DOCTORAL THESIS

Organizational Tensions when Managing Interorganizational Projects

Applying a Paradox Perspective on Large Construction Projects in Sweden

Henrik Szentes

Construction Engineering and Management

LULEÅ UNIVERSITY OF TECHNOLOGY

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En verklig upplevelse

Sinnen som fylls av bild, lukt och ljud,
entydiga intryck eller finns det flera bud?
Somliga hävdar det bara finns en verklighet,
andra att allt kan tolkas, att ingen säkert vet.

De som tror på enkla svar,
har snart inga tvivel kvar.
Men förmågan att tänka kritiskt,
är något vi bör öva nitiskt.

Pessimist eller optimist,
båda två har omdömet mist.
Den förste tänker att allt är svårt,
den andre hoppas men faller ofta hårt.

Men vilka människor mår då bäst?
Skygglappar på, eller bli vid sin läst?
Kanske man istället kan kombinera,
tänka efter före, och sen avancera!

Forskare vill om kunskap värna,
fyller därmed ivrigt sin hjärna,
med tankar om modeller och teori,
applicerade på ett urval av empiri.

Men icke att förglömma,
om våra hjärtan vi också bör ömma.
Lust och glädje är som bränsle för själen,
viktigt att bejaka och erinra sig skälen.

En fin balans jag starkt rekommenderar,
att vi både känner och tänker, och sen kommunicerar.

Henrik Szentes
Augusti, 2016

Preface

Ever since I graduated with my master's degree in Civil Engineering at Chalmers University of Technology in 1993, I have been considering going for a Ph.D. However, it took me more than 15 years, working in different managerial roles in different industries, to find a topic that I deemed interesting enough to spend all that time and energy on. Another goal that emerged during those years was to start and run my own consulting business and achieve flexibility along with control over my own time, as balancing direction and empowerment is easier when you are your own manager. As a result, in 2010, I simultaneously started two journeys: one as a Ph.D. candidate at Luleå University of Technology and one as founder of my own consulting company focusing on the management and risk management of large and complex projects. The following six years can certainly be described as a paradoxical tension between these two simultaneous journeys. Although most aspects of both journeys made sense, it seemed almost absurd to combine them. Yet, instead of choosing either, I made the decision to simultaneously once again explore the academic world and exploit my professional experience. Initially, I believed in synergies, and now I know that there are great synergies. It should be noted, though, that this thesis is based solely on empirical material derived from case studies within the research project.

I´d like to express my gratitude to all people who have helped, supported, and encouraged me during my research journey. First of all, I'd like to send a warm hug to my three beloved children; Elvira, Alfred, and Alice, for your patience during the many occasions when I have spent my time and focus on completing this journey. You are always in my heart.

Two people that are very important for the completion of this thesis are my supervisors Professor Per Erik Eriksson, and Professor Thomas Olofsson. Per Erik, it has been a pleasure discussing various topics with you, from overarching questions concerning methods and positioning of papers to specific linguistic issues, but perhaps most of all to elaborate on organizing in general and on different phenomena occurring in the Swedish construction sector. You are a truly listening and continuously reflecting human being, and I have the deepest respect for your professional expertise as well as for your approach on how to manage obstacles and setbacks occurring. Thank you for supporting and encouraging me in moments of dejection and when I hesitated to proceed with this journey. Thomas, thank you for your support, ideas and encouragement, always saturated with your vast experience from the academic field.

Moreover, I´d like to thank my colleagues at the Division of Industrialized and Sustainable Construction, especially Susanne Engström, Ekaterina Osipova, and

Johan Larsson for your support and important questions and notions during the writing process of this thesis.

I gratefully acknowledge the financial support of the Development Fund of the Swedish Construction Industry (SBUF) and Ragnar Söderbergs stiftelse (RSS). Moreover, I´d like to thank all members of the reference group for sharing your perspective and ideas throughout the research journey. I´d like to specifically thank Adjunct Professor Jan Byfors for your support during the initiation process and Adjunct Professor Staffan Hintze for your important and reflective reviews and suggestions during the journey.

Henrik Szentes
Svedala, August 2016

Abstract

Over the years, technological developments and societal changes have forced companies to modify their organizing practices. Companies operating in the construction sector are no exception, but due to their project-based structure, it is more difficult to coordinate change initiatives. Indeed, the construction sector is often described as conservative and unwilling to adopt change. However, there is a growing interest and ambition within the construction sector to develop and implement new ways of working. In addition, the need to adapt organizing practices of large construction projects due to societal changes is particularly strong because large construction projects are very dependent on a wide range of societal stakeholders.

Changes in organizing practices as well as contextual changes often create new and intensify existing organizational tensions. Because most large construction projects span organizations, tensions can emerge and develop at several organizational interfaces. For instance, tensions related to control and flexibility can emerge between the client and the contractor, within each of these parties, but also between the project organization and societal stakeholders. Another type of tension relevant to construction projects is between the exploitation of current knowledge to perform efficiently today and the exploration of new knowledge in order to innovate for tomorrow's demands. The abovementioned tensions have a paradoxical nature, meaning that although both elements in the tension make sense, they appear to be impossible to combine. Yet, applying a paradox perspective on organizational tensions recognizes that both elements are required when organizing. Moreover, prior research has shown that due to interdependencies between different organizing activities, responses to tensions may evolve into reinforcing cycles, substantially impacting performance.

Therefore, the aim of this thesis is to create an improved understanding of the dependencies between tensions at different organizational interfaces in large construction projects by applying a paradox perspective.

Empirical material was drawn from a qualitative study of seven large construction projects in Sweden, including three rounds of interviews during a four-year period, site visits, and reading of project documentation. All projects had an original contract sum of at least 50 million Euros and durations over several years; they included both transport infrastructure and building projects. An initial analysis of changes that project managers in large construction projects perceived in their role due to changing external and internal conditions provided a better understanding of the origin and nature of tensions in contemporary large construction projects, resulting in Paper I. Moreover, specific questions on the

subject of exploration/exploitation during the first round of interviews provided input to Papers II and III. The two concluding rounds of interviews focused on dependencies between the tensions related to control/flexibility at different organizational interfaces and, analyzed using a paradox perspective, resulted in Papers IV and V.

This thesis contributes to the construction management literature by showing that despite institutional barriers, substantial changes in the organizing practices of large construction projects have occurred over the years. However, the statements and attitudes exhibited by several interviewees indicate that the construction sector's reputation for being conservative has become institutionalized, blocking creativity and favoring exploitation over exploration.

This thesis also contributes to the literature on managing large construction projects by showing that distinguishing between interorganizational and intraorganizational aspects is essential to achieving a better understanding of the dependencies between organizing activities. For instance, analyses using a systemic paradox perspective showed that tensions related to control/flexibility coexist at both interorganizational and intraorganizational interfaces and that there are interdependencies between the two tensions, resulting in reinforcing cycles. For example, urges from client governance to their project manager to increase control of the contractor translated into an increase of control over the contractor project manager by his/her governance forum in order to retain the contractor's flexibility. This triggered further controls by the client, and so on, in a vicious cycle of control. Similarly, this thesis demonstrates that in order to better understand how exploration and exploitation in large construction projects is dependent on intraorganizational strategies and decisions, it is fruitful to apply a systemic paradox perspective and simultaneously analyze both intraorganizational and interorganizational aspects.

In addition, this thesis contributes to the literature on paradoxical tensions by identifying tensions and reinforcing cycles simultaneously nested across both inter- and intraorganizational interfaces, thus further calling for a systemic view of paradoxical tensions.

For practitioners it is therefore essential to reflect not only which project managers to appoint in large construction projects, but also simultaneously thoughtfully chose members of each governance forum to avoid vicious cycles to occur.

Keywords : Paradoxical tensions, interorganizational projects, construction sector, control, flexibility, exploration, exploitation

Sammanfattning (Abstract in Swedish)

De senaste decennierna har teknologisk utveckling och samhälleliga förändringar såsom globalisering och urbanisering tvingat företag att anpassa sina sätt att organisera sig. Företag verksamma i byggsektorn är inget undantag, även om det är svårare att driva koordinerade förändringsinitiativ i projektbaserade verksamheter. Byggsektorn har dessutom haft ett rykte om sig att vara konservativ och ovillig att utvecklas. Men, det finns ett spirande intresse och en växande ambition inom byggsektorn att utveckla och implementera nya sätt att arbeta. Eftersom stora byggprojekt är särskilt beroende av flera olika samhälleliga intressenter, så har de samhälleliga förändringarna inneburit stora förändringar av förutsättningarna för att driva stora projekt, med nya sätt att organisera och driva projekten som effekt.

Förändringar i arbetssätt såväl som kontextuella förändringar skapar nya samt intensifierar befintliga organisatoriska spänningar. Eftersom de flesta stora byggprojekt engagerar flera olika organisationer, s.k. interorganisatoriska projekt, kan dessa spänningar uppkomma och utvecklas i flera olika gränssnitt. Till exempel kan spänningar avseende kontroll flexibilitet uppkomma mellan beställare och entreprenör, inom respektive organisation, men också mellan projektet och det omgivande samhället. En annan typ av spänning som är relevant för byggprojekt är att å ena sidan nyttja dagens kunskap och teknik för att prestera idag, å andra sidan utveckla ny kunskap för att möta morgondagens krav. Båda spänningar omnämnda ovan har paradoxiska drag, det vill säga, trots att båda sidor av respektive spänning verkar förnuftiga att satsa på, så verkar de motstridiga och svåra att kombinera. Likväl, enligt paradoxlitteraturen så är det just en kombination av båda som behövs. På grund av korsberoenden mellan olika aktiviteter kopplade till organisation och ledning kan organisatoriska spänningar utvecklas till självnärande spiraler som riskerar ytterligare öka på spänningen, vilket starkt påverkar projektets genomförande och resultat.

Därför är ansatsen för denna avhandling att använda ett paradoxperspektiv i strävan i att öka förståelsen för hur beroenden mellan spänningar i olika organisatoriska gränssnitt ser ut.

Empirin är hämtad från en kvalitativ studie av sju stora byggprojekt i Sverige, omfattande tre rundor av intervjuer under en fyraårsperiod, byggarbetsplatsbesök samt inläsning av projektdokumentation. Alla projekt hade en ursprunglig kontraktssumma om minst 50 miljoner Euro, en byggtid på flera år och inkluderade både infrastruktur och byggnader. En inledande analys av förändringar som intervjupersonerna upplevde hade påverkat deras roll skapade en bättre bild av ursprunget och karaktären av organisatoriska spänningar i nutida

byggprojekt, vilket resulterade i artikel I. Under den första intervjurundan ställdes också frågor relaterade till spänningen mellan att nyttja befintlig kunskap och utveckla ny kunskap för morgondagens affärer, vilket resulterade i artikel II och III. De två avslutande intervjurundorna fokuserade på spänningen mellan kontroll och flexibilitet i olika organisatoriska gränssnitt, vilket efter analyser med hjälp av paradoxlitteraturen ledde fram till artikel IV och V.

Avhandlingen bidrar till litteraturen kring byggprojektledning genom att påvisa att det trots starka institutionella krafter har skett stora förändringar i hur stora byggprojekt organiseras och leds. Men, många intervjuer avslöjar också att själva ryktet som sådant om att byggbranschen är konservativ tycks ha blivit institutionaliserat, vilket blockerar kreativitet och får kortsiktiga vinster att favoriseras framför långsiktig utveckling.

Avhandlingen visar också hur ett särskiljande av spänningar mellan organisationer och inom organisationer kan leda till en bättre förståelse för hur aktiviteter relaterade till hur projekt organiseras och leds är sammankopplade och beroende av varandra. Ett systemiskt paradoxperspektiv applicerat på stora byggprojekt belyser att det finns både inter- och intraorganisatoriska spänningar relaterade till kontroll och flexibilitet, och att korsberoenden mellan dem gör att det lätt kan uppstå självnärande spiraler som förstärker spänningarna. Till exempel ledde ökade krav från beställarens styrgrupp till sin projektledare på mer kontroll av entreprenören att entreprenörens styrgrupp uppmanade sin projektledare till att stå emot för att behålla flexibilitet och handlingsutrymme, vilket ledde till ytterligare kontroll från beställarens sida, osv. En avgörande aspekt i hur olika spiraler uppkom och utvecklade sig var erfarenhet och personliga egenskaper hos såväl projektledare som de som satt i respektive styrgrupp. På liknande vis lyfter avhandlingen också fram hur ett systemiskt paradoxperspektiv kan öka förståelsen för hur balansen mellan kortsiktiga vinster och långsiktig utveckling i stora byggprojekt påverkas av strategier och beslut inom beställarorganisationen såväl som inom entreprenörsorganisationen.

Avhandlingen bidrar till paradoxlitteraturen genom att visa att såväl spänningar som självnärande spiraler kan vara samtidigt kopplade över såväl interorganisatoriska som intraorganisatoriska gränssnitt, vilket ytterligare talar för vikten av ett systemiskt paradoxperspektiv vid studier av stora byggprojekt och andra interorganisatoriska projekt.

För verksamma inom byggsektorn är det därför av största vikt att man vid tillsättandet av projektorganisationer inte isolerat beaktar vilka projektledare man tillsätter utan samtidigt tänker igenom vilka som skall sitta i respektive styrgrupp.

Nyckelord: Paradoxiska spänningar, interorganisatoriska projekt, byggsektorn, kontroll, flexibilitet, delegering, innovation, effektivitet

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Appended Papers

The five papers are presented first in the order of the empirical material used and second in order of topic. Paper I is based on the first round of interviews in 2011 and concerns changes in society and within the construction industry. Papers II and III are also based on the first round of interviews in 2011, but focus on the organizational tension between exploration and exploitation. Papers IV and V are based on longitudinal studies, including three rounds of interviews during 2011–2015, and focus on organizational tensions related to control, flexibility, direction and empowerment.

Paper I

Szentes, H. and Eriksson, P-E. (2013) "Societal changes and new conditions for the management of large construction projects" *Open Construction & Building Technology Journal*, 7, 182-92.

Author contribution: The paper was written by Henrik Szentes and Per Erik Eriksson. Henrik's contribution was collecting the main body of the empirical material, outlining the main idea of the paper by structuring and analyzing different themes of changes and the corresponding new conditions; these were derived from the empirical material from the seven projects. The writing was mainly done by Henrik, with editing by Per Erik.

Paper II

Eriksson, P-E., Olander, S., **Szentes, H.**, and Widén, K. (2014) "Managing short-term efficiency and long-term development through industrialized construction" *Construction Management and Economics*, 32(1-2), 97-108, 10.1080/01446193.2013.814920

Author contribution: The paper was written by Per Erik Eriksson, Stefan Olander, Henrik Szentes and Kristian Widén. Henrik's contribution was collecting empirical material, providing support in identifying and analyzing relevant examples of short-term efficiency and long-term development in the empirical material from the three infrastructure projects, and discussing the outline of the paper structure. The writing was primarily done by Per Erik and Stefan, with support and editing by Henrik and Kristian.

Paper III

Eriksson, P-E., **Szentes, H.** (----) "Managing the tensions between exploration and exploitation in large construction projects", *Submitted to a Journal in May 2016*

Author contribution: The paper was written by Per Erik Eriksson and Henrik Szentes. Henrik's contribution was collecting the main body of the empirical data, providing support in identifying and analyzing short-term exploitative and long-term explorative practices in the empirical material from the seven projects, and discussing the idea and outline of the paper. The writing process was driven by Per Erik, with support and editing by Henrik.

Paper IV

Szentes, H., and Eriksson, P-E. (2015) "Paradoxical organizational tensions between control and flexibility when managing large infrastructure projects" *Journal of Construction Engineering and Management*., 10.1061/(ASCE)CO.1943-7862.0001081

Author contribution: The paper was written by Henrik Szentes and Per Erik Eriksson. Henrik's contribution was collecting the main body of the empirical data, identifying and analyzing the relevant organizational tensions in the empirical material, relating them to theories on control/flexibility and paradox perspectives, and finally outlining the idea and structure of the paper. The writing was mainly done by Henrik, with editing by Per Erik.

Paper V

Szentes, H. (----) "Inter- and intraorganizational paradoxical tensions when managing large construction projects", *Further developed version of a paper that was submitted to a Journal in March 2016*

Author contribution: The paper was written by Henrik Szentes, including collecting empirical material, identifying and analyzing relevant organizational tensions, and relating them to previous research on control/flexibility, direction/empowerment and paradox perspectives. Finally, Henrik outlined the idea and structure and wrote and edited the paper.

Additional Publications

Peer reviewed conference articles

Szentes, H. (2010) "Success Factors in Large Construction Projects", *Proceedings at CIB World Building Congress*, Manchester.

Eriksson, P-E., and Szentes, H. (2013) "Managing exploration and exploitation in construction projects", *Proceedings for 7th Nordic Conference on Construction Economics and Organisation*. Akademika Forlag, Trondheim, s. 451-60. ⋆

⋆ *The paper was nominated as one of the three best conference papers*

Eriksson, P-E., and Szentes, H. (2014) "Organizational ambidexterity in construction projects". *Proceedings, IEEE International Conference on Management of Innovation and Technology: ICMIT 2014*, 6942405, IEEE, Piscataway, NJ, 81-86., 10.1109/ICMIT.2014.6942405

Technical reports

Eriksson, P-E., Szentes, H-, Olofsson, T., and Lagerqvist, O. (2012) "Hinder och drivkrafter för industriellt anläggningsbyggande: Underlagsrapport till Produktivitetskommittén [Hindrance and driving forces for industrial civil engineering, a technical report]", Näringsdepartementet. [Ministry of Enterprise and Innovation]

Articles in trade magazines

Szentes, H., and Eriksson, P.E. (2014) "Samhällsutveckling innebär nya förutsättningar för stora byggprojekt [Development of society entail new conditions for large construction projects].", Samhällsbyggaren no. 3/2014.

Part I

1. INTRODUCTION

This chapter provides the motivation for undertaking the research project that resulted in this thesis. This introductory chapter starts with a background section that explains the research context, followed by a discussion of the problem and the aim and research questions. The chapter concludes with an outline of the thesis structure.

1.1. Background and research context

In recent years, major technological developments as well as globalization, urbanization and other changes to social structures have forced the companies and organizations in most sectors to modify their structure, managing practices, and business models (Tushman & O´Reilly, 1996; Riot & de la Burgade, 2012; Lewis & Smith, 2014). Project-based organizations are no exception in adapting to societal and technological developments (Jaafari, 2003; Saynisch, 2010; Hope & Moehler, 2014). Floricel et al. (2015) emphasize that understanding that projects are embedded in social contexts entails a need to review and change both the theoretical and the practical approaches to project management. Further, Hornstein (2015) highlights that project managing practices need to take into account ongoing organizational changes to avoid failure and create success.

Construction is, in many aspects, the epitome of a project-based sector, and project-oriented work methods have long been the norm. In most countries, the construction sector represents an important part of all investments made, for example approximately 6 % of the Gross Domestic Product (GDP) globally (World Economic Forum, 2016) and between 8-10 % of GDP in Sweden over the past ten years (Sveriges Byggindustrier, 2015). Furthermore, it can be noted that the number of large construction projects globally is growing, including the so-called megaprojects (Hu et al., 2015), which comprise a number of these large construction projects (Flyvbjerg, 2014). Prior research has highlighted a need for improved productivity in construction projects (e.g., Chan & Kumaraswamy, 1997; Chua et al., 1997), and similar conclusions have been presented in recent publications (World Economic Forum, 2016). Moreover, it has frequently been claimed in prior research and governmental reports that the lack of productivity stems from the construction sector's tendency to be conservative and unwilling to adopt changes (e.g., Latham, 1994; Egan, 1998; Rooke et al., 2010) and that too strong focus on existing best practices can block development (Fernie et al., 2006). Similarly, conservative attitudes in the Swedish construction sector have been highlighted for a long time in research, e.g., by Ekstedt et al. (1992), as well as in governmental reports (e.g., SOU 2002, 2012).

There is prior research arguing that institutionalization can partly explain the apparent lack of development in the construction sector (e.g., Kadefors, 1995; Sminia, 2011). Similarly, Bresnen (2016) argues that institutionalization has hindered changes to and the development of project managing practices. According to institutional theory, institutional forces derive from normative and cognitive rules that organizational members believe they must adopt in order to achieve legitimacy and stability (Meyer & Rowan, 1977). According to Dacin et al. (2002), it is therefore often necessary to de-institutionalize prevalent institutions in order to enable change.

