stockholm City. The existing double-track railway is one of the most heavily used in Sweden, handling both the commuter rail traffic for the Mälardalen area as well as long-distance trains. With Project Mälarbanan the existing double-track railway will be extended to four tracks: two separate tracks for commuter trains and two separate tracks for long distance-trains. By this set up the capacity is heavily increased for all train types and leaves the commuter trains to use the two middle tracks without disturbance. In addition to the track work three new stations for commuters will be constructed in Kalhäll, Barkaby and Sundbyberg to support the increased traffic.

The project is divided into two main parts. The first part is between Barkaby and Kalhäll, together with separate construction works in the Tomtebodavägen area. The second part is between Tomtebodavägen and Barkaby. Construction works for the first part between Barkaby and Kalhäll began in 2012 with estimated completion in 2016. The second part is still in the planning phase and the whole Project Mälarbanan has an expected completion date in 2025. In this case study only the first part is in focus and only the ground works and BEST-works will be covered. The total contract sum is 1,6 billion SEK.

### **5.2 Project organisation**

Project Mälarbanan is carried out through a three-party collaboration model between the client, contractor and consultant, based on the concept of increased co-operation. The contractual setup was according to a design-bid-build approach where the client has separate contracts with the consultancy firm and the contractor. The contracts were combined target-cost and fixed price contracts with a bonus pool for all project parties if delivering the project below the target cost. According to the consultant representatives, the combination of both a fixed price and target cost resulted in a low hourly compensation for the consultant compared to a pure cost-plus contract.

An overall steering group as well as several collaboration groups were appointed in the beginning of the project to coordinate, facilitate and control the work between the different parties. The initial plan was to engage the consultant and the contractor at the same point in time. However, an appeal process delayed the entry of the contractor by eight months. This led to the consultant team beginning the detailed design works while waiting for the contractor. As soon as the contractor was awarded, workshops with all project parties were conducted to help reinforce common goals and working methods for parallel design and construction works.

The project delivery is separated into an ‘inner’ and ‘outer’ organisation. The inner organisation consists of the client representatives, the design leaders from the consultancy firm and representatives from the contractor. The inner organisation is responsible for planning of the design works and construction works, and is not located on site. The outer organisation consists mainly of the contractor and is responsible for the construction works on site.

### **5.3 Working in collaboration**

The main reason why the client chose a collaborative delivery approach in Project Mälärbanan was because of its high complexity. It is a large project with high risk and many uncertainties, as existing heavy rail traffic has to be maintained on tracks alongside the construction works. In combination with a tight time plan this puts high demand on all parties to work closely together to meet the overall goals and be responsive towards fast changes.

#### **5.3.1 Benefits**

Working in collaboration Project Mälärbanan has led to a number of benefits during the entire delivery process. According to a consultant representative and a client representative, the overall goal of meeting critical stages of the time plan was facilitated by the collaborative approach. This was mainly accomplished by creative input from all parties resulting in shorter lead times and consequently higher marginal in relation to the master time plan. A consultant representative suggested that the input from the contractor helped the consultant team to produce simplified drawings and documents and thus increased their productivity. The close collaboration with the contractor also reduced the need for review of drawings by the client, which further increased efficiency in the consultant team’s work.

The common working processes reduced the natural silos present between the different disciplines, both within the project organisation but also between the technology areas of the consultancy firm. This has according to a client representative and a consultant representative further helped to create an environment where competence and knowledge could be shared continuously between the project parties and their individual members. A client representative also suggested that working in collaboration helped the overall project organisation, and especially the consultant team, to develop new ways of approaching common processes and continuously question how the work was conducted throughout the project. Furthermore, working in collaboration helped the consultant team to gain important construction knowledge, creating a more holistic overview over the project and preparing the consultancy firm for future collaboration projects.

#### **5.3.2 Challenges**

All respondents argue that it was difficult to understand the magnitude and complexity of the project in the initial stage, despite the collaborative approach. This led to an insufficient amount of resources being engaged at an early stage from all project parties. In combination with a later-than-planned award of the contractor and consequent stress to meet the time plan, a common base of expectations, conflict management and a best-for-project mind-set could not be sufficiently enforced.