Bresnen et al. (2005), however, claim that there is a growing interest and ambition within the construction sector to change and develop. Accordingly, Löwstedt and Räisänen (2012) argue that the reluctance to change is a well-rehearsed myth. Moreover, a recently published global report confirms that societal changes are placing major pressure on construction companies to develop and transform their ways of working (World Economic Forum, 2016). Similarly, prior research within construction management highlights how various societal changes and technological developments have created a need to specifically adapt how large construction projects are organized and managed. For instance, contemporary large construction projects need to take into account the often discrepant interests of an increased number of stakeholders (Olander & Landin, 2005; Patanakul et al., 2016), including demands from the public for performance and accountability in tax funded projects (Flyvbjerg, 2005; Bruzelius et al., 2002). Furthermore, Puerto and Shane (2014) highlight that new regulations, funding principles, and an increase in refurbishing projects also require new ways of working when executing large construction projects.

In addition to being largely influenced by external stakeholders and regulations, large construction projects are most often interorganizational in the sense that a client holds a contractual agreement with one or several contractors to deliver a project with a specific scope. A common setup is to have a defined main contractor using sub-contractors to deliver the scope of work. As shown in Figure 1 on the next page, there are both horizontal and vertical organizational interfaces in interorganizational projects: interorganizational interfaces between the client and the contractor on different organizational levels, interorganizational interfaces between stakeholders in society and each of the involved parties, and intraorganizational interfaces within the client and the contractor organizations.

The coexistence of multiple organizational interfaces increases the complexity for all of those working with the project, but most of all for the people operatively managing the project. More specifically, project managers need to adhere to expectations and directives from their governance forums while simultaneously working with their counterpart and managing the personnel reporting to them. For people in project governance forums, the main interface is with their project

manager, although they occasionally need to communicate with the governance forum of the counterpart as well, for instance during project initiation and if issues are escalated.

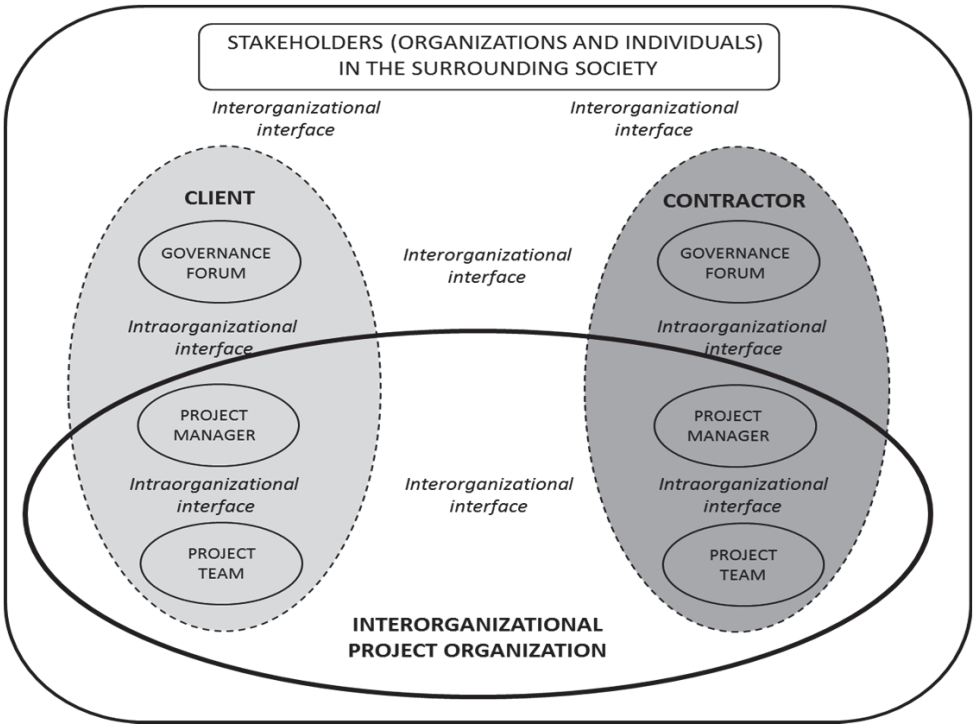

Figure 1. Interorganizational and intraorganizational interfaces existing in large construction projects

1.2. Problem discussion

As noted in the previous section, societal changes and technological developments have created pressure to change the organizing and the managing practices of large construction projects. However, there appears to be insufficient knowledge about whether this pressure has actually created change in organizing practices despite institutional barriers, and how the conditions for organizing and managing large construction projects have then changed as a result of these societal changes and technological developments.

Prior research on organization theory highlights that changes in organizing practices often entail various organizational tensions that management needs to address (Lewis, 2000), such as control and flexibility (Smith & Lewis, 2011). In

addition, contextual changes create tension between the need to explore new knowledge to meet future demands while simultaneously exploiting existing knowledge to perform today (March, 1991; O'Reilly & Tushman, 2013). Moreover, organizational tensions are often paradoxical in the sense that both elements in the tension make sense, but they appear to be impossible to combine. For instance, when implementing changes in organizing practices, the prior practices still make sense to some people, as the new practices do to others (Lewis, 2000), and similarly it makes sense both to strive for efficient performance today and to develop for future demands (Andriopoulos & Lewis, 2010).

Applying a paradox perspective when analyzing or managing tensions means that one does not choose either side when there is a tension, but instead promotes a both/and perspective (Beech et al., 2004; Smith et al., 2010; Lewis & Smith, 2014), recognizing that both elements coexist and persist over time (Smith & Lewis, 2011). This both/and approach stems from the insight that responses to paradoxical organizational tensions can lead to reinforcing cycles (Lewis, 2000; Smith & Lewis, 2011), that impact organizing activities as well as project outcomes. Moreover, recent studies highlight a need for more holistic views, recognizing that tensions may be multi-layered and nested across different organizational levels (Clegg et al., 2002; Andriopoulos & Lewis, 2010). Despite the growing interest in using paradox perspectives as a meta-theory combining other strands of literature (Lewis & Smith, 2014), studies of paradoxes in project contexts seem to be scarce, and even more so in the construction management literature (Chan et al., 2012).

Section 1.1 highlights some important circumstances: first, the number of large construction projects is growing, second, there is a pressure on project-based companies to change their organizing practices due to societal changes and technological developments, and third, in large construction projects, several inter- and intraorganizational interfaces coexist, as shown in Figure 1. Due to these circumstances, together with the notion that changes to organizing practices often spur organizational tensions, it seems relevant to improve our knowledge about those paradoxical organizational tensions related to control and flexibility emerging at different organizational interfaces when organizing large construction projects (see section 1.2.1). Moreover, section 1.1 highlights how ongoing societal changes and technological developments are forcing project-based companies to develop new concepts and ways of working in order to perform in the future, as there is simultaneous pressure on construction companies to address the highly desired increase in productivity. Therefore, it makes sense to investigate how to explore new ways of working and simultaneously exploit existing knowledge in large construction projects (see section 1.2.2), despite the strain between the two activities in terms of, e.g., resources and managerial focus.

1.2.1. Tensions emerging when organizing

Although the prevalent tendency in the project management field has been to focus on control (Atkinson et al., 2006; Perminova et al., 2008; Lenfle & Loch, 2010), there is research arguing that more flexibility is required when organizing and managing large construction projects (e.g., Ford et al., 2002; Olsson, 2006; Shahu et al., 2012). Moreover, recent research on large construction projects highlights that both practitioners and scholars should seek ways to combine control and flexibility instead of viewing them as competing approaches (e.g., Walker & Shen, 2002; van Marrewijk et al, 2008; Koppenjan et al., 2011), particularly emphasizing the influence of attitudes and leadership.

Gluch and Räisänen (2012) emphasize that in project contexts, tensions are often created due to contradictions between different organizational interfaces and that it is therefore important to apply a system view when studying project organizations. In interorganizational projects such as large construction projects, tensions related to control and flexibility can simultaneously emerge and evolve at the different organizational interfaces presented in Figure 1 in the previous section. For example, there may be interorganizational tensions related to uncertainty, risk allocation and trust between the client and contractor (Atkinson et al., 2006; Jensen et al., 2006). There might also be intraorganizational tensions related to delegation of authority and mandate within each party's organization derived from, e.g., contradictory company- and project-level objectives (Ahola et al., 2014; Too & Weaver, 2014), from contradictions in overarching governance structures or from top managers' attitudes (Müller et al., 2015). In addition, interorganizational tensions can emerge between the flexibility needed for the project organization to deliver the project and various requirements for control by external stakeholders, e.g., those highlighted in section 1.1.

The distinction between tensions at different organizational interfaces has seldom been specified in prior research on large construction projects, and the use of the associated terms control, flexibility, direction, and empowerment has often been inconsistent and overlapping. Therefore, from this point in this thesis, to enhance clarity and readability, the terms control and flexibility are consistently viewed as interorganizational tensions, whereas direction and empowerment are consistently viewed as intraorganizational tensions. Further explanations and arguments for this distinction are presented in section 2.2.3.

Considering that prior studies have most often not distinguished between inter- and intraorganizational tensions, it is not surprising that studies of dependencies between these different tensions in construction projects are scarce. However, Lazar (2000) argues that interorganizational trust is dependent on intraorganizational trust, and Tuuli et al. (2010) highlight dependency in the other direction, arguing that control at the interorganizational level can trigger

intraorganizational reactions. In addition, there are prior studies implicitly illuminating dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment in large construction projects, although often using a different vocabulary. For instance, the importance of employing interorganizational flexibility to manage changes stemming from intraorganizational decisions such as variation orders on the client side is implicitly highlighted in studies by Walker and Shen (2002), Olsson (2006), and Cui and Olsson (2009). Initiatives that implement intraorganizational empowerment are challenged by the temporal and fragmented nature of interorganizational project teams (Greasley et al., 2005). Moreover, van Marrewijk et al. (2008) argue that while intraorganizational direction is needed to manage issues related to budget, media exposure, and societal impact, a lack of intraorganizational project autonomy can block interorganizational cooperation between the involved parties. Likewise, Koppenjan et al. (2011) argue that opportunities to establish a combination of interorganizational control and flexibility are often constrained by, e.g., decisions made by politicians and governing forums.

Altogether, the abovementioned studies indicate that failing to recognize and address the dependencies between tensions at different organizational interfaces can lead to various impacts on project execution. For instance, the development of intraorganizational trust and empowerment can be aggravated, capacity to address scope changes can diminish, and interorganizational collaboration may be negatively affected. Nevertheless, there is a lack of explicit studies on the dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment in large construction projects. Moreover, the above-described studies include few details on time considerations, for instance how dependencies between interorganizational control and flexibility and intraorganizational direction and empowerment emerge and evolve over time.

1.2.2. Current knowledge and innovation for sustainable performance

For companies in different industries, it makes sense, on the one hand, to exploit existing knowledge and technologies to perform efficiently today but, on the other hand, to also simultaneously explore new knowledge and technologies to adapt to future demands and conditions (March, 1991; Benner & Tushman, 2003). However, although both strategies are important, they can seem hard to combine due to constraints in resources and managerial focus. Therefore, tensions between exploration and exploitation are paradoxical, something emphasized by Andriopoulos and Lewis (2010), who also stress that paradoxical management approaches are accordingly required that can address both elements in a thoughtful way. Similarly, Tse (2013) argues that simultaneous focus on both elements may enable virtuous cycles and strategic innovation.

The ability of an organization to combine exploration and exploitation is often called organizational ambidexterity (Duncan, 1976). Prior research on organizational ambidexterity has mainly studied high-tech manufacturing industries (Katila & Ahuja, 2002; He & Wong, 2004), rather than project-based contexts. In these latter contexts, it is especially difficult to achieve both exploration and exploitation due to decentralization, short-term project focus, and dependencies between activities (Eriksson, 2013). Accordingly, research investigating exploration and exploitation on the project-level is scarce (Tiwana, 2008). However, a recent example by van Fenema and Loebbecke (2014) emphasizes the importance of intraorganizational strategies to managing joint value creation in dyadic interorganizational relationships, and that the development of tensions related to exploration and exploitation can become cyclic. Similar conclusions regarding construction projects were emphasized by Harty (2008), who stressed that the complex interplay between intraorganizational strategies and interorganizational relations is seldom taken into account in prior studies on innovation and organizational ambidexterity. However, although there are recent studies of the project-based construction sector that highlight the need to improve innovation capabilities (Tawiah & Russell, 2008; Ozorhon, 2012), most initiatives on the topic have failed to take into account the characteristics of construction projects (Dubois & Gadde, 2002; Harty, 2008). Further, Harty (2008) observes that the dominant view is that innovation in construction projects is mainly a reactive process.

Thus, although there are prior studies that have highlighted either short-term efficiency or long-term innovation in construction projects, there appears to be a lack of research recognizing and investigating the tension between the two and how they can be combined. In other words, there appears to be insufficient knowledge concerning exploration and exploitation in construction projects in general and, in particular, regarding if and how organizational ambidexterity is dependent on intraorganizational strategies and decisions.

1.3. Aim and research questions

The background and subsequent problem discussion highlight a need for further research on organizational tensions in interorganizational projects, including large construction projects. More specifically, there is a need for an improved understanding of the interplay between interorganizational control/flexibility and intraorganizational direction/empowerment as well as of how exploration and exploitation in large construction projects are influenced by intraorganizational aspects.

Therefore, the aim of this thesis is to create an improved understanding of the dependencies between tensions at different organizational interfaces in large construction projects by applying a paradox perspective. To enable this work, an initial study of how the conditions for executing large construction projects have changed, despite institutional barriers, provides a better understanding of the origin and nature of many organizational tensions.

From the purpose and aim, the following four research questions are derived:

- **RQ1:** In what way have organizational tensions emerged from the new ways of organizing large construction projects developed to meet societal changes and technological developments?
- **RQ2:** How is the tension between exploration and exploitation in large construction projects influenced by intraorganizational strategies and decisions?
- **RQ3:** How do dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment influence the execution of large construction projects?
- **RQ4:** How can a paradox perspective and simultaneous analyses of tensions at the different organizational interfaces in large construction projects produce new insights?

The empirical studies forming the base for this thesis focus on large construction projects in Sweden; these are defined as interorganizational construction projects with an original contract sum of at least 50 million Euros and duration over several years. The empirical material is drawn from studies of three large transport infrastructure projects (roads, overpasses, bridges), three large building projects (office, hospital, and a public authority building), and one large project comprising both an industrial facility with complex foundation and an adjacent office building.

1.4. Structure of the thesis

This thesis consists of two main sections. The first section is the main part, offering integrated results and contributions derived from the five appended research papers that are presented in part II.

Part I consists of six chapters and is an attempt to integrate the key results and contributions of the research papers. Chapter 1 describes the background, a problem discussion, and the aim and research questions. Chapter 2 provides a literature review of the paradox perspective on organizational tensions and then looks at studies of control and flexibility, direction and empowerment, and finally exploration and exploitation. Chapter 3 describes the researcher's experience-based view of knowledge and critical thinking as well as theoretical reasoning on the same topic. A description of the method applied follows, including the selection of case study projects, collection of empirical material, and analysis. The chapter concludes with a discussion of reliability and validity. Chapter 4 contains summaries of the relevant key results and contributions in the five appended papers, and chapter 5 discusses how the five appended papers provide answers to the research questions in this thesis. Part I concludes with chapter 6: conclusions and implications for theory and management.

Part II contains the five appended papers, of which three papers have been published in three different scientific journals and two papers have been submitted to two different scientific journals.

2. LITERATURE REVIEW

This chapter describes the central strands of the literature applied and referred to in this thesis. The chapter begins with a review of the literature on applying a paradox perspective when analyzing organizational tensions, followed by reviews of the literature related to the specific organizational tensions discussed in this thesis: control and flexibility, direction and empowerment, and exploration and exploitation.

2.1. Paradox perspective on organizational tensions

In recent years, there has been growing interest in research on paradoxical organizational tensions and an idea is emerging on how to use the paradox perspective as a theoretical lens (Lewis & Smith, 2014). A paradox perspective has previously been used to elucidate many different phenomena, e.g., theoretical contradictions (Poole & van de Ven, 1989; Lewis, 2000; Lewis & Smith, 2014), organizational change (Beech et al., 2004), simultaneous exploration and exploitation (Andriopoulos & Lewis, 2010; Papachroni et al., 2015), and similarly, innovation under complex business models and strategies (Smith et al., 2010). According to Weick (1979), inherent ambiguity is a driving force in organizing activities because people need to make sense of their impressions. Westenholz (1993) argues that thinking in terms of paradoxes is a way for people to establish a new relationship with ambiguous situations. Similarly, Clegg et al. (2002) argue that managers are confronted with paradoxes every day. Moreover, according to Lewis (2000), a paradox emerges from elements that are logical when studied separately but seem irrational or even absurd when juxtaposed. Although the elements seem inconsistent and incompatible, they nevertheless coexist. Smith and Lewis (2011: p. 382) emphasize continuity and propose the following definition of a paradox: "*Contradictory yet interrelated elements that exist simultaneously and persist over time*".

When paradoxical tensions become known, they evoke responses (Lewis, 2000; Smith & Lewis, 2011); according to Poole and van de Ven (1989), there are four basic approaches to working with paradoxes: 1) Opposition: Accept paradoxical contradictions and learn to live with them, 2) Spatial separation: Assume and identify different locations/levels for each element in the underlying tension, 3) Temporal separation: Assume that each element in the underlying tension can be separated in time, and 4) Synthesis: Introduce new concepts that resolve the paradox.

Over time, paradox research has mainly focused on the first approach: allowing the paradox to be part of daily work and promoting managing practices that

support both elements of the underlying tensions, i.e., a both/and approach rather than an either/or approach (Lewis & Smith, 2014; Papachroni et al., 2015). Beech et al. (2004) argue that paradoxes can be seen as invitations to managerial actions that develop the organization and promote creativity. Accordingly, Smith et al. (2010) and Lewis and Smith (2014) highlight a need for research about the leadership characteristics required to integrate the opposing views in paradoxical tensions. Attempts to resolve a tension by placing one element on one level of the organization and the other element on another level will often fail because tensions may be multi-layered and nested across different organizational levels (Clegg et al., 2002; Andriopoulos & Lewis, 2010). Therefore, spatial separation is not easy to accomplish in practice.

In his seminal work on social psychology in organizing activities, among other phenomena, Weick (1979) elaborated on cause and effect in organizations and noted that due to interdependencies causal loops often occurred, being self-reinforcing and sometimes complex circles of events. Similarly, Eisenhardt (2000) discussed reinforcing spirals. Moreover, applying a paradox perspective to underlying tensions and responses that simultaneously promote both sides of tensions may create virtuous reinforcing cycles (Smith & Lewis, 2011; Tse, 2013) that enhance performance and sustainability. However, defensive responses insisting on consistency or strong focus on a particular element of the tension may generate vicious reinforcing cycles that block development (Sundaramurthy & Lewis, 2003; Smith & Lewis, 2011). Applying a paradox perspective requires as well as fosters a holistic understanding of tensions, avoiding suboptimal outcomes and vicious cycles (Lewis & Smith, 2014).

According to Lewis and Smith (2011), there are four main categories of organizational tensions: *'Learning'* (innovation and building upon and renewing existing knowledge), *'Organizing'* (tensions related to differences in organizing activities), *'Performing'* (plurality of stakeholders entailing contradictory goals and expectations), and *'Belonging'* (tensions between the individual and the collective and between competing values and group identities). However, tensions may also emerge between these categories.

As stated in the introduction, the extensive changes in society have pressured organizations to adapt their organizing practices, and project-based organizations including construction companies are no exception. Organizing activities and related management decisions regarding, for instance, strategy, organizational structure, and delegation of authority indirectly inhibit existing ways of working and exclude possible alternatives. Therefore, the tensions created by organizing activities are paradoxical, because both old and new practices as well as excluded alternatives continue to make sense to some people in the organization long after implementation (Lewis, 2000). As motivated and explained in the introduction, this thesis focuses on control and flexibility and direction and empowerment

(section 2.2), which belong to the category *'Organizing'*. Moreover, the introduction also highlights and explains why this thesis also focuses on tensions between exploring new knowledge to innovate for future demands and simultaneously exploiting existing knowledge to achieve efficiency today (section 2.3). Exploration and exploitation involve a tension that emerges between the categories *'Learning'* and *'Performance'* (Smith & Lewis, 2011). This ability to combine exploration and exploitation is important for companies and organizations, as it can allow them to achieve sustainable results; it is often referred to as organizational ambidexterity (Duncan, 1976).