Additionally, the contractor representative suggested that the large geographical distance between the inner and outer organisation implied communication challenges between the contractor organisation on site and the project office. In all, this led to both an insufficient amount of input from the contractor in the design work and consequently a more limited understanding from the contractor side of the later produced drawings. According to the all respondents this was however resolved with time, as the understanding and respect for each party's contribution to the time plan, budget and overall project results increased.

Another challenge, according to a consultant representative, was to find suitable resources meeting the demands of this type of project. There were difficulties in securing the right competence with enough experience and still meet the financial prerequisites in the contract, as more experienced consultants implies a higher cost for the firm. Furthermore, consultant line managers, responsible for staffing the projects, were present during the design process. This meant that there was always a focus on the debit rate of each individual consultant, which put pressure on the cost of each hour worked instead of focusing on the competence needed.

## **5.4 The role of the consultant**

In Project Mälarbanan the consultant team was engaged at an early stage with the intent to work closely with the contractor. When the contractor was awarded, a parallel process of design and construction work was launched, with a tight time schedule between the production of drawings and on-site construction. During the interviews a number of aspects on how the consultant handled their role in this situation were identified.

### **5.4.1 Approach to project mission**

In Project Mälarbanan the client organisation was smaller than usual, which led to the consultant team taking more responsibility for coordinating the design activities together with the contractor. According to a consultant representative this helped to gain greater understanding for the project as a whole and especially for how the work of the consultant affected the overall budget. The increased input and commitment of the contractor in the design phase also meant producing more drawings and documents adapted to production. To achieve this, the consultant team was forced to be more flexible and structured in their work.

“The consultant needs to be fast in revising drawings [...]. It is not all about the relationship aspect, collaboration requires a significant amount of structure among the individual consultants and the design leader”

Consultant representative B

A client representative argued that securing that everyone has the same information and understanding of the process should be enforced at the initial stages when setting the common goals. A consultant representative agreed but also stressed that communication routines have to be adapted and secured throughout the organisation along the project execution. In addition, proper documentation is a key element for securing that information is always available to all project parties. It is however clear that the communication within the project organisation as well as understanding of the

collaborative working methods throughout the project organisation was difficult to obtain for the project parties. Here, all respondents argued for the importance of securing that the consultant team and contractor develop a process for reviewing drawings and documents together to avoid misunderstandings, unnecessary revisions and consequent time constraints.

“A consultant must move away from using garters, belt and parachute when engaged in a collaborative project”

Client representative A

A client representative finally argues that the consultant team need to be more flexible on the rigid quality assurance that is normally applied on all drawings and documents produced. When engaged in a collaborative project the consultant needs to take one step back and rely on the input from the other parties, especially the contractor. Instead more effort should be put on documentation of the working process, as structure is crucial when working together in parallel under tight time pressure.

#### **5.4.2 Competence requirements and team composition**

According to a client representative, the most important prerequisite for the consultant team regards the mix of senior and junior resources. The senior resources can provide experience and security, while the junior resources provide new viewpoints and in the same time develop their own competence in a collaborative setting. Team members should be flexible and have enough authority to proceed in an efficient way in collaboration with the contractor, as long as they have enough competence and capability. Only experienced senior consultants can produce the right type of drawings and documents to a contractor with much higher expectations.

In Project Mälärbanan all respondents believe that the tight financial frame in the consultant contract reduced the firm’s possibility to provide enough experienced consultants with full chargeability. However, up to 200 individual consultants participated in the design works during the most intensive periods. According to a consultant representative it became clear that the most challenging task was to introduce these resources in an efficient way and to make them understand the specific dynamics of the collaboration in Project Mälärbanan. This was seen as mainly due to the setup of the consultancy firm, where the consultants worked on multiple projects, serving different project organisations in parallel. A client representative and the contractor representative stressed the importance of adaptability in the consultant team. The consultant team should be engaged, good listeners but also not hesitate to take the space they need and deserve. If the consultant team see their input as equally important as the other project parties, a common respect arises and the project proceeds more efficiently. To achieve the goals of working in collaboration all three parties confirm the crucial need for having people that support the collaborative fundamentals of openness, trust and flexibility.

Finally all respondents emphasise the importance of construction knowledge within the consultant team when working in collaboration. At the same time the respondents accept the fact that this can be hard to demand from each individual within the consultant team. Instead the consultant team should always seek to increase its construction knowledge throughout the project and not be afraid of providing a tentative proposition instead of a final suggestion to the contractor.