2.2. Control and flexibility, direction and empowerment

In the management literature, the terms 'control', 'flexibility', 'direction' and 'empowerment' have been defined differently and combined in several ways. This subsection provides examples of the wide range of definitions and combinations in previous research on organizations in general and then applications in project management literature. This is followed by an explanation of how the four terms are defined and applied in this thesis.

2.2.1. Applications on organizations in general

Applying systems theory, De Leeuw and Volberda (1996) elaborated on control and flexibility within an organization and how this relates to its environment, highlighting the paradoxical nature of the tension between control and flexibility and that any manner of directed influence can be viewed as control. Similarly, Aaker and Mascarenhas (1984) and Englehardt and Simmons (2002) argue that increased organizational flexibility is required due to uncertainties in the environment and a constantly changing world, although control over execution is still required. Moreover, Englehardt and Simmons (2002) view control/flexibility as a question of e.g., hierarchy/decentralization or top-down/bottom-up. However, initially, the research related to control and flexibility focused on studying manufacturing industries using varied terminology. For example, flexibility in processes and systems in manufacturing industries was studied by Sethi and Sethi (1990), and Abernethy and Lillis (1995) argued that flexibility in functional organizations can be created by appointing task forces and cross-functional committees. Flexibility and efficiency in car manufacturing industries were studied by Adler et al. (1999), viewing control as formalization, standardization, hierarchy, and specialization. Further, they established that a firm may achieve flexibility by 'enabling bureaucracy', which demands routines and that suppliers are managed in a high-trust mode. Similarly, Ahrens and Chapman (2004) studied flexibility and efficiency in restaurant chains with particular focus on management control systems, and they also emphasized trust as an enabler for organizations to deal with changes occurring. Furthermore, Sundaramurthy and

Lewis (2003) studied tensions between control and collaboration in the empirical context of corporate governance, arguing that monitoring as well as empowerment and trust are essential for corporate boards.

Other scholars have studied empowerment in different contexts and constellations. Quinn and Spreitzer (1997) distinguish between "mechanistic empowerment" and "organic empowerment", where the former is a directive top-down approach with defined tasks and roles, and the latter is more loose and bottom-up relying on team building, trust and cooperation. Moreover, they argue that empowerment depends on how the individual perceives the empowering initiatives, which is also emphasized by Tuuli and Rowlinson (2010). Similarly, Wilkinson (1998) provides support to the idea of 'organic empowerment', defining empowerment as the ambition to engage in upward problem solving by listening to the individuals in the organization to identify relevant problems as well as their solutions. Moreover, he emphasizes task autonomy and the elimination of inspectors as a mean to create a sense of empowerment among staff, an approach that requires trust. In contrast, several other scholars emphasize that empowerment is mainly given top-down by management. For instance, Lorinkova et al. (2013) distinguish empowering leadership (sharing power, increased autonomy, open communication, collaborative decision making, and teamwork) from directive leadership (positional power, structure, clear directions, instructions, clear roles, monitoring and feedback), and Denison et al. (1995) define four leadership roles that entail flexibility and four others that entail stability. Similarly, Mills and Ungson (2003) define formal empowerment as losing control, decentralization, and participation, but note that creating mutual trust can also be viewed as a way of controlling empowered people or organizations. However, they also emphasize that it often takes a long time to create basic emotional trust between people, beyond trust in routines or competence.

2.2.2. Applications in project contexts

Applying control in terms of planning, coordinating, monitoring and defining project stages and milestones has been the prevalent approach taken within the project management field (e.g., Atkinson et al., 2006, and Lenfle & Loch, 2010). However, Lenfle and Loch (2010) remind us that some 50 years ago, project management involved much more flexible trial-and-error and parallel work with alternative solutions. Accordingly, in recent years, an interest seems to have grown in exercising more flexibility in project management practices, e.g., in terms of late and step-by-step locking of concepts, specifications, and organizations (Olsson, 2006), working with pre-specified 'real options' (Ford et al., 2002), and similarly, preparing for swift change of alternatives under consideration of the costs of creating flexibility (Shahu et al., 2012). It is argued that increased flexibility can, for instance, increase creativity and innovation

(Keegan & Turner, 2002) and be effective in dealing with slow decision making or client-initiated variation (Assaf & Al-Hejji, 2006; Olsson, 2006; Sweis et al., 2008).

In the project management literature, it has been increasingly argued that both scholars and practitioners would benefit from combining control and flexibility instead of viewing them as competing approaches. For instance, Walker and Shen (2002) argue that project managers in large construction projects need the ability and desire to incorporate flexibility into their daily management of the project as well as planning and control skills. Similarly, Koppenjan et al. (2011) stress that in large engineering projects, it is necessary to practice both control and flexibility in management practices, recognizing that although there is a tension between the two, a failure to combine them may endanger project success. In addition, van Marrewijk et al. (2008) highlight that both control and flexibility are needed in large infrastructure projects to enable interorganizational cooperation. Similarly, Osipova and Eriksson (2013) stress that both control and flexibility are required for effective joint project risk management, and Olsson (2006) states that both control and flexibility are important in large investment projects.

Large construction projects are interorganizational and characterized by the simultaneous existence of several organizational interfaces. The interface between the client and the contractor is regulated through a contract, but there are also formal and informal intraorganizational interfaces within each party. A large body of prior research in the project management field has focused on intraorganizational tensions between project owners and project managers and their project teams. Some researchers use the terms 'control' and 'flexibility' when discussing these intraorganizational tensions (e.g., Lenfle & Loch, 2010; Zwikael & Smyrk, 2015), whereas others are prone to discuss project governance (e.g., Too & Weaver, 2014; Müller et al, 2015) or empowerment (e.g., Greasley et al., 2005; Tuuli & Rowlinson, 2010; Daniel, 2010). In addition, Turner and Müller (2003) argue that there is a need for control both between project owners and project managers and between project managers and project teams, thus highlighting the two intraorganizational interfaces that project managers need to focus on. Other existing research focuses on the interorganizational interface, discussing control and flexibility in terms of e.g., contracts types, control/collaboration, monitoring/self-control, and formal/informal control modes, between clients and contractors in interorganizational projects (e.g., Eriksson, 2006; Bresnen, 2007; Osipova & Eriksson, 2013; Liu et al., 2014). Furthermore, several studies elaborate on trust related to flexibility and to empowerment, e.g., Atkinson et al. (2006), Bresnen (2007), and Zwikael and Smyrk (2015). Tuuli et al. (2015) add that in project settings, the implementation of empowerment depends on individual and cultural factors. However, prior studies recognizing and explicitly addressing the coexistence of tensions related to control and flexibility at different organizational interfaces in interorganizational

projects appear to be scarce. Nevertheless, some examples of such studies are presented below.

Based on a review of both project governance literature and general governance literature, Ahola et al. (2014) emphasize that for projects involving several organizations, project governance can either be viewed as internal to any project or external to any project. The view prevalent among project managers can thus impact on how to interpret, prioritize and manage intraorganizational strategies and decisions. Similarly, Jensen et al. (2006) highlight that among projects involving several organizations parallel attempts are often made by different governance forums to control the goals of the interorganizational project teams. These authors also highlight the influence of trust and call for research on the interplay between vertical and horizontal relationships. Similarly, Maurer (2010) argues that in interorganizational projects, trust and collaboration between parties depends on intraorganizational approaches to project staffing over time. In their study of two large construction projects, Tuuli et al. (2010) note that interorganizational control can trigger intraorganizational reactions. Moreover, dependency between interorganizational and intraorganizational trust is highlighted by Lazar (2000), who notes that trust develops over time, although pre-existing trust can be beneficial. Nevertheless, there appears to be insufficient knowledge on how the dependencies between tensions related to control, flexibility, direction and empowerment at different organizational interfaces emerge and evolve over time in interorganizational projects in general and in large construction projects in particular.

2.2.3. Operationalization used in this thesis

In this thesis, 'control and flexibility' are used either to describe interorganizational tensions between the client and the contractor or between the project as an entity and society, whereas 'direction and empowerment' are consistently used to describe intraorganizational tensions within either party. See Figure 1 in section 1.1 for an overview of the organizational interfaces.

Stakeholders in society exercise different types and levels of control and flexibility over project organizations, e.g., authorities and the public (see section 1.1). In this thesis, this is interpreted as any influence from society on what, when, or how to build. For instance in terms of permit processes, appeals, restrictions of working hours or production methods, administrative requirements, management of public citizens living close by or passing through the area, etc.

Interorganizational control and flexibility between the client and the contractor occur at many different hierarchical levels, although the main interface during project execution is between the two project managers. Intraorganizational direction and empowerment unfold mainly at two different organizational

interfaces within each party: between project managers and their governance forum and between project managers and their respective project team. Informed by the literature mentioned in sections 1.2.1, 2.2.1 and 2.2.2, the key concepts describing each element of interorganizational control/flexibility and intraorganizational direction/empowerment are summarized in Table 1. Considering the inconsistent use of the four terms in prior literature, including the notion that many aspects of 'mechanistic empowerment' are rather directive, and that some key concepts are highlighted by several authors whereas other key concepts are overlapping or even used somewhat contradictory; Table 1 represents the author's interpretation of the key concepts of each tension in the empirical context of large construction projects, informed by prior research on the overarching topic. Thus, Table 1 is an attempt to openly describe and communicate the approach and operationalization used as guidance in this thesis when analyzing the empirical material, thus leaving room for discussion and alternative interpretation.

Table 1. Key concepts describing interorganizational control/flexibility and intraorganizational direction/empowerment

Area	Interorganizational		Intraorganizational	
	Control	**Flexibility**	**Direction**	**Empowerment**
Goal setting & Economy	Specific solutions and objectives, lump sum contracts	Functional requirements, cost plus contracts	Clear objectives, centralized budget responsibility	Vision, values, delegated budget responsibility
Decision making	Single point of contact between parties. Clarity on who makes decisions and how	Participation, collaboration, consensus, compromises, alternative decision routes	Hierarchical, centralized, clarity about who makes decisions and how, functional focus	Network, decentralized, participation, consensus, compromises, alternative decision routes, cross-functional
Roles, Tasks, Resources	Required key personnel selected, resources for several functions specified	Minor requirements/actions by client, focusing on the fulfilment of functional requirements	Clear work tasks & clear and distinct roles, individualistic, specialization, management controlled resource allocation	Large assignments, focus on output, role ambiguities, teams, cooperation, generalists, delegated resource allocation
Planning, Performance	Detailed schedule with milestones, performance measurements, minimize change orders, benchmarking	Overarching schedule and focus on final objectives, trust in performance, self-control, change orders accepted	Detailed plans, performance measures, controls, continuity	Overarching milestones and tollgates rather than detailed plans, trust in others
Change & Ideas	Design and methods specified, change process controlled	Ideas and creativity are encouraged by the client as long as the desired function is achieved	Controlled by management	Ideas, change and creativity are encouraged
Communication	Limited information sharing; only information that is essential or contracted	Open flow of wide and rich information	Specific and limited information required to address assigned tasks and mainly top-down negative feedback	Broad two-way information sharing, open dialogue about everything individuals believe is important, positive feedback
Quality assurance & Administration	Instructions, inspectors, monitoring, standardization, excessive specified administrative routines	Functional requirements, trust in the other party, autonomy, self-control, few and vague administrative routines	Instructions, inspectors, monitoring, standardization, excessive specified administrative routines	Training/competence, trust in others, autonomy, self-control, few and vague administrative routines

2.3. Exploration and exploitation

Subsection 2.3.1 discusses how to combine exploration and exploitation, and subsection 2.3.2 discusses how this can be achieved in project-based companies in general and in construction projects in particular.

2.3.1. Ambidexterity - performance today and tomorrow

Exploration can be described by diversity, adaptability, experimentation, risk taking, innovation and a long-term perspective, whereas in contrast, exploitation can be described by alignment, constraints, refinement, efficiency and a short-term orientation (March, 1991; Gibson & Birkinshaw, 2004; Andriopoulos & Lewis, 2010). Organizational ambidexterity is often described as the ability for an organization to simultaneously address both exploration and exploitation (Duncan, 1976). In other terms, ambidexterity in this context involves exploiting existing knowledge and technologies for short-term profits and simultaneously exploring new knowledge and technologies for long-term innovation and development (O´Reilly & Tushman, 2008).

Organizational ambidexterity is primarily achieved or enabled in three different ways: 1) Structural ambidexterity includes measures that separate exploration and exploitation in different organizations or business units (Benner & Tushman, 2003; Tushman & O'Reilly, 1996). 2) Sequential ambidexterity means that focus shifts from exploration to exploitation and back (Adler et al. 1999; Gupta et al., 2006). A third approach is suggested in recent research: 3) Contextual ambidexterity, capabilities to simultaneously pursue both exploration and exploitation within the same organization or business unit (Gibson & Birkinshaw, 2004; Gupta et al., 2006). Thus, this third approach is in line with applying a paradox perspective, as it applies a both/and perspective (Lewis & Smith, 2011).

2.3.2. Applications in construction projects

Prior research has emphasized that focus on short-term efficiency by exploiting existing knowledge is common in construction projects (e.g., Chan & Kumaraswamy, 1997; Josephson & Hammarlund, 1999; Odeh & Battaineh, 2002; Assaf & Al-Hejji, 2006; Faridi & El-Sayegh, 2006; Sambasivan & Soon, 2007). Other studies highlight that there are barriers to explorative innovation in construction projects, e.g., goal misalignment, client pressures, inflexible product specifications, liability concerns (Rose & Manley, 2012), and time pressure (Gil et al., 2012). Although there are drivers for investments in innovation such as focus on sustainability, client championing, and incentive-based payment (Barlow, 2000; Tawiah & Russell, 2008; Ozorhon, 2012), as well as enabling initiatives such as increased collaboration and the early involvement of key actors (Caldwell et al., 2009; Bröchner, 2010; Ozorhon, 2012), it appears to be difficult to achieve

organizational ambidexterity in the project-based construction sector. One possible reason for stifled innovation is that exploratory development initiatives in project-based organizations are often managed with traditional focus on control-related measures (Keegan & Turner, 2002).

According to Eriksson (2013), neither structural nor sequential ambidexterity is suitable in construction projects because dependencies between different actors make it inefficient or even impossible to separate exploration and exploitation in time and space. The question is then whether it is possible to simultaneously use both exploration and exploitation within a construction project, thus achieving contextual ambidexterity by applying a paradox perspective.

3. RESEARCH METHODOLOGY

In this chapter, the methods used in those studies that serve as a basis for this thesis are discussed. The chapter starts with an elaboration of how the combination of my prior professional experiences from large construction projects and becoming increasingly informed by prior relevant research has influenced my research journey, followed by a description of my research project. The main body of the chapter comprises a description of the selection of case study projects, data collection, and analysis within the study of multiple cases conducted over a four-year period. The chapter ends with a discussion on reliability and validity.

3.1. My reflections on critical thinking, theory, and construction

3.1.1. Prior experience and critical thinking

Becoming a Ph.D. candidate when you have more than 15 years of professional experience relevant for the subject studied is a mixed blessing. On the one hand, I claim that my experience from different managerial roles in the construction sector and other sectors is a great asset in my research work, especially in qualitative studies because it has enabled deeper and more complex discussions with interviewees as well as more fine-grained observations. On the other hand, there is a risk of being biased in terms of making generalizations based on isolated events.

However, my whole life, I have always tried to take a critical standpoint to new information and claims, not accepting things without understanding why and getting a reasonable explanation. A few years after I finished high school, I met one of my teachers, and he told me that he remembered me well because during his classes he knew that I was always listening eagerly, carefully judging what he said and willing without exception to ask relevant questions if anything was unclear to me. This critical approach has followed me during my professional life, perhaps not always facilitating my career in the short term, but I believe that it has enabled a deeper understanding of organizations, management and behavior.

In prior literature on qualitative research methodologies in the social sciences, there are different suggestions for defining and categorizing different views on how to treat material drawn from interviews. For instance, Silverman (2006) refers to 'Positivism' (facts about behavior and attitudes), 'Emotionalism' (authentic experiences), and 'Constructivism' (mutually constructed in the interview situation). Although there are similarities, Alvesson (2011) develops these three concepts further into 'Interactive rationalism' (facts, recognizing that language issues and the researcher may impact these facts), 'Romanticism' (recognizing that social norms and situations impact the interviewee, and need to

be managed by achieving closeness with the interviewee), and 'Localism' (interview results are considered to be a representation of the specific interview situation and interaction between the interviewee and the interviewer, and nothing more). However, as emphasized by Alvesson (2011), in most research studies using interviews as the prevalent method, researchers attempt to adhere to aspects from at least the two latter schools of thought: 'Romanticism' and 'Localism'. In practice, this means that interviews can provide a valid source of knowledge if the researcher continuously reflects on his/her standpoint of how to interpret the information and accepts that there is always some degree of ambivalence.

I will not try to categorize my research journey using any of the abovementioned schools of thought, but I can say that I have throughout the research journey recognized that all interview statements are dependent on the context, the interview situation, the interviewee, and the researcher (me). As mentioned above, I believe that my prior professional experience has been an asset in that it has enabled the interviewees to feel trust and relevance in the interaction (indeed, several of them told me this explicitly). Moreover, instead of focusing only on formal procedures and structures, my existing understanding of construction management has facilitated the identification and discussion of informal and emergent organizing practices, an aspect that is receiving growing recognition among researchers (Chan & Räisänen, 2009).

In line with suggestions by Kvale (1997), Hartman (2007), and Alvesson (2011), I have continuously reflected on my impact on the answers and dialogue due to my preunderstanding of the subject. According to (Bergström, 1987), attempting to create self-awareness about the conditions for the research conducted and then communicate those analyses openly to the reader is important in social sciences. In those introspective and retrospective analyses, the recordings and transcripts of my own statements and practice have been important, interesting (and sometimes embarrassing) sources of information. Although continuous reflection on this topic has been one approach to mitigating influence and biased interpretations, there are unconscious influences that are impossible for the researcher (i.e., myself) to identify (Alvesson and Sköldberg, 2009). This type of reflection over the relation between the researcher and the research subject is sometimes called 'Reflexivity', although Alvesson (2011) argues that 'Reflexivity' is a broader term covering a conscious and consistent striving to view a topic from different angels and avoid the privilege of a certain perspective. To do this, he emphasizes attention to the interview context, the interviewee, and the stories produced. Thus, interpretations by the researcher may influence not only the interview dialogue but also the analyses and writing process (Hartman, 2004; Føllesdal et al., 2001).

In my research journey, my desire to think critically and not blindly jump into conclusions has influenced my plans and execution in several ways. First, I started my research journey with several doctoral courses in scientific philosophy and research methods at different universities. My goal was to achieve a better theoretical understanding of different important concepts and methods. Second, I have kept my mind open to different approaches and have strived for theoretical pluralism – realizing that every theory has its strengths and weaknesses. Third, throughout the research project, I have openly exposed my ideas and constructs to a very strong reference group, consisting of 3-4 experienced practitioners and 3-4 experienced scholars, to enhance my reflections via feedback. Fourth, combining part-time doctoral studies with part-time consulting assignments has enabled me to critically test and evaluate constructs derived from the empirical material by comparing them to similar situations in other large construction projects. Fifth, I have actively participated in several workshops for doctoral students at different universities to gain perspective on my research and my journey. Sixth, alternative perspectives and approaches to the academic writing process have been achieved by writing Paper II in collaboration with two experienced researchers at Lund University and by writing a technical report with three experienced researchers at Luleå University of Technology.

On the topic of the benefits and risks of having prior practical experience, Flyvbjerg (2006, p. 223) argues: "The highest levels in the learning process, that is, virtuosity and true expertise, are reached only via a person's own experiences as practitioner of the relevant skills. Therefore, beyond using the case method and other experiential methods for teaching, the best that teachers can do for students in professional programs is to help them achieve real practical experience". In light of that quote, I would like to think that my prior and continuously growing professional experience in managerial roles in a wide range of large construction projects counts as valuable "real practical experience".

To summarize, the six strategies for achieving a critical approach described earlier in this section do not guarantee unbiased research – far from it. In my view it is impossible to create totally unbiased research. However, I believe that I have done as much as possible to mitigate the risks and still utilize the advantages that my professional experience provides. And, by openly describe my background and approach, I have opened up for readers of my research to make own assessments of biases and respondent influence. During my academic journey I have occasionally met scholars who stress the risk of biases but do not seem to appreciate the opportunities that accompany prior professional experience. My impression is that some of those scholars mentally patent objectivity, thinking that only researchers can be objective and think critically. However, I believe that although an academic journey can provide tools and terminology for discussing objectivity, biases, and critical thinking, there are plenty of critically thinking practitioners, striving for objectivity, as well as there are biased scholars.

3.1.2. Holistic views and theoretical pluralism

Another reflection on my research journey concerns the academic publishing process. My current experience of academic writing is that to get published in academic journals, you often need to dig very deeply into a rather narrow area of knowledge, squeeze out some detailed and specific contributions, and then fit it all into the quite limited word count of scientific papers. I am not saying that this is wrong, considering the academic definitions of knowledge, but it has certainly been a challenge for me in my research journey; because in my consultant role, I am more used to contributing by understanding the big picture and how different phenomena interrelate from an overarching perspective. I feel that it is hard to isolate an issue in theory when I believe that there are dependencies or interdependencies with other issues in practice. Although challenging for a Ph.D. candidate, implying a risk of not keeping the research project simple enough (Silverman, 2006), this thesis as well as some of the appended papers attempt to adopt a systemic perspective on project organizations and project management.

In my search for a theoretical approach suitable for the systemic analyses of project organizations, I came across the literature on how to apply a paradox perspective to organizational tensions, which emphasized the importance of holistic views and systemic analyses. For instance, Poole and van de Ven (1989) highlight that due to complexity in organizations, there will always be theoretical inconsistencies when studying the entire organization rather than a part of it. Furthermore, Lewis and Smith (2014) explicitly argue that using a paradox lens will accentuate the need for a holistic understanding of organizational tensions, and Smith et al. (2010) stress that the complex business models of today require managers who can simultaneously address issues at different levels of the organization. All in all, applying a paradox perspective to large construction projects appeared to be a promising approach to create systemic views.

Moreover, applying a paradox perspective requires the researcher to study the dynamics in organizations rather than static snapshots of organizational structures. Indeed, important contributors to the paradox literature such as Marshall Scott Poole, Andrew H. van de Ven, Marianne W. Lewis, and Wendy K. Smith refer to the works of Karl E. Weick, who strongly emphasizes the importance of studying what is going on in organizations (Weick, 1979). My take is that applying a holistic view to project organizations should therefore include a holistic view of project duration as well, hence following project organization over time rather than taking a single snapshot. Accordingly, I have tried to focus on organizing and managing practices in large construction projects rather than on the organization and management as such.

In addition, recent research emphasizes that paradox perspectives can be used as a meta-theory to combine other theories (Smith & Lewis, 2014), although similar

thoughts were raised by Poole and van de Ven (1989). This is in line with conclusions drawn by Söderlund (2011), who argues for cross-fertilization and the unification of different theories and methodological approaches in order to achieve a more pluralistic understanding of contemporary projects. After exploring the project management literature from different schools of thought (Söderlund, 2011), as well as several approaches to analyzing organizations such as institutionalism (Di Maggio & Powell, 1983; Davis & Marquis, 2005) with a focus on coercive and normative isomorphism (Mizruchi & Fein, 1999; Greenwood et al., 2002), principal-agent theory (Eisenhardt, 1989b), sense-making (Weick et al., 2005), to me, the paradox perspective offered a structured framework for analyzing a systemic view of the project organizations while simultaneously being inspired by several different organizational theories. Using that approach, I felt that the complexity and interdependencies in project organizations that I had experienced myself could be analyzed, recognizing that there is seldom one single best approach to organizing and managing projects. Instead, a thoughtful combination of many, sometimes apparently contradictory, managerial actions could be what defines good project management and project governance.

3.1.3. Reflections on project management and the construction sector

During my professional career I have been working consistently in project-based industries. Certainly, assignments related to construction and infrastructure projects have been the most frequent over the years, but I have also had the pleasure of participating in and sometimes managing projects in other industries such as software development, telecom network rollout, the creation of research facilities, and mining. My experience is that the similarities between projects in different industries are far greater than the differences, if you chose to view it that way. Attitudes are crucial, and those who don´t think that they can learn anything from other industries or contexts won´t, which provides them with deceptive confirmation. But, if on the contrary you are open minded and filled with curiosity, in my experience there is most often knowledge to gain on some level of abstraction. Indeed, during the 1950s, project management emerged as a distinct profession (Lenfle & Loch, 2010), recognizing generic features such as a temporal organization with a defined scope, objectives, and resources. Accordingly, over the years, the literature on project management has grown, creating its own field of research (Söderlund, 2011).

During my many years in the construction sector, one phenomenon that strikes my mind is that many practitioners talk about construction projects and construction management as if nothing has changed during recent decades. They seem to assume and take for granted that yesterday's ways of organizing and managing as well as traditional project manager competencies and traits work best in modern society as well. Indeed, there are several governmental reports (SOU,

2002 and 2012), well known to most Swedish practitioners, arguing that development has been very slow and even non-existent in the construction sector, but at the same time media has strongly highlighted that the world in general is changing at an increasingly rapid pace. Although my impression as of today is that this belief in the status quo in the construction sector is weakening, my reflections on these apparently contradictory phenomena in combination with my own experience that large construction projects are highly dependent on contextual stakeholders led me to the overarching question that in 2010 led me to again enter the academic world:

> *Is it really the same undertaking to organize and manage a large construction project today as it was some decades ago?*

3.2. The research project

My research journey started with discussions with some scholars in my existing network about how to approach the overarching research question mentioned in 3.1 and on potential funding. An early and quite shallow literature review resulted in a conference paper on success factors in large construction projects, presented at the CIB World Congress in Manchester (Szentes, 2010). In the initial funding application in May 2010, the concept was to use quantitative methods to compare success factors related to the project management of large construction projects in existing literature with new empirical material gathered in a broad survey in an attempt to identify changes and relevant contextual factors. However, I never liked that approach. First, I felt that I would not be able to utilize my experience as well in a survey compared to a qualitative study and second because it seemed more purposeful to adopt an explorative and open-minded approach when attempting to identify and analyze supposed changes in ways of working. Shifting to a qualitative approach was also supported by the funding agency, the Development Fund of the Swedish Construction Industry (SBUF), who rejected the initial application but encouraged me and my supervisor to send in a new application on the same topic, but instead suggesting qualitative studies of approximately ten large construction projects. Four months later, in September 2010, a revised application was submitted.

In November 2010, the application was approved by SBUF, resulting in funding for a two and a half year part-time research project, using a qualitative approach to studying potential success factors in several large construction projects. The work defining interview questions and identifying and selecting appropriate cases started, and under consideration of resource constraints and after consultation with the reference group and SBUF, it was decided that seven large construction projects would be sufficient to fit the purpose.

Meanwhile my supervisor saw an opportunity to combine the SBUF study with a study funded by "Ragnar Söderbergs stiftelse" (RSS) focusing on the tension between exploration and exploitation in project-based organizations. Moreover, in 2011, the Swedish Ministry of Enterprise and Innovation (SMEI) initiated several studies and activities with the aim of investigating barriers and drivers to increased industrialization in transport infrastructure projects. This was deemed to be an opportunity to combine the study on exploration/exploitation in general and the specific case of industrialized construction. After submitting an application, we received funding to write a technical report (Eriksson et al., 2012 – listed under additional publications) on the topic based on our studies of the three transport infrastructure projects that at that point were included in the SBUF study. As a result of the additional funding and workload, the duration of the SBUF study was extended accordingly. Figure 2 provides an overview of the research project, including three rounds of collecting empirical materials with an evolving focus, different funding, subsets of case projects studied, and papers produced.

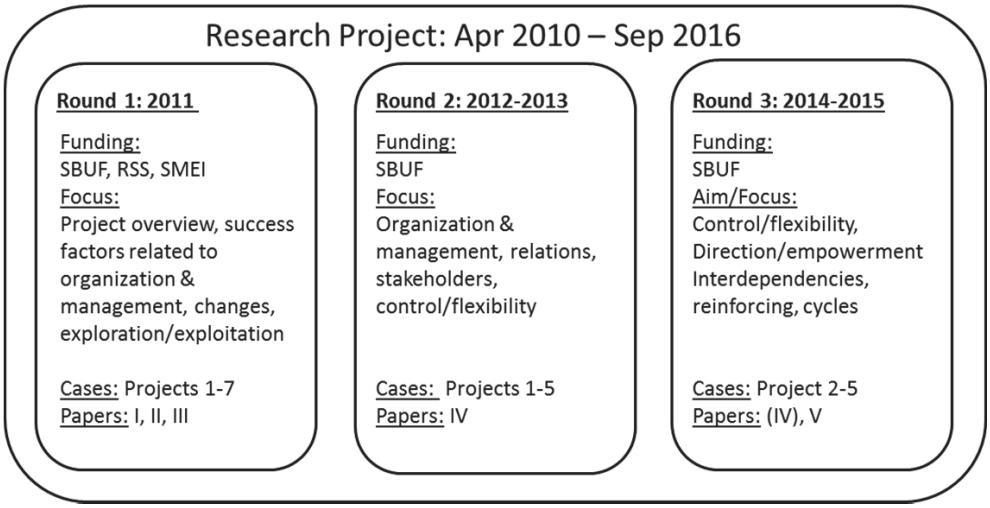

Figure 2. Overview of the research project

Thus, the first round of interviews, site visits and studies of project documentation had three purposes, as described in detail in section 3.3: First, to provide an overall understanding of each large construction project and the perceptions of each project manager as regards changes, governance and leadership, as a starting point for the SBUF study; Second, to gather empirical material regarding activities related to exploration and exploitation; Third, to gather empirical material regarding barriers to and drivers of industrialized construction in the three transport infrastructure projects. The main focus was on

the SBUF study, although the overall understanding of each construction project was also an important input to the studies on exploration/exploitation.

During 2011-2012, as a result of the qualitative content analyses of interview results as well as complementary literature studies, the focus in the SBUF study shifted from success factors to organizational tensions at different organizational interfaces, with more emphasis on managerial practices, attitudes and behaviors. By the end of 2013, a continuation project was taking form, and in June 2014, SBUF approved funding for an additional two and a half years part time. The purpose was to further study organizational tensions within some of the large construction projects used in Round 1 as well as between the projects and society using a paradox perspective. The process through which a subset of case study projects was chosen for Rounds 2 and 3 is described in 3.3.1.

3.3. Research design

The empirical materials used in this thesis as well as in the five appended papers are drawn from a qualitative study of seven large construction projects in Sweden and include interviews, site visits and reading of project documentation. An initial round collecting the empirical material and the subsequent analyses resulted in the specified research questions, as well as in Papers I, II, and III. A second round of interviews in five of the case study projects and then a third round of interviews in four of these created longitudinal empirical material deemed relevant for the studies of organizational tensions that led to the writing of Papers IV and V. The relation between the four research questions defined in section 1.3 and the five papers is presented in Table 2.

Table 2. Research questions and corresponding journal papers

Research questions	**Appended papers**				
	I	II	III	IV	V
RQ1: In what way have organizational tensions emerged from the new ways of organizing large construction projects developed to meet societal changes and technological developments?	X	X	X	(X)	
RQ2: How is the tension between exploration and exploitation in large construction projects influenced by intraorganizational strategies and decisions?		X	X		
RQ3: How do dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment influence the execution of large construction projects?				X	X
RQ4: How can a paradox perspective and simultaneous analyses of tensions at the different organizational interfaces in large construction projects produce new insights?			X	X	X

The initial idea in the SBUF project was to identify project success factors by interviewing project managers during execution, not knowing the project outcome, and then to compare these with interviews conducted after completion. Repeated interviews with the same interviewees enable better contact with each interviewee and analyses of consistency over time (Alvesson, 2011). However, this longitudinal approach is indeed also suitable for studies of paradoxical tensions (Lewis & Smith, 2014). Qualitative research using multiple cases and data collection over several time points are especially suitable for investigating the emergence, development and characteristics of organizational tensions because it allows the researcher to identify cross-case patterns (Eisenhardt, 1989a; Brown & Eisenhardt, 1997) and to follow initial constructs over time (Sundaramurthy & Lewis, 2003; Beech et al., 2004). Moreover, a longitudinal approach with a focus on organizing activities rather than a snapshot of organizational structures is necessary to enable the identification and analyses of causal loops (Weick, 1979). In addition, Flyvbjerg (2006) argues that the context-dependent knowledge created by case studies is essential and that in the study of human affairs, only context-based knowledge exists.

3.3.1. Selection of case study projects

Part of the preparations for **Round 1** of collecting empirical material was to select the appropriate case projects. As described in section 3.2, in consultations with the reference group and SBUF, it was determined that seven case projects would be an appropriate number considering the aim and the available resources.

Construction projects can be categorized according to the type of object being constructed, e.g., housing, buildings, industrial facilities, roads, bridges, railroads, airports and ports. The latter five are sometimes referred to as transport infrastructure projects, whereas civil engineering is sometimes used to describe the latter six together with, e.g., drinking water and energy systems. However, it should be noted that building projects as well as housing projects include civil engineering activities in terms of, e.g., soil works, foundations, and ground piping. For large buildings, such civil engineering activities may be substantial and complex. Furthermore, construction projects can also be categorized according to size, duration, geography, complexity, etc.

The selection of case study projects was purposive (Hartman, 2004; Silverman, 2006; Baxter & Jack, 2008). The main purpose of the selection was fit with the SBUF study, which focused on large construction projects in Sweden; thus, in terms of size and duration the selection can be seen as a stratified sample (Flyvbjerg, 2006), enabling generalization for the selected subgroup of construction projects in Sweden. Accordingly, the seven case projects selected all had an initial contract sum above 50 million Euros, a multi-year production phase, and were situated in Sweden. Within that subgroup of large construction

projects, following the aim and purpose of the SBUF study, the desire was to study projects covering different contextual aspects: type of client, object to construct, contract type, and proximity to urban areas.

Projects 1, 2, and 3 were sub-projects in two different overarching infrastructure megaprojects; these latter are often defined as complex, multibillion dollar projects lasting for several years, most often publically funded and delivered by private enterprises, and involving a wide range of stakeholders (van Marrewijk et al., 2008; Flyvbjerg, 2014). The client for Projects 1-3 were the Swedish Transport Administration (STA); Project 1 was in a dense urban area, Project 2 was in a suburban area, and Project 3 was in rural and mainly virgin areas. Project 4 was construction of a new office building in a suburban area for a private real estate company. Project 5 was construction of a heavy industrial facility and a new office building in a suburban area for a publically owned company. Project 6 comprised refurbishment of an existing public hospital as well as construction of a new hospital building in suburban areas, and Project 7 was the construction of a new public authority building in a dense urban area, although for a private real estate company. See Table 3 on the next page for the case study project details.

Table 3. Summary of general characteristics of the seven studied projects

Project	Object type	Client	Contractor	Location	Contract Types *	Collaboration	Client Governance	Contractor Governance	No. of Interviews
1	Tunnel, road, and concrete	The Swedish Transport Administration (public)	Medium sized, focused on civil engineering	Dense urban	DBB (minor DB)	Collaborative approach	Megaproject manager	Project board	3 + 3
2	Road, bridge, overpasses	The Swedish Transport Administration (public)	Large, comprising both civil engineering and other areas	Suburban	DBB, DB on bridge and overpasses	Collaborative approach	Megaproject manager	Project board, contract manager	3 + 3 + 2
3	Road, overpasses	The Swedish Transport Administration (public)	Large, comprising both civil engineering and other areas	Rural	DBB, DB on overpasses	Collaborative approach	Megaproject manager	Project board, contract manager	2 + 2 + 2
4	Office building	Private real estate company	Large, comprising both civil engineering and other areas	Urban	DB	Partnering	Manager of real estate company	Project board, contract manager	3 + 3 + 2
5	Industrial facility, office building	Municipality owned company	Large, comprising both civil engineering and other areas	Suburban	DB and DBB	Partnering	Project board, project director	Project board, contract manager	5 + 3 + 2
6	Hospital, refurbishment and new building	Public authority	Two, medium sized, both focused on housing and buildings	Urban	DB	Partnering	Joint project board		5
7	New public building	Private real estate company	Large, comprising both civil engineering and other areas	Dense urban	DB	Nothing specific	Project Board with tenant	Line manager	2

* Design-Bid-Build (DBB), and Design-Build (DB)

Large construction projects with a long duration were also deemed relevant for the study of exploration and exploitation in construction projects. Similarly, Projects 1, 2, and 3 were deemed suitable for studies of barriers and drivers to industrialized construction in infrastructure projects. The logic behind these decisions is that projects of long duration can be seen as a selection of extreme cases (Flyvbjerg, 2006), noting that time pressure and short-term project focus may hinder explorative activities (Gil et al., 2012, Eriksson, 2013). Moreover, it was noted during selection that several of the case study projects involved initiatives regarding collaboration. Although not knowing the exact scope and level of collaboration, it was recognized that prior research had highlighted collaboration and the early involvement of key actors as enablers for innovative initiatives in construction projects (Caldwell et al., 2009; Bröchner, 2010; Ozorhon, 2012). Thus, it can be assumed that achieving exploration and exploitation as well as industrialized construction would likely be even more difficult in shorter projects and in projects without collaborative approaches than they were expected to be in the selected case projects.

Papers I and III were based on Round 1 of interviews for all seven case study projects, whereas Paper II focusing on infrastructure projects accordingly used the empirical information from Round 1 of interviews for Projects 1, 2, and 3.

As described in sections 3.2 and soon in detail in this section, 3.3.1, analyses of Round 1 and the writing of Papers I, II, and III entailed the focus of interview **Rounds 2 & 3** shifting to organizational tensions at different organizational interfaces in large construction projects. More specifically, the focus was on organizational tensions related to control/flexibility between the client and the main contractor as well as between the project and society and on direction/empowerment within each party. This choice of research focus made it necessary to review the selection of case projects again, using the information gathered during Round 1. Table 4 presents the rounds of interviews and case projects used for each Paper I to V, and in the subsequent paragraphs, the logic behind the selection for Rounds 2 & 3 is described.

Table 4. Overview of projects and interview rounds used as empirical data for each paper

	Project 1			Project 2			Project 3			Project 4			Project 5			Project 6			Project 7		
Round	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1			1		
Paper I	●			●			●			●			●			●			●		
Paper II	●			●			●														
Paper III	●			●			●			●			●			●			●		
Paper IV	●	●		●	●	●	●	●	●												
Paper V				●	●	●	●	●	●	●	●	●	●	●	●						

Most projects comprised both design-bid-build (DBB) and design-build (DB) contracts simultaneously with the same main contractor; thus, several contractual setups were managed within one interorganizational project. Moreover, Projects 1, 2, and 3 had some degree of collaboration stated in the contracts, although not a particularly strong ambition; Projects 4, 5, and 6 stipulated partnering; whereas Project 7 had no explicit collaborative approach at all. Prior research has highlighted that the increased use of partnering and collaborative approaches represents attempts to enhance relations in construction projects (Alderman & Ivory, 2007; Hartmann & Bresnen, 2010) and to enhance trust and cooperation, mainly between the client and contractors (Kadefors, 2004). Moreover, prior research emphasizes that to fully exploit the possibilities from partnering, company strategies and company management must support the idea and be willing to hand over real power to the project team (Bresnen, 2007; Mollaoglu et al., 2015). Therefore, case projects with some sort of collaborative approach are suitable for simultaneous studies of both interorganizational and intraorganizational tensions.

Reviewing the results from Round 1, it turned out that Project 6 was very complex, with two different contractors working in parallel and two client project managers working together, and the project comprised a mix of refurbishment and new buildings. Although Project 6 can be seen as a deviant case (Flyvbjerg, 2006; Silverman, 2006), it was deemed too complex in terms of the number of organizational interfaces and therefore not suitable for the intended simultaneous study of interorganizational control and flexibility between client and contractor and intraorganizational direction and empowerment within the parties. In addition, it was very hard to get hold of the interviewees, partly because the project was in a relatively distant location. Furthermore, Project 7 turned out to be more or less a construction management project, in which the client procured several contractors separately, thus creating complexity in terms of several interorganizational interfaces. In addition, no collaborative approach was used. For these two reasons, Project 7 was deemed not suitable for the intended studies of organizational tensions between the client and the main contractor and within each party. Therefore, after reviewing Round 1, Projects 1, 2, 3, 4, and 5 were selected for further study.