### 5.4.3 Design team leadership

The contractor representative argued for the need of a non-hierarchical consultant organisation. A client representative suggested that the leader of the consultant team always must strive to create an environment of out-of-the-box thinking and motivation for continuous learning among the individual consultants. The management within a collaboration project should actively invite and collect the competence of the other project parties. This is most important for the contractor and the consultant team, as they are central in the delivery of the works. According to all respondents, a leader within the project organisation should have enough authority and trust to be able to make appropriate decisions. In addition it is also important for the leader to be active in his or her leadership and take action if something is not working properly. For example, individuals not complying with the collaboration principles or having a wrong mind-set. The project manager or design leader should in this case not hesitate to remove these individuals on short notice.

“It is important with a production-focused design leader [...]. Preferably he or she should come from the production side or have enough experience to speak the language of the contractor “

Consultant representative A

When collaborating with the contractor, a competent project management is fundamental for successful completion of the works. For the consultant this means a project manager and design leader with high production knowledge as well as experience from interacting with the contractor. A consultant representative argued that the new environment of interaction with the contractor requires consultant team leaders with experience, competence and integrity to allow a constructive dialogue with the contractor throughout the project.

## 5.5 Summary

The case study of Project Mälarbanan can be summarized in the following bullet points with regard to collaboration and the role of the consultant:

- Reduced silos between consultant technology areas and project parties resulted in new approaches to established working methods, better time efficiency and more production adapted drawings of higher quality
- Collaborative working implied a cultural difference for consultants as they had to be more pro-active and open-minded to develop new solutions in collaboration with the contractor
- Geographical distance between inner and outer organisation in combination with limited experience of collaboration working created communication barriers between the contractor and the consultant team
- Challenge in securing a holistic perspective of the project as well as understanding of collaborative working methods due to the high number of consultants involved.
- Challenge in setting right prerequisites for both involving required senior competence and developing junior resources, due to both contractual constraints and internal business model and mind-set in the consultancy firm
- Important to have a competent and strong project management and design leadership to have a constructive dialogue with the contractor and make appropriate decisions

## **6 Case study – Project Norrströmstunneln**

*In this chapter the case study of Project Norrströmstunneln is presented. First an introduction to the project, describing the overall characteristics is presented. Then the organisational arrangements are covered, followed by a more in-depth analysis of the role of the consultant based on the interviews conducted. Finally, the main findings are summarized.*

### **6.1 Introduction**

Citybanan is a new railway tunnel passing under Stockholm City, between Tomtebodan and Stockholm Södra station. The 6 km tunnel will be used by commuter trains to relieve Stockholm Central station, which has reached its capacity limit. Today commuter trains, regional trains, long distance trains and cargo trains all pass through or use Stockholm Central station jointly, which puts high pressure on the railway system. With Citybanan the track capacity is doubled, as all commuter trains will move to the tunnel. Along the tunnel two new commuter train stations will be constructed, Stockholm City and Stockholm Odenplan.

The construction of Citybanan is divided into eight different contracts. The construction works began in 2008 and the whole Citybanan is estimated to go into service in 2017. In this case study the contract covering the tunnel segment Norrströmstunneln and the new commuter train station Stockholm City is in focus. Thus the name Project Norrströmstunneln will be used to describe the project in the case study. The total contract sum for this part is 1,5 billion SEK.

### **6.2 Project organisation**

Project Norrströmstunneln is conducted according a three-party collaboration model developed between the client, the contractor and the consultant team. The client has separate contracts with the consultancy firm and the contractor. The contract with the consultant is a cost-plus contract, while the contract with the contractor is a target-cost contract. For the contractor the contract included an incentive scheme. Initially the consultant was engaged to be in charge of developing the target cost and general plans, while the contractor came in when the detailed design works were about to begin.

When the contractor was awarded, two design-process developers were appointed by the contractor organisation. The design-process developers were in charge of coordinating the design activities between the client, the contractor and the consultant team within a steering group. To form a common basis for all project parties several workshops were conducted during the first weeks after the contractor was awarded. These have been followed by more workshops continuously during the project execution.



## **6.3 Working in collaboration**

The client chose to work in a collaborative model due to the complexity of Project Norrströmstunneln. Constructing a tunnel and station underground implies by nature a lot of risks. Citybanan and Project Norrströmstunneln pass under several historic buildings and close to the existing subway and railway system. The public opposition as well as anxious property owners has imposed a lot of press on the project parties. Thus input from the client, contractor and consultant team was crucial for good project execution.

### **6.3.1 Benefits**

Working in collaboration resulted in a number of benefits for the whole project organisation. Initially the possibility of procuring a contractor earlier on a more basic set of figures instead of complete drawings and documents was beneficial. Engaging the contractor at an early stage helped the consultant team to retain important construction knowledge and other input, creating a mutual agreement over the drawings when submitted for construction. According to the contractor representative, this reduced the problems with drawings being too complex. Working in collaboration has also provided a lot of inspiration to the younger consultants engaged in the project, preparing them for future engagement in projects of this magnitude.

The client and contractor representatives argued that working in collaboration saved a lot of time by the natural flexibility obtained through the project setup. It was easy to change between different production methods and still keep the consultant team on track with their work. Production stops were also reduced as the understanding of the importance of providing the right material on the right time could be rooted in the consultant team. Furthermore the natural reduction of distance between client, consultants and the contractor on site helped to create a feeling of teamwork and mutual respect.

### **6.3.2 Challenges**

According to the consultant representative, the main challenge with working in collaboration was to keep up with the tight time schedules of parallel design work and construction work. This has demanded large resources from the consultant team at all times. Delivering construction projects in collaboration required adaption to the contractors working methods, which are normally much faster than what the consultants are used to. The contractor representative also mentioned the challenge in making the project parties understand what to prioritize in the daily work. When engaged in a project where everyone provides input at all times, things can easily be overworked. In such situation the project parties need to know how to prioritize and in the same time possess enough integrity and experience to stop the process at that given point.

Another challenge in this project was, according to the client representative, to keep the right resources throughout such a long project as Project Norrströmstunneln. It became clear that with a project time frame of about ten years, it was important to both retain existing resources as well as engage junior resources continuously.

## **6.4 Role of the consultant team**

In Project Norrströmstunneln the consultant team was led by a design leader working together with the client during the initial phases before the contractor came in. As soon as the contractor was awarded, a collaborative steering group was formed with representative from all parties. The goal was to create a basis for effective collaboration and to secure that common goals were followed throughout the project.

### **6.4.1 Approach to project mission**

Working closely together with the contractor helped the consultant team to adapt their work to the overall target cost of the project. Receiving input from the contractor on how the design work affects the overall budget of the project is, according to all respondents, crucial for the consultant to avoid producing drawings and documents with over-quality. This means being more questioned and flexible on revision after input from the contractor. It can also mean that a consultant team could need to invest more hours in the early stages of the project to secure that the subsequent construction works can be kept within the cost frames later on in the project.

“The consultant needs to sit down and understand what should be built first, these drawings should be produced first and with enough margin [...]. It is then up to the contractor and the consultant to sit down and coordinate the time plans”

Contractor representative

Following the time plan for delivery of drawings and documents is crucial for successful collaboration between the consultant team and the other project parties. As the consultant team and contractor worked with separate time plans for design and production that still needed to be aligned, it demanded flexibility from the consultant team, as this approach is still somewhat new for many consultants. In addition, working close to the contractor the consultant team was forced to adapt to the somewhat more fluctuating production time plan. Therefore all key resources on the consultant side had full dedication to the project, with 100 % debit rate. This was according to all respondents a very important factor for the consultant team to secure before engaging in a collaborative project.

If everyone in the consultant organisation stands behind the collaboration concept, it is much easier to fulfil the goals of producing drawings and documents with the right quality on time. In such situation it should be clear who are responsible for solving the problems that arise. According to all respondents there is a common view in the industry that it is the contractor who should be responsible for the problem solving in a project. When working in collaboration as in this project, it was natural that the most suitable party was responsible for the problem solving. In many situations this fell on the consultant team, which sometimes demand a new working approach.