In Paper IV, the aim was to look into the tensions between control and flexibility experienced by project managers. Considering the findings in Paper I that extensive changes in society have indirectly created organizational tensions, together with highlights in Paper II about the importance of infrastructure projects for society and the barriers to change in infrastructure projects, it made sense to use Projects 1, 2, and 3 for the study of tensions between control and flexibility exerted and provided by societal stakeholders. In addition, Projects 1, 2, and 3 were all sub-projects of two different megaprojects, making it even more likely that societal stakeholders would have an impact. Moreover, the prior

analysis of Projects 1, 2, and 3 resulting in Paper II spurred constructs regarding organizational tensions between control and flexibility due to megaproject governance and STA.

In Paper V, a mix of infrastructure and building projects was used. Paper IV highlighted interorganizational tensions between the client and the contractor as well as intraorganizational tensions within each party in large infrastructure projects, and it made sense to broaden the stratified selection (Flyvbjerg, 2006) to also cover building projects. At this point, having conducted site visits, documentation studies and two rounds of interviews, I was well acquainted with all case study projects, and a combination of two infrastructure projects and two building projects that I knew comprised promising constructs were chosen: Projects 2, 3, 4, and 5. Project 1 was excluded in Round 3 mainly because the client project manager as well as the contractor project managers were shifted late in the project, making longitudinal studies of interorganizational relations difficult, and because there were already two other infrastructure projects in the sample.

3.3.2. Collection of empirical material

Three rounds of interviews were conducted: the first interview was conducted in the middle of project execution when the outcome was unknown; the second was conducted when the projects were nearly completed; and the third round of interviews occurred 1-2 years after completion. The interviews during Round 1 (and in some cases during Round 2 as well) were combined with site visits to better understand the scope of work and to enable informal chats with various personnel. In addition, basic project documentation was collected and studied. The combination of these different methods for collecting empirical material provided opportunities for triangulation (Eisenhardt, 1989a; Silverman, 2006).

Considering the nature of the research questions and to facilitate open and honest communication during interviews by mitigating the risk of adjusting statements due to loyalty or fear for retaliation (Alvesson, 2010), it was decided at an early stage to anonymize all empirical data as well as any quotes and to openly declare this position to each interviewee. For that reason, the seven studied projects are not named or specified in the previously published papers or in this thesis. Instead, only the relevant characteristics of each project are described to enable readers to appreciate the context. Yet, to enhance understanding of the analysis and results, quotes have consistently been labelled in the different papers by identifying the project (1-7) and role of the speaker (client project manager, contractor project manager, or design manager).

In total, 45 interviews (nearly 55 hours) were conducted with client project managers and contractor project managers and, in Rounds 1 and 2, with the

design managers as well. In Project 5, two project managers representing process contractors (mechanical engineering) were also interviewed during Round 1 to better understand the scope and complexity of the industrial facility being built. In Projects 3 and 4, the client project manager changed during the production phase, and in Project 5, the contractor project manager changed during production. Due to this personnel turnover and the fact that some projects had parallel project managers, 25 different people were interviewed. See Table 5 for more information about the interviewees.

All interviews were digitally recorded to enable later complementary listening for details. In Round 1, detailed field notes with time notations were taken, but the recordings were not fully transcribed after the pros and cons of transcription were considered (Kvale, 1997; Alvesson, 2011). Due to the volume of rich unstructured empirical material obtained in Rounds 2 and 3, those recordings were fully transcribed.

Table 5. Information about the interviewees

#	Project	Role	Gender, Age	Education	Years in sector	Consultant or employee	Length [min]	Rounds
1	1	Client	Female, 33	M.Sc. Civil Eng.	8	Employee	170	2
2	1	Contractor	Male, 54	M.Sc. Eng., Eco.	24	Employee	220	2
3	1	Designer	Male, 41	M.Sc. Civil Eng.	17	Consultant	153	2
4	2	Client	Male, 38	B.Sc. Constr.	18	Consultant	205	3
5	2	Contractor	Male, 39	B.Sc. Constr.	17	Employee	220	3
6	2	Designer	Male, 39	M.Sc. Civil Eng.	15	Employee	155	2
7	3	Client	Male, 29	M.Sc. Civil Eng.	6	Employee	165	3
8	3	Contractor	Male, 37	M.Sc. Civil Eng.	13	Employee	230	3
9	4	Client (initial)	Male, 35	M.Sc. Ind. Eco.	8	Consultant	154	2
10	4	Client (succ.)	Female, 42	High sch.	15	Consultant	60	1
11	4	Contractor	Male, 55	M.Sc. Civil Eng.	30	Employee	145	3
12	4	Designer	Male, 45	High sch., Eng.	25	Consultant	128	2
13	5	Client (parallel)	Female, 30	M.Sc. Mech.	3	Employee	136	2
14	5	Client (parallel)	Male, 48	M.Sc. Civil Eng.	24	Consultant	222	3
15	5	Contractor (initial)	Male, 44	M.Sc. Civil Eng.	17	Employee	80	1
16	5	Contractor (succ.)	Male, 52	High sch., Eng.	32	Employee	120	2
17	5	Process contractor	Male, 48	B.Sc.	N/A	Employee	102	1
18	5	Process contractor	Female, 29	M.Sc. Energy	N/A	Employee	75	1
19	6	Client (parallel)	Male, 66	High Sch., Eng.	45	Employee	88	1
20	6	Client (parallel)	Male, 41	B.Sc. Constr.	19	Employee	80	1
21	6	Contractor A	Male, 55	High sch., Eng.	34	Employee	67	1
22	6	Contractor B	Male, 34	Craftsman	15	Employee	73	1
23	6	Designer	Male, 60	M.Sc. Civil Eng.	36	Consultant	73	1
24	7	Client	Male, 44	M.Sc. Civil Eng.	18	Employee	85	1
25	7	Contractor	Male, 35	M.Sc. Civil Eng.	10	Employee	82	1

In **Round 1**, the interviews were semi-structured with open-ended questions. The aim was to understand each project in terms of scope, contracts, organization, governance structure, performance and collaboration, as well as to obtain a view of each interviewee's background and thoughts about project management. Moreover, the interviewees were asked to elaborate on changes within the sector affecting their project manager role, as well as on changes in society that they perceived having influenced how large construction projects are organized and managed. In addition, following the aims of the parallel studies on exploration/exploitation and industrialized construction, the interviewees were also asked to elaborate on innovation and the refinement of solutions and methods in their projects, including examples of industrialization.

In **Round 2**, a far less structured approach was used in an attempt to minimize the researcher's influence on the direction of the stories provided by the interviewee, although recognizing that empirical material is created through interaction between the researcher and the interviewee (Silverman, 2006). The interviewees were first asked to describe the project results as they perceived them and then to elaborate freely on possible reasons and explanations for the outcome (good or bad). In addition, follow-up questions from the analysis of Round 1 were asked, for instance, regarding how they perceived the relationship with the other party and their own management, and about the influence of external stakeholders and other contextual factors.

In **Round 3**, the client project managers and the contractor project managers were asked to describe and elaborate on how they perceived 1) the control and flexibility exerted by the client over the contractor, 2) the direction and empowerment exerted by their own project governance forum and management, 3) the direction and empowerment that they applied to their own project team, and 4) control over the client exerted by the contractor. The focus was on identifying events that entailed changes in control and flexibility or direction and empowerment. Each interviewee was also asked to describe how he or she perceived his or her counterpart's governance situation and leadership style and to elaborate on the project performance in retrospect. Moreover, follow-up questions from the analyses of Rounds 1 and 2 regarding organizational tensions, leadership and governance were also asked.

3.3.3. Analyses of empirical material

To ensure that the collected empirical material over time was stored and analyzed systematically (Baxter & Jack, 2008), all field notes and transcriptions were continuously entered into the software NVivo 9.0. In that database, different tentative patterns, themes and structures could be easily tried out during the entire research project without losing the necessary and desired richness of

empirical material, allowing readers of the papers to assess their validity (Flyvbjerg, 2006; Baxter & Jack, 2008).

After the interviews in **Round 1**, the analysis started with a qualitative content analysis, comprising within-case analysis followed by cross-case analysis. The aim was to identify themes that were either frequent in the data set, following suggestions by Eisenhardt (1989a), or that were deemed interesting and relevant, following Dyer and Wilkins (1991). This resulted in several tentative themes related to leadership styles, governance, collaboration, and contextual influence on project management. Furthermore, the empirical data on changes in society and changes within the construction sector were analyzed and structured in several categories, providing insights into tensions due to contradictory demands and change processes. The additional processing of field notes and interview recordings resulted in Paper I.

Moreover, the empirical material regarding innovation and the refinement of solutions and methods was analyzed using theories on organizational ambidexterity (Duncan, 1976) and the paradoxical tensions between exploration and exploitation (e.g., March, 1991; Gibson & Birkinshaw, 2004). These analyses resulted in a conference paper presented in Trondheim (Eriksson & Szentes, 2013). In addition, combining the analyses of Projects 1, 2, and 3 with findings from a single case study made by Stefan Olander and Kristian Widén at Lund University resulted in Paper II.

At a later stage, continued analyses of the empirical material on tensions between exploration and exploitation from Round 1 employing a meta-theoretical paradox perspective (Lewis & Smith, 2014) resulted in Paper III, thus further developing the research previously presented in the conference paper in Trondheim (Eriksson & Szentes, 2013).

Inspired by the writing of Paper II and the abovementioned conference paper on tensions between exploration and exploitation, the initial analysis of **Round 2** further showed that many other aspects highlighted during Rounds 1 and 2 could be interpreted as tensions between two opposing views or approaches. Before continuing with detailed analyses, the researcher conducted an extensive review of the literature related to organizational tensions, particularly that regarding control versus flexibility. In parallel, the literature on how to apply a paradox perspective (Lewis & Smith, 2014) on organizational tensions was explored.

Continuing the analyses, it was recognized that tensions between control and flexibility emerged and developed at several organizational interfaces, both between the project and the surrounding society, as well as within the project organization. Adding empirical data from Round 3 on tensions from authorities and the public and further analyzing Round 2 resulted in Paper IV.

Continued literature reviews on paradoxical tensions highlighted that tensions may be nested across different organizational levels (Clegg et al., 2002; Andriopoulos & Lewis, 2010) and also that paradoxical tensions may turn into reinforcing cycles (Smith & Lewis, 2011). Moreover, it was noted that Tuuli et al. (2010) briefly argue that control at the interorganizational level may trigger intraorganizational reactions, although they do not offer details about how and why. Altogether, this entailed further studies of the literature on organizational tensions in projects, and **Round 3** of interviews focused on investigating interorganizational control and flexibility and intraorganizational direction and empowerment, as described in the previous subsection. Within-case analyses of Round 3 and a return to the empirical materials from Rounds 1 and 2 as well as reflections on the site visits generated explicit descriptions of how direction and empowerment were enacted by governance forums and by the project managers and also views on how control and flexibility between parties developed over time. Analyses were concluded by searching for cross-case patterns (Eisenhardt, 1989a) in events, governance actions, and project managers' practices and actions, and identifying several reinforcing cycles involving control/flexibility and direction/empowerment. Further processing of the relevant empirical data from all three rounds of interviews resulted in Paper V.

3.4. Reliability, validity, and generalizability

Adding to the reasoning about critical thinking and reflexivity in subsection 3.1.1 and the method descriptions in subsection 3.3, this subsection elaborates specifically on reliability and validity, two key concepts used to evaluate the quality of case study research (Kvale, 1997; Silverman, 2006). In addition, generalizability within the empirical context of large construction projects is discussed, whereas applicability of the results to other types of interorganizational projects is elaborated on in section 6.3.

3.4.1. Reliability

Reliability in qualitative research is one of several aspects related to authenticity (Silverman, 2006). To achieve authenticity, I have consistently used open-ended questions and allowed the interviewee to elaborate freely on each topic, especially during Rounds 2 and 3 of the interviews. Moreover, I have personally conducted all but one of the interviews, reducing the risk of interpreting empirical material collected by other researchers based only on transcripts and recordings (Silverman, 2006), allowing me to afterwards reflect on implicit details and impressions from each interview. My supervisor participated in eight interviews, enabling joint reflections not only on statements and impressions but also on method.

Another aspect of reliability is replication: two or more researchers with the same purpose studying the same cases should come to similar results (Kvale, 1997; Silverman, 2006). To achieve replication, the research process should be made transparent through detailed descriptions of the research strategy, data collection methods, and analyses (Kvale, 1997; Silverman, 2006). In this thesis, such information is provided in subsections 3.1, 3.2 and 3.3. In addition, the theoretical stance for interpretations should be described (Silverman, 2006), which is done in chapter 2. Moreover, in this study I have used cross-case analyses, which according to Eisenhardt (1989a) will increase reliability.

Reliability has also generally been addressed by using detailed field notes with time notations and recordings in Round 1 of interviews, and recordings that were consistently fully transcribed in Rounds 2 and 3. To further enhance reliability, most interviews were transcribed by the same person (a consultant), who received continuous feedback regarding technical terms and expressions to achieve consistency over time. To further enhance reliability, all field notes and transcriptions were loaded into the software NVivo 9.0, a database facilitating structure, consistency, and traceability. Moreover, during the analyses, the recordings were repeatedly returned to in order to recall how the words in the transcriptions were actually expressed and pronounced.

3.4.2. Validity

Validity in case study research is dependent on the entire research process from the initial idea to the writing process (Kvale, 1997). In this thesis, subsection 3.2 describes the research project as a whole, and subsection 3.3 describes the research design. Both subsections contain information relevant to the question of validity. For instance, they describe keeping the richness in the empirical material by saving the interview recordings and project information in a structured way and using NVivo 9.0 to keep track of field notes and transcripts as well as of tentative constructs and analyses made to enable traceability (Flyvbjerg, 2006; Baxter & Jack, 2008).

The conducted research includes different variants of triangulation (Eisenhardt, 1989a). For instance, triangulation of the sources of empirical material (interviews, project documentation, and site visits), and triangulation of different stakeholder views on the same topic (client, contractor, and designer). In addition, researcher triangulation (Baxter & Jack, 2008) was partly achieved in that the supervisor participated in several interviews, and a reference group consisting of experienced scholars and practitioners was used for the discussion of constructs. Respondent validity (Silverman, 2006) was partly achieved by taking the longitudinal approach, allowing the researcher to bring back findings from prior interviews for further discussion.

3.4.3. Generalizability

Generalizability in case study research is often criticized by researchers prone to quantitative methods (Silverman, 2006), who argue that there are too few data to generalize at all. Indeed, the question of 'representativeness' as regards qualitative research needs to be addressed differently than it is in quantitative research, in which statistical sampling procedures provide generalizability (Silverman, 2006). As noted in subsection 3.3, the selection of case study projects in this thesis was purposive (Hartman, 2004; Silverman, 2006; Baxter & Jack, 2008). Deliberately choosing a stratified sample (Flyvbjerg, 2006) of case study projects based on size, duration, location (Sweden) enables generalization within that subgroup of construction projects in Sweden. However, within that subgroup (sample), there were differences in contextual aspects as regards the type of client, object to construct, contract type, and proximity to urban areas. The question is then whether the findings in this thesis can be applied to all projects in the sample?

Some differences in findings are highlighted in chapters 5 and 6; for instance, there is a difference between DBB and DB contracts as regards control/flexibility and exploration/exploitation. However, at the same time, it can be noted that a majority of the projects studied in this thesis comprised a mix of DBB contracts and DB contracts. Moreover, no specific differences between projects with a public client and those with a private client were found as regards the three types of tensions studied, although it must be noted that there is only one pure private client represented in the cases used for those analyses. Last, there are only minor differences noted based on the type of object constructed and based on proximity to urban areas.

4. CONTRIBUTIONS OF THE FIVE APPENDED PAPERS

After a short elaboration on shifts in terminology over time, this chapter presents an introduction, key results and contributions of each of the five papers, all collectively contributing to the discussion and conclusions of this thesis.

4.1. A comment on the shift in terminology over time

During the research journey, I have slightly shifted terminology as a result of an enhanced understanding of topics and terms and due to changes in the applied theories, refined analyses and new insights. For instance, in Paper I, the term 'organizational tension' is not specifically used, although some of the contradictions and inconsistencies highlighted can indeed be interpreted as tensions. Moreover, in Paper IV, the terms control and flexibility are used for both inter- and intraorganizational tensions, whereas Paper V as well as this thesis emphasize the distinction by viewing control/flexibility as an interorganizational tension and direction/empowerment as an intraorganizational tension. Moreover, in this thesis I use the term 'construction sector', but in some of the papers the term 'construction industry' is used instead; early papers talk about 'organization and management', whereas Paper V and this thesis emphasize 'organizing and managing practices'. The latter is due to an understanding that in order to discuss organizational tensions, it is necessary to study events and practices over time.

4.2. Paper I

Szentes, H. and Eriksson, P-E. (2013) "Societal changes and new conditions for the management of large construction projects" *Open Construction & Building Technology Journal*, 7, 182-92.

Introduction

The construction sector has often been described as mature, conservative, and resistant to adopting changes, including new management practices for large construction projects. However, studies in other industries have shown that societal changes have resulted in new ways of organizing and managing businesses. Therefore, it seems reasonable to believe that these changes should have occurred in the construction sector as well. Accordingly, this paper aimed to investigate how different societal changes and changes within the construction sector have imposed new conditions for organizing and managing large construction projects.

The empirical material was drawn from explorative interviews with 23 project managers representing clients, contractors and design managers working in seven different large construction projects in Sweden.

Key Results

Many interviewees were almost surprised when they were asked to elaborate on changes, initially arguing that changes were scarce. However, after a while, most interviewees were able to describe several.

Content analyses of the interviews highlighted seven categories of societal changes that have influenced large construction projects: Globalization, Urbanization, Demographic processes, Values and attitudes, Democratic processes, Technological developments, and Productivity and revenue. These societal changes have generated the following new conditions for organizing and managing large construction projects: 1) increased dependency on external project stakeholders, 2) larger and more complex project organization, 3) increased tempo during the construction phase, 4) requirements for more flexible working conditions, 5) increased openness, collaboration and communication, 6) increased variety of contractual setups, and 7) increased variety of methods and solutions used on construction sites.

Contributions

The paper contributed to the construction management literature by showing that there have been substantial changes within the construction sector, although many of them appear to be reactive in the sense that they originate from changed conditions rather than from proactive initiatives to develop the business case. Reactivity indicates conservative thinking and behavior within the construction sector, and many interview statements implicitly highlight that the reputation of the construction sector as being conservative has become institutionalized among practitioners. To facilitate change and development within the sector, this self-image needs to be de-institutionalized. Furthermore, people within the sector in general and managers, politicians and representatives for different professional organizations in particular need to realize their responsibility for conserving or developing the self-image of the construction sector.

Moreover, the paper contributed to the construction management literature by categorizing several societal changes and the corresponding new or revised conditions for organizing and managing large construction projects. These new conditions are important to take into account when determining organizational structure and when staffing, planning and executing large construction projects.

Furthermore, the categorization helped in identifying the organizational tensions derived from contradictory demands from different societal changes, or tensions created by changed conditions. The understanding of such tensions is important

in attempts to become more proactive in innovative processes or to better understand how the interplay of different societal changes has created increased complexity and demands for more flexibility. Therefore, Paper I contributed directly by identifying tentative topics for several papers and indirectly to the four research questions in this thesis.

4.3. Paper II

Eriksson, P-E., Olander, S., **Szentes, H.**, and Widén, K. (2014) "Managing short-term efficiency and long-term development through industrialized construction" *Construction Management and Economics*, 32(1-2), 97-108., 10.1080/01446193.2013.814920

Introduction

The infrastructure sector is of great importance to any society due to its monetary value and impact on sustainability. Most infrastructure projects are funded by tax money, another factor that highlights public demand for a productive and innovative infrastructure sector. One commonly suggested way to improve performance in construction projects is increased industrialization, although most prior studies have focused on housing and building projects and on short-term aspects only.