### **6.4.2 Competence requirements and team composition**

A consultant in a collaborative project must be both flexible and experienced. According to the contractor representative the ability of reducing the complexity of drawings and documents produced to a simplicity that everyone understands is a new

approach for many consultants. In such situation the consultant team needs to be enough experienced to know how to produce that type of material with support from the contractor but also enough flexible to accept the changed way of approaching the mission. The client further argues the need for stability and integrity to invite the contractors input for obtaining the goal of producing such simplified material, while still securing the quality and safety of the drawings and documents produced.

“There is this somewhat inbuilt pride among consultants [...]. Consultants need to learn how to bring in the contractors input but also to question the information they get and talk and react if something is not working well in the project”

Consultant representative

The consultant representative pointed out the need for socially competent individuals led by equally competent managers. This has been one of the most important success factors. The drive of developing the individual competences among the consultants must be a basic qualification for being engaged in a collaboration project. According to the respondents it is more important to have the determination to increase knowledge and competence as a consultant throughout the project, rather than having this specific competence from the beginning. Being humble without prestige is characteristic that the consultant team needs to possess to be able to fully invite the contractor and client in the design process. Only then the consultant team can receive and handle consequent input from the contractor in a good way.

Construction knowledge is a recurring subject that all respondents bring up during the interviews. When working as a consultant team close to the contractor, a basic understanding of the construction process is required to be able to engage in the discussions. As it is a new setting for the consultant to be invited to the work site and get immediate feedback on the produced material, it is important to have enough competence to take that discussion. However, at the bottom line all respondents focus on the need for the right people. Therefore a mix of experienced senior consultants together with new junior talents was seen as preferable in a project like his.

### 6.4.3 Design team leadership

In Project Norrströmstunneln a strong leadership of the consultant organisation was combined with individual consultants having a curious and open-minded approach towards the additional parties involved. When working in collaboration it is important to have a flexible mind-set and always strive to communicate with fellow project allies as a consultant team. Showing trust and working according to an open book mentality and bringing up challenges and questions directly as they occur, creates an environment of mutual respect between the consultant team and the rest of the project.

The client and contractor argue for the importance of knowing the people in the consultant organisation as a design leader or project manager. It is also important to have a supportive culture internally within the consultant team so the individual consultants feel that they are equally included in the collaboration process as the team management. By doing so they understand why they should work so closely with the contractor. The client also suggests that the leadership within the consultant team should be named already during the tender process, to secure the right management organisation from the start.

“It is about taking everyone hostage on the meetings”

Client representative

The collaboration model in Project Norrströmstunneln meant new possibilities for the consultant and contractor to refine their methods connected the reviews of drawings and documents. Here the consultant leadership developed a new system for measuring the number of remarks and how to rate them depending on their impact on the project progress for the contractor. With goals connected to the different remark levels it created a motivation within the consultant team to continuously improve their work. This system of continuous review of the drawings and documents helped the contractor in their time planning as they had access to the material from the consultant on an earlier stage. The review process also had a very practical implication on the efficiency of the construction works on site. As everyone had been engaged in the review process, much less time had to be put on explaining how the contractor should interpret the drawings and documents.

## **6.5 Summary**

The case study of Project Norrströmstunneln can be summarized in the following bullet points with regard to collaboration and the role of the consultant:

- The high level of interaction with contractor during the design stage reduced complexity and over work of drawings and created an acceptance from all project parties
- High competence, flexibility and proactivity were crucial factors for successful delivery by the consultant team
- Strong and proactive leadership of consultant team created base for effective collaboration, enhancing new working methods and increasing the communication throughout the project
- It was important with key resources from the consultant working full time in the project to sustain collaborative fundamentals and create a strong project team
- Challenge in keeping and developing enough experienced resources throughout a large project with long time frame
- Introducing a system for review and feedback on design work from all project parties increased efficiency and mutual understanding

## 7 Discussion

*This chapter discusses and analyses the results from the study in relation to the presented theory. The discussion is divided into four main areas, focusing on the technical consultants' approach to project mission, competence requirements, project management and team composition and firm level implications.*

First of all it is important to recognize that collaborative construction project delivery is a developing concept and not yet fully mature. As seen in the literature review many different models of collaboration exist in the industry today, yet all with the goal to create a greater extent of collaboration between project parties. Involving the contractor early in the design phase to obtain construction knowledge and increase constructability and project performance is a key activity. However, it is still up to the procuring party to decide the contractual framework for the consultancy firm. As a contract represents the steering mechanism for a project (Mosey, 2009), this is an important aspect to keep in mind during the discussion.

### 7.1 Approach to project mission

More and Dainty (2001) suggest that professionals within the construction industry often see themselves as members of their individual disciplines rather than as members of a project team. In both Project Mälarbanan and Project Norrströmstunneln it was seen that the collaborative delivery approach reduced the traditional silos between different disciplines within a construction project as well as between the technology areas within the consultancy firm. This helped the consultant teams to gain more insight in the overall project. It also supports the findings of the exploratory study, as a more holistic picture over the different project processes could be obtained through the collaboration approach chosen in both of the studies cases.

Trust and mutual understanding are fundamentals for successful collaboration (Bresnen & Marshall, 2001; Kent & Becerik-Gerber, 2010; Walker & Lloyd-Walker, 2015). Developing trust also requires individual consultants adopting the collaborative setting with an open mind-set, not hesitating to work in a new ways and embracing the changed dynamic in the respective roles of the project parties and keeping a best-for-project mind-set (Jørgensen & Emmitt, 2009; Chiochio *et al.*, 2011). In both Project Mälarbanan and Project Norrströmstunneln the consultant could provide more production-adapted drawings with less complexity through increased contractor input. This however required the consultant team to trust the contractor input to a higher extent. Lieftink *et al.* (2014) argue that design professionals often keep any type of innovation strongly linked to what is perceived as professional logic and appropriate in the industry, which could limit the will of adopting such approach throughout the whole consultant team.

According to Løwendahl (2005) and von Nordenflycht (2010) the professional norms of PSF's can also be an inhibitor for commercial competitiveness. This as client satisfaction and trust is often valued higher than profit. In Project Mälarbanan the consultant team was procured according to a fixed price model in combination with a target cost and bonus pool. This led to the consultant team feeling constrained by the contractual terms and experiencing difficulties providing sufficient resources in the project to meet the demands of the client and contractor. Furthermore, consultant line

managers, responsible for staffing the projects, were present during the design process. This meant that there was always a focus on the debit rate of each individual consultant, which put pressure on the cost of each hour worked instead of focusing on the competence needed. In Project Norrströmstunneln, where the consultant team was procured through cost plus contract, the possibilities of engaging sufficient sources working full time on the project was higher. This is an important factor for obtaining a higher flexibility and understanding of the project within the consultant team.

In both Project Mälarbanan and Project Norrströmstunneln, the tight time frame for parallel design and construction works required a higher extent of flexibility within the consultant team compared to a traditional design-bid-build project where design and construction is more separated. For example the organisations within Project Norrströmstunneln chose an approach where the consultant took a more equal responsibility as the contractor for the problem solving and progress of the construction works of project. As pointed out in the exploratory study such approach where the consultant takes a greater responsibility, controlling the outcome of the project to a higher extent, is favourable when it comes to collaborative projects. In addition it could worth moving away from a culture of blaming each other for the upcoming problems and instead focus on the contribution of each party. The difficulties of obtaining this mind-set and working approach in Project Mälarbanan was possibly partly a result of the strong norm of autonomy present among many PSF's (von Nordenflycht, 2010), in combination with leadership and team members with little previous experience of working in a collaborative setting.

## **7.2 Competence requirements and team composition**

The most fundamental strategic challenge for a PSF is the management of its human resources (Løwendahl, 2005; Stroe, 2013). A mix of junior and senior resources is seen as important for successful delivery of professional services (Maister, 1982) and particularly when participating in design collaboration (Koutsikouri *et al.*, 2008). This is confirmed in the case studies of both Project Mälarbanan and Project Norrströmstunneln. Senior resources bring in experience and stability, while junior resources bring in new ideas and might have another way of approaching a task. The challenge however seems to be to find enough experienced senior resources with the right mind-set of working in collaboration, while the junior resources might be insufficiently trained to make decisions and have a constructive dialogue with a contractor. For example, in Project Mälarbanan the financial constraints in the contract also reduced the possibility to provide a sufficient number of experienced consultants with authority to secure enough progress in the design works, which led to some difficulties in the communication with the contractor. It is therefore important that the junior resources can work alongside more experienced colleagues and continuously take more responsibility in a collaborative project. As seen in Project Norrströmstunneln such an approach develops the individual consultants, making them trained 'collaboration consultants' for future projects.