Within the literature on paradoxical organizational tensions, organizational ambidexterity is used to describe the capability to simultaneous explore and exploit. Exploration can be characterized by diversity, adaptability, risk taking, experimentation, flexibility, innovation and a long-term orientation, whereas in contrast, exploitation involves refinement, alignment, control, constraints, efficiency, and a short-term orientation. Therefore, organizational ambidexterity can be described as an organization's ability to exploit existing knowledge and technologies to create short-term efficiency and to simultaneously explore new knowledge and technologies to strengthen long-term development.

This paper aimed to improve the understanding of how actors in infrastructure projects can combine short-term exploitative objectives with sometimes contradictory long-term explorative development when implementing industrialized construction. Extra focus was given to the explorative and exploitative aspects of the drivers for increased industrialization and to the barriers to the implementation of industrialized construction in infrastructure projects. The empirical material is based on two different qualitative studies of, in total, 4 different large infrastructure projects using 14 interviews with project managers, design managers and site managers as the main source.

Key Results

Combined analyses of the four cases generated some overarching results. 1) The interviewees displayed very different levels of understanding of the concept of industrialized construction, although prefabrication off-site, efficient and rational production, and standardization and repetition were commonly mentioned. 2) Time and money were considered by a majority of the interviewees to be the most important drivers behind implementing industrialized construction, although some also mentioned a future lack of skilled labor, an improved working environment, and industrialized processes as a means to improve the attractiveness of the sector by showing openness to innovative exploration and change. 3) The most frequently mentioned barriers to industrialized construction relate to the client, the Swedish Transport Administration (STA). For example, procurement procedures which hinder contractors from suggesting alternative solutions and instead exploit existing suggestions and the STA's own norms, rules and regulations, as well as a skepticism about new and untested solutions that favors the exploitation of existing technology. Another barrier is that money spent on exploring ways to seek standardization and repetition needs to pay off within the project at hand because the contractor cannot count on using the solution again in future projects. Moreover, the perceived conservative culture within the sector was also suggested as a barrier to industrialized construction.

Contributions

The paper contributed to the construction management literature by arguing that the identified barriers to industrialized construction inhibit not only short-term efficiency and productivity (exploitation) but also long-term innovation and change (exploration). Therefore, any initiative to implement industrialized construction within the infrastructure sector would benefit from applying an ambidextrous perspective, recognizing the simultaneous need for exploration and exploitation to achieve sustainable development. Efforts should be spent on exploiting prior explorative investments, which is possible in large projects, although investments on a firm level are often required to bring solutions forward for exploitation in upcoming projects.

Project actors would thus benefit from applying a more ambidextrous perspective and continuously addressing the existing barriers. Otherwise, there is an imminent risk that perceptions prioritizing short-term benefits will block more explorative initiatives. Public clients can act as champions of industrialized construction by combining exploration and exploitation, adapting their procurement strategies and focusing on functional requirements. The STA is currently undertaking such initiatives. However, in general, there is a need for a change of attitudes toward more openness to explorative measures among clients, contractors and other actors within the infrastructure sector.

4.4. Paper III

Eriksson, P-E., **Szentes, H.** (----) "Managing the tensions between exploration and exploitation in large construction projects", *Submitted to Journal in May 2016.*

Introduction

Prior research has shown that companies need to achieve both the exploitation of current knowledge to be profitable today and the exploration of new knowledge to earn money in a future that will have new conditions and demands. The tension between exploration and exploitation has a paradoxical nature: although both approaches appear to be relevant, they are difficult to combine due to scarce resources. The ability to simultaneously work with both exploration and exploitation is often called organizational ambidexterity. Most prior research on organizational ambidexterity has focused on the firm or business unit level and has mainly studied the effects of exploration and exploitation rather than how to achieve ambidexterity. Although there are researchers highlighting the tensions related to exploration/exploitation between different organizations, studies focused on how to achieve ambidexterity in interorganizational projects are scarce.

The construction sector is project-based and most projects are inter-organizational, in that a client has a temporary contract with a primary contractor to deliver a defined scope of works. The need for improved efficiency and productivity in the construction sector has often been emphasized in prior research, and similarly, others have highlighted a need for improved innovation capabilities in construction projects. Several studies have pinpointed barriers to development within the construction sector, but few have studied how to achieve both short-term efficiency and long-term innovation in construction projects.

The paper aimed to investigate exploration and exploitation in large construction projects with a goal of improving the understanding of how organizational ambidexterity can be achieved, considering interorganizational characteristics. The empirical material was drawn from 23 interviews with clients, contractors and design companies in seven large construction projects in Sweden.

Key Results

In general, the respondents argued that exploitation is more important than exploration from a project perspective, whereas exploration is more important for the sector. However, the distinction between the two approaches was not clear: some respondents expressed that every type of development is perceived as exploration and that it is sometimes hard to distinguish between ordinary design work and innovation.

Exploitation in terms of fine-tuning was seldom formalized and often performed on craftsman level. Other respondents highlighted how exploitation could be enhanced by long-term relationships in which knowledge can be transferred from project to project. Tight schedules were common in the studied projects, which diminished exploitative initiatives (e.g., refinement of methods or solutions) due to a lack of time and a desire to minimize the risk of delays and fines for the contractor.

For exploration to take place in large construction projects, it is important that the client encourages the designers and contractors to be innovative and suggest alternatives, hence stimulating exploration across the interorganizational interfaces. The willingness to suggest innovative solutions is very dependent on the contract form; to summarize, the late procurement of contractors in DBB contracts often blocks innovation, whereas DB contracts with a collaborative approach appear to be most appropriate when it comes to stimulating long-term innovation. Moreover, in the three infrastructure projects where the Swedish Transport Administration (STA) was the client, the STA's internal attitudes, norms, rules, and regulations often blocked exploration and innovations. However, similar attitudes were also found among other clients as well as among contractors. Another important finding is that contractors often have the opinion that an investment in development work must pay off during the project at hand, which is sometimes possible in large construction projects with long durations.

Contributions

The paper contributed to the ambidexterity literature by arguing that in mature industries such as construction, exploitation often involves the utilization of existing knowledge as it is, without any refinement at all. Although this strategy can increase efficiency in the short term, it is important to recognize that such an approach can severely impact the development of new solutions that might be better for both production and long-term maintenance. Moreover, contributing to the literature on ambidexterity and construction management, in construction projects, the paper emphasizes the importance of recognizing the paradoxical nature of tensions between exploration and exploitation and therefore of employing contextual ambidexterity in which contractors are involved early and throughout the different project stages. Another contribution to the construction management literature is the finding that tight schedules and time pressure can act as both a barrier to and driver of innovation. If tight schedules are identified early, it can spur innovation initiatives, but time pressure at a late stage will often lead to traditional solutions with low anticipated risk.

By becoming aware of the importance and opportunity as well as the lower risk associated with incremental development (exploitation), compared to more intense exploration, a better mix of development efforts can be achieved in

construction projects. Moreover, managers can enhance organizational ambidexterity by implementing procurement strategies that enable early contractor involvement, reasonable schedules, and large-scale projects with long durations.

4.5. Paper IV

Szentes, H., and Eriksson, P-E. (2015) "Paradoxical Organizational Tensions between Control and Flexibility When Managing Large Infrastructure Projects" *Journal of Construction Engineering and Management*., 10.1061/(ASCE) CO.1943-7862.0001081

Introduction

Major technological developments, globalization and other socioeconomic changes have pressured companies and other organizations to modify their ways of organizing and managing activities, and the construction sector is no exception. Both external changes as well as internal modifications of practices entail various organizational tensions, for instance between control and flexibility at many different organizational interfaces.

In project contexts, the focus has traditionally been on control by means such as planning and coordination, although there is more recent research calling for increased flexibility in how projects are managed. Most previous studies within the literature of construction management have focused on either control or flexibility, leaving the tension between the two insufficiently investigated. Prior control-related research has often emphasized that in a contractual relation between two parties, the client needs to apply certain level of control over the contractor due to goal conflicts, risk aversion and to verify performance. However, the cost of this monitoring should be compared with costs for controlling outcomes when transferring risk to the contractor. Applying a paradox perspective means recognizing that both elements in a paradoxical tension make sense, no matter how impossible it appears to be to combine them. Hence, instead of choosing either control or flexibility, it is suggested that managers and other decision makers try to simultaneously promote both.

The paper aimed to identify and analyze the paradoxical organizational tensions between control and flexibility that arise at different organizational interfaces and influence project managers in large infrastructure projects during the construction phase. The empirical data were drawn from a multiple case study of three large infrastructure projects with the Swedish Transport Administration (STA), in which project managers from both the STA and each contractor as well as design managers in two of the projects were interviewed three times and twice in the last project, representing 20 interviews altogether.

Key Results

Several paradoxical organizational tensions between control and flexibility were identified and categorized according to three different organizational interfaces: 1) External control by authorities and the public versus flexibility in production and organizing activities, e.g., regarding health & safety, the environment, the public procurement act, statutory planning processes as well as more informal demands by the public; 2) Control by governance forums within client and contractor organizations versus flexibility for project managers, e.g., regarding resources and the alignment of technical solutions; 3) Control by clients versus flexibility for contractors, e.g., regarding contracts, monitoring, reporting routines, and documentation.

Hence, project managers need to address the interorganizational control and flexibility applied by authorities and the public and existing in the relationship between the client and the contractor while simultaneously addressing the intraorganizational control and flexibility applied by their respective governance forum (in this thesis, labelled intraorganizational direction/empowerment). Because there are connections and dependencies between the tensions in these three interfaces, it presents a challenge for project managers on both sides. On the contractor side, it was common for the contractor project manager to be reporting to several parallel governance forums, adding further demands for managing a complex mix of control and flexibility.

Moreover, public procurement acts (PPA) often impose indirect control over organizing processes because clients often choose a supplier based on the lowest price out of fear of appeals if using soft criteria reflecting supplier capabilities. In addition, the empirical findings highlight that different authorities sometimes impose contradictory demands related to control and flexibility on large construction projects.

Contributions

The paper contributed to the construction management literature by providing support for previous notions that the traditional focus on control needs to be complemented with more flexibility. This finding is in line with the paradox perspective, highlighting that both client project managers and contractor project managers can benefit from simultaneously promoting control and flexibility. Moreover, to identify and analyze connections and dependencies between the tensions related to control and flexibility at different organizational interfaces, a systemic paradox perspective is essential. Analyzing tensions at one interface in isolation is likely to result in limited understanding. Furthermore, by combining conclusions from different strands of the project literature in a systemic paradox perspective, new insights and a better understanding of how tensions between control and flexibility at different organizational interfaces interplay may be

achieved. For instance, strong focus on control in early project stages often creates demands for flexibility later, and vice versa.

Similarly, applying a systemic paradox perspective is equally important for project managers and for those involved in project governance, recognizing that both control and flexibility are simultaneously required in an optimal balance at multiple organizational interfaces. An inappropriate balance will quickly lead to suboptimal outcomes.

Moreover, public clients need to develop more competence in using soft criteria in partner selection, otherwise procurement based on the lowest price will prevail, and indirectly, the client will lose control of the important staffing process. Policy makers need also to reflect on who is actually coordinating and prioritizing the controls exercised by different authorities. There is an imminent risk of sub-optimization in the use of tax money.

4.6. Paper V

Szentes, H. (----) "Inter- and intraorganizational paradoxical tensions when managing large construction projects", *Further developed version of a paper that was submitted to a Journal in March 2016*

Introduction

In recent years, scholars have shown a growing interest in exercising both control and flexibility when organizing and managing large construction projects, despite the prevalent tendency in the project management field to focus on control. Some researchers recognize that there is paradoxical tension between the two approaches; although both approaches make sense when studied alone, they seem impossible to combine. Yet, combining control and flexibility is necessary to achieve success in large construction projects.

Large construction projects are interorganizational, entailing simultaneous tensions related to control and flexibility between the parties (interorganizational) and tensions related to direction and empowerment within each party (intraorganizational). This distinction has rarely been made in previous research, but there are a few explicit and several implicit examples in which dependencies between the two types of tensions are highlighted. Insufficient understanding of the dependencies between intraorganizational direction/empowerment and interorganizational control/flexibility may hinder development of trust and empowerment and challenge the management of scope changes as well as interorganizational collaboration. Moreover, interdependencies (dependency in two directions) between the two types of tensions at different organizational interfaces may develop into reinforcing cycles, either vicious cycles leading to organizational decline or virtuous cycles leading to sustainable development.

Altogether, there is an urgent need to improve our knowledge about how dependencies and interdependencies between interorganizational control/flexibility and intraorganizational direction/empowerment influence project execution and about the related reinforcing cycles.

The aim of the paper was to investigate whether and how the practice of intraorganizational direction and empowerment influences interorganizational control and flexibility and vice versa, and specifically to try identify reinforcing cycles involving the two types of tensions at different organizational interfaces. This aim was accomplished by applying a paradox perspective in studies of the interplay over time between client project managers and contractor project managers and between each project manager and his or her respective governance forum. Empirical materials were drawn from a multiple case study on four large construction projects in Sweden involving 30 in-depth interviews, in which three rounds of interviews were held with both parties' project managers over a four-year period.

Key Results

Vicious reinforcing cycles of direction/control emerged in three projects. For different reasons, the client started to increase control over the contractor, which evoked responses by the contractor that appeared to then further strengthen the control exerted by the client. In many cases, control was initiated and directed by client governance and the contractor response was often initiated and directed by the contractor's governance. In some cases, this affected the trust between the project managers, who at least initially believed in a flexible approach to managing projects. Moreover, the experience and level of self-confidence of the project managers appears to have influenced the extent to which the direction of the governance forums shifted into increased control. Less experienced and less confident project managers opted for more control when governance suggested it, although the level of direction also made a difference.

In one project, a virtuous cycle combining both control and flexibility emerged, and over time, trust and a very good relationship developed between the client project manager and the contractor project manager. One reason for this relationship appears to be that they had similar experiences, competences and views on leadership, and that they enjoyed working together. However, it seems that empowerment by the contractor governance forum and the fact that the client project manager used his experience and self-confidence to manage direction from his governance forum also nurtured the virtuous cycle and strengthened the trust between the two project managers.

Contributions

The paper contains empirical evidence that the management teams of all four projects simultaneously used both control and flexibility, supporting recent research within the construction management literature. However, the paper contributed further by distinguishing interorganizational control/flexibility from intraorganizational direction/empowerment and then investigating how these two types of tension interrelated over time. The overarching contribution to the construction management literature is that it is fruitful and important to employ a systemic paradox perspective when analyzing organizational tensions related to control, flexibility, direction, and empowerment in large construction projects.

In large construction projects, tensions can be nested across both intra- and interorganizational interfaces. This means, for instance, that intraorganizational direction by a governance forum can translate into interorganizational control, and vice versa. Moreover, the paper contributed by showing that reinforcing cycles can involve tensions at several organizational interfaces. More specifically, an increase of intraorganizational direction within one party translated into interorganizational control, which initiated an increase in intraorganizational direction within the other party, etc. Similarly, virtuous cycles delicately combining both control and flexibility could emerge and develop partly based on how direction and empowerment was played out by the two governance forums. However, theoretically, other combinations of elements could evolve into a vicious cycle, for instance increasing intraorganizational direction by client governance forcing their project manager to decrease control and increase interorganizational flexibility could entail similar directions by the contractor governance forum, further increasing interorganizational flexibility into a situation where lack of monitoring and control impose a risk to the fulfilment of the project objectives. To be able to identify and analyze those types of scenarios and reinforcing cycles, a systemic paradox perspective is required.

Trust is important for collaboration and flexibility. The paper contributed to the construction management literature, but implicitly also to project management literature, by showing that actions taken by either or both governance forums can diminish or even destroy trust between the client project manager and the contractor project manager, most often through a vicious reinforcing cycle. The combination of individuals (with certain levels of experience and confidence) in managerial and governing positions makes a difference in interorganizational projects. It is not enough to focus only on assigning appropriate project managers but is also necessary to define suitable governing forums; these together can then form a well-functioning entity that fits the managerial strategy. A systemic paradox perspective can facilitate the organizing and staffing process, avoiding the emergence of vicious cycles and facilitating the development of virtuous cycles.

5. DISCUSSION

This chapter provides a discussion of the key results and contributions of the five appended papers, attempting to identify and clarify common features relevant to the four research questions. The first subsection discusses findings regarding how organizational tensions have been created because of societal changes (RQ1). The second subsection discusses findings related to exploration and exploitation (RQ2), and the third subsection discusses findings related to control/flexibility and direction/empowerment (RQ3). The chapter concludes with a subsection discussing how insights were derived by applying a systemic paradox perspective to interorganizational projects (RQ4).

5.1. Organizational tensions due to societal changes

Using an explorative approach, Paper I mapped and described the changes in society, including technological developments, that have changed the conditions for organizing and managing large construction projects. Although Paper I shows that many solutions, methods and processes have changed within the construction sector, many changes appear to be reactions to new conditions rather than the proactive development of new business ideas, providing support to similar notions by Harty (2008). This passive approach indicates conservative thinking (Dacin et al., 2002), which was confirmed by the attitudes and statements of several interviewees in the study, supporting arguments that the construction sector is believed to be conservative by nature. Such descriptions of the sector impose a risk of decreased openness and enthusiasm for new practices among practitioners (Karrbom Gustavsson & Hallin, 2014). Due to the principles of symbolic leadership (Smircich & Morgan, 1982), it is particularly important for people in managerial positions and for people representing professional associations and the like to reflect on how they describe the construction sector. The importance of an attitude change was further illuminated in Paper II, which clarified that in order to enable and speed up the implementation of industrialized construction in transport infrastructure projects, clients and contractors as well as other actors in the sector need to change their attitude toward industrialized construction and innovations in general. Similarly, Paper III highlights that attitudes blocking innovations were not only found among public clients but also among private clients and among contractors.

Thus, Papers I, II, and III illuminate the importance of understanding how attitudes and institutionalized perceptions and behaviors can become barriers to change and to the development of new organizing practices for large construction projects. Similar conclusions have previously been noted by, e.g., Kadefors (1995) and Sminia (2011) regarding development in general, but this

thesis contributes by highlighting specifically that the reputation of the Swedish construction sector as conservative has become institutionalized and by pinpointing how this institutionalized reputation seems to make practitioners pessimistic about development and leads them to favor exploitation over exploration in large construction projects.

Several prior studies have highlighted that changes in society entail new ways of organizing companies, which then often indirectly create organizational tensions (e.g., Lewis, 2000; Smith et al., 2010; Smith & Lewis, 2011). Other studies have specified that an increased number and variety of stakeholders (Olander & Landin, 2005), increasing demands from tax payers (Flyvbjerg, 2005; Bruzelius et al., 2002), and new regulations and funding principles (Puerto & Shane, 2014) are examples of societal changes that have entailed new ways of organizing and managing large construction projects.

Additional insights are provided by Paper I, which shows how societal changes as well as the subsequent changes of organizing practices have created organizational tensions related to control and flexibility in large construction projects. Examples are tensions between increasing public requirements for more flexible working conditions and public control of tax money spending; between more control in terms of regulations on health & safety and flexibility needed for contractors to deliver within budget and schedule; or an increased variety of contractual setups within the same project including different levels of control exerted by the client and of flexibility given to the contractor. Similarly, Paper IV further illuminates tensions between control and flexibility, capturing how project managers often experience tensions in terms of a variety of simultaneous and complex demands for control and flexibility from authorities and the public as well as from project internal stakeholders.

Prior research has also highlighted that societal changes and technological developments have created and intensified a need for companies in different industries to both exploit existing knowledge and explore new knowledge (March, 1991; Benner & Tushman, 2003), including the project-based construction sector (Dubois & Gadde, 2002; Harty, 2008). Paper I highlights an intensified pace in construction activities that diminishes the time available for both exploitation and exploration during the production phase. Paper II elaborates on tensions between exploration and exploitation in transport infrastructure projects specifically and highlights that this tension is partly the result of increased societal demands on how to spend tax money and of changes in norms, regulations and procurement practices within the sector. Tensions between exploration and exploitation in large construction projects in general are further illuminated in Paper III, which stresses how new procurement strategies and tight schedules influence the tension between explorative long-term innovation and exploitative short-term profits.