In both case study projects the foremost challenge for the technical consultant was to handle the closer dialogue with the contractor. Hughes and Hughes (2013) argue that professionals within the construction must move away from claiming exclusive ownership of a specific body of knowledge and work more across firms. Taking advantage of the provided construction knowledge, being humble and use it in an appropriate way in the design works is a way to do this. The consultants must

however be experienced enough to fully understand the contractor input and have a constructive dialogue about the work process. As seen in the exploratory study, such experience should ultimately include the high level of specialist knowledge needed to provide drawings to a recipient with much more competence in the field of work than a traditional client. In addition, the consultants should keep a supportive and analytical role in driving the design works as well as a structure over the progress. As seen in the case studies, and supported by Song *et al.* (2009) and Eriksson and Westerberg (2011), the right type of construction knowledge fully integrated in the design work can provide important input, improving the overall project performance through avoiding latter need for rework and increased productivity.

### **7.3 Design team leadership**

A project manager and design leader is responsible for the work of the team. For collaborative project delivery efficient project management and leadership is crucial (Koutsikouri, 2008; Mosey, 2009; Kent & Becerik-Gerber, 2010; Walker & Lloyd-Walker, 2015). Therefore it is important that all expectations are clarified at the beginning and that the individuals involved has both the experience and will of working in a collaborative setting. In both Project Mälarbanan and Project Norrströmstunneln the respective project organisations understood the need for strong project managers and design leaders with experience from collaboration as well as previous relationships with contractors. These leaders need to have both the capability and authority to make decisions in difficult situations under pressure. Thus both construction knowledge and leadership skills are necessary, securing that everyone in the team stands behind the collaborative setting and the mutual goals.

In the exploratory study a consultant project manager argued for the need of having enough time at the beginning of the project to secure that everyone in the project understands the collaborative setting. Finally the design management has a responsibility to secure that the right amount of contractor expertise is brought in to collaborative design process. This requires systems for review and feedback on the produced material from all project parties but also that individuals in the teams are responsive to changes throughout the design work. In Project Norrströmstunneln the design management developed a system for efficient review of drawings, where all project parties could contribute with their viewpoints. By doing so a commitment from the whole project organisation could be achieved, and progress in both design and construction works was obtained. This supports the findings of Jørgensen & Emmitt (2009) concluding that design managers must secure a balance between fixing design parameters sufficiently early to achieve progress and still maintain a possibility for continuous improvement.

### **7.4 Implications for the consultancy firm**

Including the contractor early through collaboration helps the technical consultancy firm with efficient resourcing and profitability analyses (Søldal, 2014; Eadie and Graham, 2014). In both case studies it was seen that it could be a challenge to find enough human resources suitable for a collaborative design team. One factor could be financial constraints in the contract, but also that not all individual consultants are suitable for participating in the special environment of a collaboration project. By having a system for continuously engaging new and promising resources and training



them in collaborative projects, the identified challenge of keeping enough experienced consultants well included in the collaborative setting throughout long project life cycles could be reduced. Such development initiatives would also help the firm to further attract, motivate and keep human resources over a longer period of time and stay competitive on the market (Yisa & Edwards, 2002; Huang et al, 2007; Stroe, 2013). As not all projects will be collaboration projects, it is desirable that the consultancy firm therefore prioritise these projects in terms of developing resources for the future.

The development of collaborative construction project delivery and increased use of design collaboration bring new challenges for the technical consultancy firm to tackle. Both the market dynamics as well as the final customer of the firm's output change. There is a risk that large contractors start integrating backward and develop own engineering departments (Koch, 2004; Stroe, 2013) as early contractor involvement becomes increasingly applied. This could require the technical consultancy firms to either develop their internal competence profile to be more specialized, add more services to their portfolio or create more strategic relationships with the contractors. A subsequent risk with having strong relationships with certain contractors is however if the partner is not awarded the contract. On the other hand, as the market is still evolving it is possible that contractors will instead have multiple looser relationships and choose individual consultants from different firms based on the requirements of a specific project. In such case it would be beneficial for the consultant to have many strategic relationships with several contractors instead of just a few.