Thus, Papers I, II, III, and IV confirm previous notions from other empirical contexts that changes in society and within a sector entail organizational tensions, but they further contribute by describing several explicit examples of tensions in large construction projects. Also, it is illuminated that organizational tensions in large construction projects are often derived from contradictory demands and requirements from different stakeholders, both intraorganizational and external to the project.

5.2. Intraorganizational influence on organizational ambidexterity

Prior research on organizational ambidexterity has highlighted the importance of simultaneously pursuing both exploration and exploitation within the same organization, which is so-called contextual ambidexterity (Gibson & Birkinshaw, 2004; Gupta et al., 2006). Similarly, Eriksson (2013) argues that due to dependencies between different actors, neither structural nor sequential ambidexterity is suitable for construction projects. In line with these notions, Papers II and III show that within the large construction projects studied, both exploration and exploitation were practiced, although the exploitation was often viewed as including no refinement at all. Nevertheless, Paper III highlights that exploitation was more frequent as well as more appreciated by project actors than exploration, thus providing support to prior notions that exploitation is common in construction projects (Chan & Kumaraswamy, 1997; Josephson & Hammarlund, 1999; Odeh & Battaineh, 2002; Assaf & Al-Hejji, 2006; Faridi & El-Sayegh, 2006; Sambasivan & Soon, 2007). Paper III adds, however, that many practitioners seem to recognize that exploration is important for the construction sector but finds they are not equally willing to pursue exploration in their own projects. Moreover, Paper III emphasizes that the early identification of tight schedules can stimulate an increase of exploration, for instance by initiating the early involvement of contractor competence to adjust and enhance production methods. If tight schedules are identified too late, time pressure will instead decrease the willingness to pursue explorative (and exploitative) activities due to risk aversion and lack of time.

Prior research on how to achieve exploration and exploitation in large construction projects has highlighted the influence of intraorganizational aspects such as goal transparency, product specifications (Rose & Manley, 2012), the degree of collaboration in procurement strategies and the timing for the involvement of key actors (Caldwell et al., 2009; Bröchner, 2010; Ozorhon, 2012). As shown in the next three paragraphs, Papers II and III provide support for some of these conclusions, but add explicit details and emphasize that strategies and decisions within both client and contractor organizations influence organizational ambidexterity.

Papers II and III highlight that attitudes within both client and contractor organizations influence organizational ambidexterity. Paper II adds that there are processes within both client and contractor firms that block exploration, and routines are lacking to facilitate the solutions explored in one project being brought forward to future projects. Paper III adds that both clients and contractors lack routines and competence for employing exploitation in terms of incremental development, and it finds that the duration of relationships within each organization (as well as between client and contractors) influence the possibilities of transitioning explored solutions to coming projects.

In addition, Papers II and III emphasize that procurement strategies within client organizations influence organizational ambidexterity by defining project size and duration, when to involve contractors and consultants, the schedule (time available in different phases), and the risk distribution in contracts. Moreover, Paper III adds that clients can stimulate exploration by encouraging both designers and contractors to suggest alternative solutions.

In addition, Papers II and III emphasize that the way that contractors evaluate their project managers influences organizational ambidexterity. The strong focus on short-term profits from ongoing projects can hinder exploration because there is no incentive to try new ideas; rather, this represents a risk from the project manager and governance perspective. Moreover, Paper III adds that there is a lack of processes and competence within contractor organizations for formalizing and better utilizing the exploration and exploitation activities performed at the craftsman level.

Thus, Papers II and III illuminate several explicit examples of how intraorganizational strategies, decisions and practices within both the client and contractor organizations influence the practical implementation of organizational ambidexterity in large construction projects.

5.3. Dependencies, interdependencies, and reinforcing cycles

Recent research has highlighted the importance of seeking ways to combine control and flexibility instead of viewing them as competing approaches to managing projects (e.g., Walker & Shen, 2002; van Marrewijk et al., 2008; Koppenjan et al., 2011). Papers IV and V provide support for this perspective by showing how project managers on the client side as well as on the contractor side apply both control and flexibility in their management practices. However, Paper V specifies and clarifies this view by distinguishing between interorganizational control/flexibility and intraorganizational direction/empowerment and by showing how project managers as well as governance forums on both the client and the contractor side apply both direction and empowerment in their management practices.

Prior research on managing construction projects has explicitly highlighted that interorganizational trust is dependent on intraorganizational trust (Lazar, 2000) and that interorganizational control can trigger intraorganizational responses (Tuuli et al., 2010). Other studies have implicitly indicated that there are dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment (e.g., Walker & Shen, 2002; Greasley et al., 2005; Olsson, 2006; Marrewijk et al., 2008; Cui & Olsson, 2009; Koppenjan et al, 2011). In this thesis, control/flexibility and direction/empowerment at several organizational interfaces in large construction projects are analyzed to move from implicit indications to explicit understanding. This work is facilitated by combining the literature on paradoxical tensions with the literature on control, flexibility, direction and empowerment (with different underlying theoretical approaches). To allow the reader to follow the descriptions below of the different tensions, Figure 3 presents a schematic overview of the relevant tensions at each organizational interface.

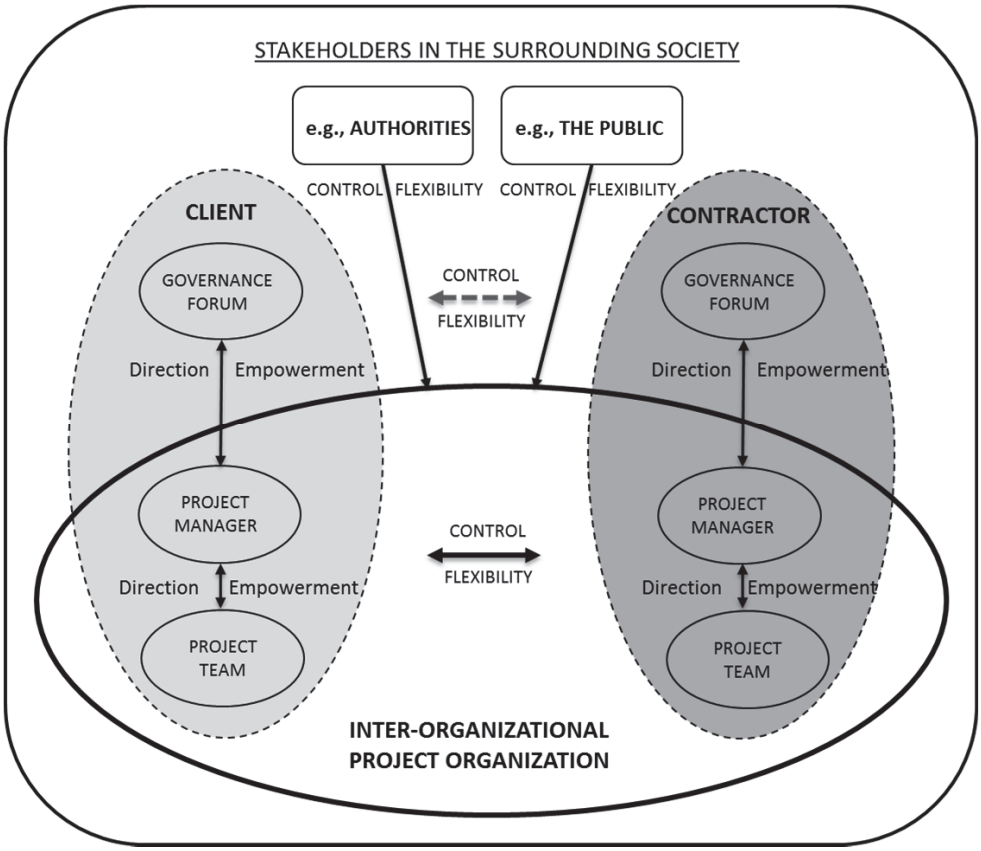

Figure 3. Schematic overview of the relevant tensions occurring at different organizational interfaces in interorganizational projects

In Paper IV, the tensions between control/flexibility imposed by different authorities, the public, and governance forums (although defined as direction and empowerment in this thesis) and in the client/contractor relationship were studied. By applying such a systemic view, simultaneously analyzing several organizational interfaces and combining different strands of the literature, new insights could be achieved. First, it is shown that simultaneously managing the tensions related to control/flexibility from authorities, the public, governance forums (often several at the contractor side), and the other party is a major challenge for project managers in contemporary large construction projects. Second, the sometimes conflicting demands for control/flexibility at the different organizational interfaces impose a risk for sub-optimization from a project perspective, putting the ability to fulfill the project objectives at stake. Therefore, not only project managers but also people in governance forums need to recognize that simultaneous control and flexibility are required to manage dependencies between different organizational interfaces. Third, it is also shown that there is a risk for sub-optimization from a societal perspective when a set of authorities impose various requirements on project organizations that are sometimes contradictory and often monitored and controlled differently. Fourth, it is highlighted that a strong focus on control in early project stages before procuring contractors creates a need for more flexibility in the subsequent relationship with the contractor, while greater initial flexibility leads to a subsequent greater need for control.

In Paper V, the interplay between intraorganizational direction/empowerment within each party and interorganizational control/flexibility was studied. By applying such a systemic view, simultaneously analyzing tensions at different organizational interfaces and combining different strands of the literature, new insights about dependencies could be achieved.

First, it is shown that there are not only dependencies between different organizational interfaces but also interdependencies. This means that dependencies often work in both directions. For example, it is shown that an increase in intraorganizational direction can increase interorganizational control, but also that an increase of interorganizational control can increase intraorganizational control. However, that is not all; Paper V also demonstrates the interdependency between intraorganizational direction/empowerment within one party and interorganizational direction/empowerment within the other party and shows that the interdependency is linked through interorganizational control/flexibility. Therefore, this thesis expands previous notions about tensions being nested across different hierarchical levels (Clegg et al., 2002; Andriopoulos & Lewis, 2010) by arguing that in large construction projects, tensions can simultaneously be nested across both intraorganizational and interorganizational interfaces.

Second, due to interdependencies, it is essential when staffing large construction projects to not only consider the traits, attitudes and practices of the appointed project managers, but also to simultaneously assess the same characteristics of those appointed to be part of the governance forums within both parties. For example, in line with notions from Lazar (2000), it is highlighted that trust between project managers can be affected by actions taken by governance forums. Therefore, when staffing large construction projects, it is necessary to apply a systemic view to the entire project organization including its governing forums.

Third, prior research has highlighted that interdependent activities may evolve into reinforcing circles (Weick, 1979), or vicious and virtuous reinforcing cycles as they are referred to in the paradox literature (Lewis, 2000; Smith & Lewis, 2011; Lewis & Smith, 2014). Paper V contains descriptions of three vicious cycles reinforcing interorganizational control and intraorganizational direction within both parties. For instance, intraorganizational directive actions taken by client governance forums transferred into interorganizational control exerted by the client project manager, which triggered a response from the contractor governance forum directing the contractor project manager to retain flexibility; this triggered the client project manager to exert further control, enforced by the client governance forum, etc. Paper V also describes the emergence and development of a virtuous cycle in which direction/empowerment within each party interplayed well with control/flexibility between the client project manager, the contractor project manager and their respective teams. Moreover, although not identified in the empirical material used for this thesis, theoretically, vicious cycles that include other combinations of direction/empowerment and control/flexibility could emerge. For instance, increasing intraorganizational direction within the client organization to increase interorganizational flexibility could entail similar directions by the contractor governance forum, further increasing flexibility into a situation where lack of monitoring and control impose a risk to the fulfilment of the project objectives.

Thus, Papers IV and V together describe several explicit examples of dependencies and interdependencies between tensions and the related responses at different organizational interfaces, as well as how such interdependencies can evolve into complex vicious and virtuous reinforcing cycles involving nested tensions.

5.4. Applying a systemic paradox perspective to tensions

In line with suggestions by Gluch and Räisänen (2012), this thesis promotes a systemic view when studying project organizations. However, this thesis also illuminates how a combination of systemic views and a paradox perspective on organizational tensions specifically can produce new insights.

First, prior research has emphasized that applying a paradox perspective to tensions includes a both/and perspective rather than choosing either side in the tension (Beech et al., 2004; Smith et al., 2010; Lewis & Smith, 2014). From a traditional project management view focusing on control (Atkinson et al., 2006; Perminova et al., 2008), the organizational tensions created by different types of changes might be perceived as negative because they appear to entail blurriness, indecisiveness, and a competition for scarce resources. However, from a paradox perspective, organizational tensions are instead perceived as important triggers for development (Beech et al., 2004; Smith et al., 2010). Accordingly, combining both elements in organizational tensions when organizing and managing large construction projects, e.g., both exploration and exploitation (Papers II and III), both control and flexibility (Papers IV and V), and both direction and empowerment (Paper V), can create sustainable project organizations with sustained productivity.

Second, in prior literature on project management and construction management, some researchers have discussed dependencies between intraorganizational and interorganizational interfaces (e.g., Lazar, 2000; Jensen et al, 2006; Tuuli et al., 2010; Ahola et al., 2015). However, an overwhelming number of the prior studies of tensions in project contexts have either focused on one organizational interface at a time or have not made any distinctions between tensions at different organizational interfaces. Moreover, prior research on organizations has highlighted that organizational tensions may be multi-layered and nested across different intraorganizational levels (Clegg et al., 2002; Andriopoulos & Lewis, 2010), and also engaging interorganizational interfaces (De Leeuw & Volberda, 1996). Papers III, IV and V, in the empirical context of large construction projects, highlight several examples of dependencies, interdependencies and reinforcing cycles that are nested across several organizational interfaces. Accordingly, it is thus suggested that in order to address the coexistence of tensions at several organizational interfaces in large construction projects while recognizing that there are interdependencies between them, a systemic paradox perspective is beneficial for both scholars and practitioners. Failing to simultaneously address both elements of tensions at the different organizational interfaces can lead to suboptimal outcomes, thus expanding similar conclusions by Lewis and Smith (2014) as regards one single/standalone tension.

Third, Papers III, IV and V show that practitioners in general seem to manage large construction projects by attempting to combine control and flexibility, direction and empowerment, and exploration and exploitation. This finding is in line with, e.g., Walker and Shen (2002), van Marrewijk et al. (2008), Koppenjan et al. (2011), and Eriksson (2013), as well as in accordance with a paradox perspective (Smith & Lewis, 2011). However, this thesis notes that what initially looks like a simultaneous focus on both elements in organizational tensions is often instead a sequential focus on each of the elements. The distinction depends on the time perspective that the researcher applies to the analysis: analyzing a project as an entity may lead to the conclusion that all elements are simultaneously employed, but the longitudinal approach used for this thesis revealed important details about sequences and the appropriate order of focus. Therefore, to be able to discuss the temporal separation of elements in paradoxical tensions (Poole van de Ven, 1989) or sequential ambidexterity as regards exploration/exploitation specifically (Duncan, 1976; Gupta et al., 2006), it is necessary to carefully reflect on and describe the time span studied.

Fourth, according to Lewis and Smith (2014), a paradox perspective can be used as a meta-theory combining other organization theories. Papers IV and V demonstrate how this can be done in the empirical context of large construction projects by applying a systemic paradox perspective to combine several different strands of the literature, e.g., on control and flexibility, direction and empowerment, and organizational ambidexterity. It is therefore suggested that a systemic paradox perspective can serve as a platform for enabling theoretical pluralism when studying large construction projects and, for instance, combining different schools of thought as regards project management (Söderlund, 2011).

Fifth, combining insights from Papers III, IV, and V with reflections on Paper I, it is suggested that applying a systemic paradox perspective on the organizational tensions created by societal and internal changes can help both practitioners and scholars de-institutionalize (Dacin et al., 2002) hindering attitudes, perceptions, and reputations (Kadefors, 1995). In other words, it can help dismantle the myth that the construction sector is slow to change (Löwstedt & Räisänen, 2012). Instead of choosing either exploitation or exploration, the exploitation of existing knowledge to achieve short-term performance and to satisfy those skeptical about new ways of working can be combined with the exploration of new knowledge to create long-term development. Thus, a both/and approach can enable gradual de-institutionalization instead of creating trench warfare between old and new by focusing on either/or.

Thus, Papers III, IV and V clearly show how a systemic paradox perspective combining different strands of literature can support both scholars and practitioners in managing the dependencies, interdependencies, and reinforcing cycles occurring in large construction projects.

6. CONCLUSIONS

This chapter provides the conclusions derived from the five appended papers and the discussion in the previous chapter in this thesis. First, theoretical contributions are presented, and the implications for managers and policy makers follow. The chapter ends with a discussion on applicability to other types of interorganizational projects, followed by a review of study limitations and suggestions for future research.

6.1. Theoretical contributions

This thesis brings forward a number of contributions to existing literature on paradoxical tensions and to literature on managing large construction projects.

6.1.1. Literature on paradoxical organizational tensions

By applying a systemic paradox perspective to the tensions occurring at different organizational interfaces in large construction projects, this thesis brings forward several implications for the literature on paradoxical organizational tensions.

First, Lewis and Smith (2014) suggest that a paradox perspective can be used as a meta-theory, combining other theories and perspectives. This thesis demonstrates how combining a systemic paradox perspective with literature on organizational tensions stemming from various theoretical standpoints can produce new insights as regards organizing large construction projects. According to Söderlund (2011), theoretical pluralism is important to project contexts, making a systemic paradox perspective as meta-theory particularly relevant in studies of projects.

Second, this thesis provides support for Clegg et al. (2002) and Andriopoulos and Lewis (2010) in their claim that organizational tensions can be nested across different organizational interfaces. However, this thesis adds that organizational tensions can simultaneously be nested across both intraorganizational and interorganizational interfaces, and that such interdependencies can lead to complex reinforcing cycles involving several organizational tensions. To identify and analyze such interdependencies and reinforcing cycles, a systemic paradox perspective is essential. This contribution is especially important in interorganizational projects, where managing organizational tensions therefore needs to involve consideration of both intra- and interorganizational aspects due to interdependencies.

Third, according to Poole and van de Ven (1989), one approach to addressing paradoxical tensions in general is temporal separation. Similarly, Duncan (1976) and Gupta et al. (2006) specify that sequential ambidexterity is one way to

achieve both exploration and exploitation. However, in recent paradox literature, simultaneous focus on both elements in organizational tensions is emphasized (e.g., Beech et al., 2004; Smith et al., 2010; Lewis & Smith, 2014). In this thesis, it is argued that there is no clear distinction between sequential and simultaneous approaches to managing paradoxical tensions because the distinction depends on the time span covered in the study. In addition, if a sequential approach is applied, this thesis highlights that the timing and order of focus on each element in the tension influence the effect and outcomes. Starting with control will require flexibility later, and vice versa.

6.1.2. Literature on managing large construction projects

By studying how societal changes have created new conditions for organizing and managing large construction projects and by applying a systemic paradox perspective to various organizational tensions occurring in large construction projects, several contributions to the literature on managing large construction projects can be presented.

First, despite the numerous research articles and governmental reports emphasizing a need for an increased level of innovation and change within the construction sector (e.g., Latham, 1994; Egan, 1998; Ekstedt et al., 1992; SOU 2002, 2012), this thesis highlights that substantial changes within the construction sector have occurred. Although this is in line with notions by Löwstedt and Räisänen (2012) that it is a myth that the construction sector is slow to change, the fact that many initiatives are reactions to societal changes rather than proactive measures to increase productivity and profits indicate conservative thinking. Nevertheless, it is important to illuminate for both practitioners and scholars that changes have and are occurring within the sector in order to dismantle the myth and de-institutionalize the reputation (Dacin et al., 2002). Moreover, this thesis shows that changes in society as well as within the sector have entailed new conditions for organizing and managing large construction projects and have created new and intensified existing organizational tensions that require further attention in studies on how to manage large construction projects.

Second, most prior research on the tensions related to control and flexibility in large construction projects does not note any explicit difference between intraorganizational and interorganizational tensions (e.g., Ford et al. 2002; Olsson, 2006; van Marrewijk et al., 2008; Koppenjan et al., 2011). Other research focuses on either intraorganizational tensions (e.g., Greasley et al., 2005) or interorganizational tensions (e.g., Osipova & Eriksson, 2013; Liu et al., 2014). In this thesis, it is argued that a deeper knowledge about the organizing activities of large construction projects could be achieved by distinguishing between intraorganizational and interorganizational tensions, with both being studied simultaneously. Moreover, it is suggested that a consistent terminology be used

related to different organizational tensions to avoid misunderstandings and to achieve clarity in analyses. For instance, in this thesis, direction/empowerment is consistently viewed as an intraorganizational tension, whereas control/flexibility is consistently viewed as an interorganizational tension. This distinction allows more accurate descriptions of organizational tensions and the application of a systemic perspective to search for interdependencies between the two tensions.