## **8 Conclusions**

*This final chapter will present the conclusions of this thesis, referring to the initial purpose and research questions. The chapter will also provide a number of recommendations for engineering and design consultants engaging in design collaboration as well as some thoughts on future research.*

### **8.1 Identified differences in the role of the consultant**

As a technical consultant team engaged in a collaborative project the main difference is that a holistic picture over the project process is needed. In a collaborative project, it is more important that both the individual consultants and the team understand how their work contributes to the overall project performance. This can be achieved through including sufficient construction knowledge from the contractor, together with a strong leadership within the consultant organisation. The consultant team will therefore be more dependent on the contractor expertise. This means a new setting for the consultants and will require more flexible consultants with an open mind-set enhancing the trust and mutual understanding needed for effective collaboration. This applies for both the individual consultants and the leadership of the consultant team.

Collaborating with the contractor in the design phase demands new working methods for the consultant team. The material produced has to be more adapted to the needs of the contractor but with maintained quality, produced under higher time pressure and with continuous review from the contractor. This requires consultants with enough experience and integrity to handle the new dynamics of the role. Therefore it is important that the consultancy firm secures that this is accounted for in the tender process, to avoid ending up feeling restrained by too low contractual margin. Furthermore it is desirable with more consultants working full time in the specific project, instead of multiple consultants working part time on smaller packages, as this limits the possibility to gain enough insight in the overall project.

Finally the increased need of sufficient communication between project parties will demand more proactive individuals in the teams combined with good team leaders. The design team leaders should first of all have experience from working in collaboration. Secondly, the capability and authority to take difficult decisions under pressure and finally the ability to conduct constructive dialogues with the contractor to integrate enough contractor expertise in the collaborative design work.

### **8.2 Recommendations to the technical consultancy firm**

To meet the new demands of collaborative construction delivery the technical consultant must become an attractive collaboration partner. Through this thesis several differences in the role of the consultant were identified. These differences can be translated into strategic implications for the firm.

To maintain a competitive market position in the future, the consultancy firm needs to adopt a system for developing collaborative individuals, leaders and relationships through its organisation. The recommendations are specified in Table 5.

**Table 5** Recommendations to the technical consultancy firm

<p><b>Prioritise collaboration from a human resource perspective</b></p>	<p>Fully secure that the individuals in the consultant organisation in collaborative projects stand behind the collaborative setting and strive to continuously develop their competence and skills. The consultancy firm also needs to allocate more resources working full time in the collaborative projects, instead of engaging multiple consultants only conducting smaller parts of the design work. In addition, the firm should aim to submit tenders that allow senior resources to be engaged in the project. Preferably this is also regulated in the contractual terms.</p>
<p><b>Collaboration training for specific project managers and design leaders</b></p>	<p>The consultancy firm should be proactive and identify suitable project managers and design leaders and train them in the dynamics of design collaboration. By securing collaborative leaders the firm is always prepared for engaging in a collaborative projects, which helps the firm to be an attractive choice for contractors and clients.</p>
<p><b>Continuous development and training of junior resources in project based environment</b></p>	<p>Engaging flexible and open-minded individuals understanding the collaborative setting is crucial. Therefore the consultancy firm should actively seek to develop junior resources in collaborative project environments. By introducing junior resources to the collaborative environment at an early stage, the available base of individual consultants suitable for collaborative projects is secured.</p>
<p><b>Establish strategic relationships with desired contractors</b></p>	<p>Contractors are involved earlier and to a higher extent they become the new client for the technical consultant in design collaboration setups. The consultancy firms should therefore develop strategic relationships with contractors of choice. It is however important to recognize the risk involved with developing too strong relationships with certain contractors, as it can result in exclusion from the project if another contractor than the partner is awarded.</p>

### 8.3 Thoughts on future research

This thesis has been conducted during a limited timeframe during the spring of 2015, with two case studies providing the main empirical data set. More thorough studies of additional cases with a greater number of respondents would be suitable to further examine the dynamics affecting the technical consultants in a collaborative project. In addition a specific study on remuneration models and the financial aspects is desirable to gain more insight in how technical consulting firm should handle contractual terms and disposition of hours to keep a project within the target cost.

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