Third, summarizing prior research on large construction projects that implicitly highlights interdependencies between intraorganizational and interorganizational tensions related to control, flexibility, direction, and empowerment (e.g., Walker & Shen, 2002; Olsson, 2006; Cui & Olsson, 2009; Koppenjan et al., 2011) illuminates that a failure to recognize such interdependencies can result in several negative impacts on project execution. In this thesis, it is shown how such interdependencies can evolve into complex reinforcing cycles (Sundaramurthy & Lewis, 2003; Smith & Lewis, 2011) involving both intraorganizational and interorganizational tensions. Thus, it is argued in this thesis that applying a systemic paradox perspective and longitudinal approaches when studying organizational tensions in large construction projects will enable identification and analyses of interdependencies and reinforcing cycles that together strongly influence project execution.

6.2. Managerial implications

A change of attitudes is required among clients, contractors and other actors within the construction sector to enable an increased level of exploration and innovation, complementing the current preponderance of focus on exploitation. Practitioners in general, and people in managerial positions as well as those representing professional associations in particular, must reflect on their descriptions of the construction sector to avoid further institutionalizing its reputation as being conservative.

Project managers of large construction projects perceive multiple tensions between control and flexibility that they must address simultaneously, e.g., interorganizational tensions in relation to authorities, the public, and the other contractual party, as well as intraorganizational direction and empowerment in the relation to their own governance and their team. This situation is very challenging and requires project managers with strong communication skills, strong negotiation skills, and the ability to prioritize. Therefore, it is important that this new situation is recognized when assigning both client project managers and contractor project managers.

Strong control over the design and solutions in early phases of large construction projects creates demand for increased flexibility during the construction phase not only to manage end-user changes and uncertainties such as soil conditions, but

also to better utilize contractors' competencies. However, strong flexibility in the early phases calls for increased control during detailed design and construction to stick to the scope and keep within budget and schedule. Timing and the order of interorganizational control and flexibility is thus essential, and instead of choosing either or, a thoughtful combination of both control and flexibility throughout the entire project could enable the management of uncertainties and changes and still keep the budget and schedule. The starting point for such an approach is an increased understanding of paradox perspectives on tensions among practitioners, recognizing a both/and approach.

Applying a systemic paradox perspective is equally important for project managers and for those involved in project governance, recognizing that both control and flexibility are simultaneously required at multiple organizational interfaces. A failure to combine control and flexibility will quickly lead to suboptimal outcomes. For instance, when organizing and staffing projects, a systemic approach can help in appointing people to managerial as well as governance positions, with experience and traits that fit together to avoid sub-optimization, to stop negative reinforcing cycles of control or flexibility, and to enable trust to develop over time without risk of a negative influence from managers with a different view. Accordingly, public clients need to develop more competence in using soft criteria in partner selection, otherwise procurement based on the lowest price will prevail and indirectly, the client will lose control of the important staffing process.

Policy makers need to reflect on how to coordinate and prioritize demands and controls from different authorities, including municipalities. Poor prioritization of the various demands and controls that must be considered during the management of large construction projects imposes an imminent risk for sub-optimal use of tax money. For instance, one risk would be that the authorities applying the most active control would have their requirements fulfilled rather than those requirements that would best serve society in the long term.

6.3. Applicability, limitations, and further research

Subsection 3.4 discusses generalizability within different large construction projects. Here, the applicability to other types of interorganizational projects is discussed, followed by observations on the limitations of this work and suggestions for future research.

6.3.1. Applicability to other types of interorganizational projects

This thesis is based on empirical material from seven large construction projects. However, there are many other sectors in which most projects have a client purchasing a certain scope of work from a supplier to be delivered as a project.

Thus, other sectors are also organizing and managing interorganizational projects. An interesting question would thus be the extent to which the findings and conclusions in this thesis are also applicable to other types of large interorganizational projects such as the manufacturing and delivery of industrial machine equipment (e.g., pulp mills, furnaces, or boilers) or the customization and delivery of complex IT systems (e.g., business systems or telecom network surveillance).

One overarching argument for similarities is, of course, the existence of a project management field at all and, similarly, that prior research often generically studies and discusses project-based organizations, so-called PBOs. A more specific and growing area of research concerns the PBOs involved in the production of complex product systems, so-called CoPS, including offshore oil platforms, airplanes, shipbuilding, IT and mobile telephone systems as well as large construction and civil engineering projects (Eriksson & Leiringer, 2015), thus implying that there are similarities between projects executed in those areas. In their literature review, Eriksson and Leiringer (2015) describe the role of a central project management office when managing exploration and exploitation in CoPS. Moreover, prior research has noted a pressure on companies in project-based industries in general to modify their business models and organizing practices (e.g., Jaafari, 2003; Saynisch, 2010; Hope & Moehler, 2014), creating different types of organizational tensions (e.g., March, 1991; Lewis, 2000; Smith & Lewis, 2011; O'Reilly & Tushman, 2013), including the tensions discussed in this thesis. But are there more explicit arguments? Let us briefly review and elaborate based on the same parameters used to specify the purposive sample used in this thesis, as described in chapter 3.

First, in terms of duration, there are other interorganizational projects that last equally long, although there are also shorter projects. Therefore, applicability of the conclusions regarding reinforcing cycles requires large projects with durations of several years. It might be that shorter time frames could be sufficient for a reinforcing cycle to develop, but there is no evidence for that in the empirical material in this thesis. Second, within the sample used in this thesis, there were only minor differences based on the type of object constructed. Therefore, it is likely that the conclusions in this thesis are fairly independent of the technology and products involved. Third, regarding the type of contract, there were differences based on whether the client or the contractor held design responsibility, especially regarding exploration/exploitation. Therefore, the type of contract needs to be considered when applying the conclusions from this thesis to other types of interorganizational projects. It is likely the case that suppliers of, for instance, industrial machine equipment and IT solutions are most often responsible for the design, although there are customizations made. Moreover, there are likely to be totally different types of business models applied in other industries, which would need to be reviewed individually to assess the

applicability to those projects. Fourth, in large construction projects, there are often a number of sub-contractors involved. In other industries, there are also many suppliers, but a difference is that in construction projects, a greater portion of the work is conducted on site. In this thesis, focus is on the organizational interface between the client and the contractor, but it is likely that the dynamics depend on the existence of sub-contractors as well. Fifth, as shown in this thesis, perceptions and the practical implementation of, e.g., exploration and exploitation is influenced by institutional forces. Therefore, to assess the applicability of the conclusions in this thesis, it is necessary to compare culture and traditions, including the strength of existing institutions. Sixth, proximity to urban areas should be a more or less irrelevant parameter for most other types of interorganizational projects.

Altogether, it is reasonable to believe that many conclusions made in this thesis are applicable on other types of interorganizational projects, especially within areas related to CoPS, although one must carefully assess the different parameters elaborated on above.

6.3.2. Limitations and future research

The research presented in this thesis has its limitations, which are important to reflect upon. Below, the limitations are discussed, followed by brief suggestions for relevant future research to overcome each limitation presented.

First, all projects were situated in Sweden, and although globalization is gradually homogenizing societies worldwide, more research is required to assess the generalizability of the presented conclusions to different geographical and empirical contexts. For instance, contractual arrangements differ from country to country, and the perceptions and practical implementation of, e.g., empowerment is linked to cultural differences (Tuuli & Rowlinson, 2010).

Second, in the research in this thesis, client project managers, contractor project managers and design managers were interviewed. Although it is logical to interview people representing the different parties when studying interorganizational tensions, researchers would benefit from interviewing both project managers and members of governance forums to compare their views on intraorganizational tensions, in particular, but also as regards the interorganizational tensions and control exerted by societal stakeholders. Additional research is also needed to investigate the extent to which project managers and those occupying governing positions are aware of the paradoxical nature of organizational tensions, along with research on how to improve knowledge of appropriate managerial actions and how to combine the traits of people working in different managerial positions in large construction projects. This observation supports prior arguments by Smith et al. (2010) and Lewis and

Smith (2014) that more research about leadership characteristics appropriate for managing paradoxes is essential.

Third, in this thesis, support is given to prior studies arguing that longitudinal studies are necessary when studying interdependencies, tensions and the emergence and development of reinforcing cycles. Accordingly, it would likely be useful to apply other longitudinal methods (e.g., long-term observations or ethnography) in systemic studies of interdependencies and reinforcing cycles involving tensions at several organizational interfaces. More knowledge is needed about the tensions studied in this thesis, for instance about reinforcing cycles of other combinations of the elements, but also about reinforcing cycles involving other types of nested organizational tensions.

Fourth, as noted by van Fenema and Loebbecke (2014), the development of tensions between exploration and exploitation may become cyclic. Although, there are traces of cyclic events as regards exploration and exploitation in the empirical material behind this thesis, there is insufficient longitudinal information to allow further analyses on this subject.

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Part II

Paper I

Societal changes and new conditions for the management of large construction projects

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Societal Changes and New Conditions for the Management of Large Construction Projects

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Abstract: The construction industry is often described as mature, conservative and resistant to change in research studies, governmental reports as well as in media. Both scholars and policy makers thereby find it critical to encourage innovation, development, and change within the construction industry. This study takes on a different perspective by investigating changes that have actually taken place. The aim is to increase the understanding of both backgrounds of changes which occurred, as well as how the changes have entailed new conditions for the management of large construction projects in Sweden. People working as clients' project manager, contractors' project manager or design manager were interviewed to obtain their perceived views on changes influencing the execution of large construction projects. Substantial changes have taken place creating new conditions for the management of large construction projects and a better understanding of these new conditions is important when planning for new projects. Changes within the field are often reactions to societal changes, and thus often implemented in an uncoordinated way creating sub-optimization and problems for the personnel. It seems as if the reputation of the construction industry being conservative has become an institution it-self amongst many professionals within the industry, potentially creating a self-fulfilling prophecy.

Keywords: Change, conditions, construction, institutional, management, project, societal.

INTRODUCTION

The construction industry has often been described as a mature industry that is non-innovative, conservative and resistant to adopt changes [1-4]. In several countries, such as the UK, Australia, South Africa, Hong Kong, and Sweden, governmental reports state that the construction industry does not adopt changes and innovations to a high enough degree, highlighting the role of the construction client as a "driver" of change and innovation [5-9]. These and similar reports are part of a "reform movement", requesting changes in organization and management of construction projects [10]. According to Fernie *et al.* [10], so far changes continue to fall short of the aspirations outlined by the reform movement. As opposed to many other scholars, Bresnen *et al.* [11] mean that a clear enthusiasm for change has been discernible within the construction industry during recent years. However, a lot of research has identified critical barriers to change and renewal, arguing that implementing change is difficult within the construction industry [11, 12]. Although there is a vigorous debate on the need for change and potential reasons for lack of change, empirical studies investigating which changes have taken place on a broader scale in the construction industry, and why, are scarce. In order to contribute with more input to the debate of the need for change in the alleged conservative construction industry it is important to improve our understanding of the changes that do occur.

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Studies in other industries have shown how changes in the surrounding society have resulted in internal changes related to the organization and management of businesses [13, 14]. The main argument is that companies are affected by societal changes and trends that occur within their external environment. These external changes are forcing or driving companies to implement new ways of organizing and/or managing their businesses in order to adapt to the changed conditions. New institutional theory provides a good framework for describing and explaining such changes occurring in the society in an increasing pace, and how these entail changes in different contexts and in specific organizational fields [10, 15]. The term '*institutional*' refers to normative and cognitive rules that organizations believe they need to adopt to reach legitimacy and stability [16]. Institutions themselves change, often due to inherent contradictions within the institution [17]. Sometimes a prerequisite for a change in organizational behavior is de-institutionalization, the weakening and diminishing of prevailing institutions [18]. However, institutions seem to have an ability to repair and conceal the contradictions that lead to institutional change or de-institutionalization [19]. Since the construction industry is often described as a mature industry, institutional theories may provide important insights regarding changes in this empirical context. One example from the Swedish construction industry is provided by Anna Kadefors [2], who concludes that construction projects should not only be studied from a project management perspective, but instead complemented by studying the institutionally imposed conditions at the macro level.

Considering the large volume of ongoing and planned large construction projects in Sweden, many of them tax

funded, it is from a societal perspective important to better understand if and how the conditions for how to organize and manage such projects have changed over the years. Large construction projects are very much dependent on many different internal stakeholders as well as a variety of stakeholders in the surrounding society that directly or indirectly impose and constraints on the project [20]. Accordingly, how to organize and manage such projects is dependent on the conditions formed by internal and external stakeholders. Furthermore, changes and innovations are more likely to take place in larger construction projects because of their potentially larger budget for innovation related efforts as well as their longer duration [21].

In order to shed light on the topic of changed conditions for the management of large construction projects, this research investigates changes that have actually taken place. The purpose is to investigate how the conditions for the execution of large construction projects in Sweden have changed. The empirical material consists of collected stories about changes affecting the execution of large construction projects and the external sources of those changes, as perceived by people managing large construction projects.

The method section describes how the empirical material was collected and analyzed, followed by a result section comprising categorized stories about changes occurred. The subsequent section presents analyses of the reasons and backgrounds for changes described in the stories, as well as how the conditions for managing large construction projects have changed. The concluding discussion elaborates on insights related to institutional theory as well as on implications for the field by the changed conditions as such.

METHOD

This paper is based on qualitative research in which an inductive approach was used for exploring changed conditions over time for the management of large construction projects. The unit of analysis follows the definition of the term organizational field; *"organizations that, in the aggregate, constitute a recognized area of institutional life; key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products"* [22, p. 148]. In this paper we accordingly define our field and unit of analysis as; the arena in which all different stakeholders to large construction projects in Sweden meet and interact. This is a broad definition, but the idea is to avoid limitations in the analyses in line with what is stated by Dacin, Goodstein and Scott [18].

Sample

The primary data source was interviews with people who, at the time of the interviews, were working in different large construction projects. In this study, a large construction project was defined as having a contract sum above 50 million Euros, and comprising production of infrastructure, industry facilities, public buildings or offices. The 23 interviewees were working as design managers or as project managers for either the client or the contractor (see Table **1**). This purposive sampling [23] was made to obtain views of changes that influence the execution of large construction projects, as perceived by the people managing such projects.

To minimize the influence on the interviewees, it was decided not to prescribe any specific time frame when asking the interviewees to describe changes that have occurred. In practice, the time frame was instead set by the age and prior experience of the interviewees in the sample. The average years of experience in the industry amongst the interviewees were 19 years, ranging from 3 years to 45 years providing a broad spectrum of project managers active in the field.

Collection of Empirical Material

All interviews were conducted in the project offices or similar, using a semi-structured approach with open-ended questions. The objective was to collect the interviewee's spontaneous thoughts of changes occurred that they perceive have an influence on the execution of their projects, and to let the interviewees elaborate on plausible reasons and origins. According to Mats Alvesson [24] the interviewee can be guided to certain answers due to interpretations and expectations on what the researcher is looking for, both prior to the interview as well as in the interview situation. In an attempt to mitigate that risk only brief information regarding the aim and purpose of the study was given prior to the study, and each interview started with wide and general questions while more specific questions about the interviewee's background concluded each interview. To increase trust and openness, information about how the gathered information would be treated anonymously in the research process was presented, though this does not at all guarantee that the interviewees will not adapt their stories due to political agendas or due to fear of being exposed with deviating opinions [24].

All interviews were recorded digitally, and after weighing pros and cons of transcripts [24, 25] it was decided not to fully transcribe all recordings. Instead detailed field-notes with time notations were used for initial analysis, making it easy to go back to the recordings to listen for further details and clarifications and make transcriptions of specific parts.

Analysis

Qualitative content analysis was used to structure the changes, inspired by grounded theory in the sense that categories of changes emerged during the analysis instead of being based upon previous research [26]. The categories represent different changes influencing the execution of large construction projects, though effects, reasons and sources are described in each category. The criterion for choosing the final list of categories was that overlaps between categories should be minimized and that each category should be based on several independent interview statements.

The change categories where then further examined by analysing the different types of underlying reasons and sources of changes occurred, and by analysing how the conditions for managing large construction projects have changed.

EMPIRICAL RESULTS – CHANGE CATEGORIES

The interviews resulted in stories of how the execution of construction projects has changed over the years, as perceived by people working in project management positions.

Table 1. Information about the 23 Interviewees

#	Party	Gender, Age	Education	Years in the industry	Previously employed by other types of actors	Worked abroad
1	Client	Female, 33	M.Sc. Civil Eng.	8	Contractor	Yes
2	Contractor	Male, 54	M.Sc. & Econ.	24	No	Yes
3	Design	Male, 41	M.Sc. Civil Eng.	17	No	Yes
4	Client	Male, 38	B.Sc. Constr.	18	Contractor	Yes
5	Contractor	Male, 39	B.Sc. Constr.	17	No	Yes
6	Design	Male, 39	M.Sc. Civil Eng.	15	No	Yes
7	Client	Male, 29	M.Sc. Civil Eng.	6	Structural Eng.	No
8	Contractor	Male, 37	M.Sc. Civil Eng.	13	Structural Eng.	No
9	Client	Male, 35	M.Sc. Ind. Econ.	8	No	No
10	Contractor	Male, 55	M.Sc. Civil Eng.	30	Carpenter	Yes
11	Design	Male, 45	High Sch. Constr.	25	Contractor	No
12	Client	Female, 30	M.Sc. Mechanics	3	No	No
13	Client	Male, 48	M.Sc. Civil Eng.	24	Structural Eng., Contractor	Yes
14	Contractor	Male, 44	M.Sc. Civil Eng.	17	No	Yes
15	Process Contractor	Male, 48	B.Sc. Undefined	N/A	N/A	Yes
16	Process Contractor	Female, 29	M.Sc. Energy	N/A	N/A	No
17	Client	Male, 66	High School	45	No	No
18	Client	Male, 41	B.Sc. Undefined	19	Structural Eng., Contractor	Yes
19	Contractor	Male, 55	High Sch. Constr.	34	No	No
20	Contractor	Male, 34	Craftsman	15	Carpenter	No
21	Design	Male, 60	M.Sc. Civil Eng.	36	Contractor	No
22	Client	Male, 44	M.Sc. Civil Eng.	18	No	No
23	Contractor	Male, 35	M.Sc. Civil Eng.	10	Carpenter	No

Several interviewees were surprised when they were asked to describe and elaborate on changes that they had perceived over the years. The initial spontaneous response was often a bit sarcastic and humorous explaining that the construction industry is conservative by nature and that change is scarce.

"I almost replied: have there been any changes within the construction sector?"…"The construction sector is very conservative, almost a bit too conservative" (Contractor)

"It is a sector that is rather difficult to change, everyone says." (Client)

"We are so immensely bound to old ways of doing things; this is how we do, and how we shall always do." … "This sector really is traditional" (Design Manager)

However, after some reflection most interviewees were able to identify several changes within the industry as well as in the surrounding society that entail changes for the execution of large construction projects.

Organizational Structure

Matrix Organizations and Specialization

Some interviewees argue that the use of different setups of matrix organization has increased, entailing that many specialists are today organized in corporate staff functions serving multiple projects with competence simultaneously. This seems to be the case for both clients, contractors and consultants, though stronger on the client side. The interviewees expressed that this development has increased the variety of roles and the number of people involved in large construction projects, as well as the number of companies involved. Moreover, the control of resources decrease, and tensions are created between objectives in the different projects as well as towards objectives set in the line organization creating sub optimization. New specialist roles in projects are for example BIM-experts, PR-experts, legal advisers, purchasers and financial controllers. The reason for this development is partly an increased technical and administrative complexity increasing the competence requirements in different areas thus requiring specialization.

ferent areas thus requiring specialization. One client representative expressed that strong staff functions and the use of matrix organizations was an organizational trend causing more trouble than benefits:

"Some resources are organized in centralized support functions. I believe that that is really stupid, and that the matrix organization is the worst possible organizational structure."…"It creates a situation in which experts are not always aware of the project objectives, entailing that those experts run their own show at a very different level of ambition, higher or lower. Quite often they are not cost consciousness enough, not from the project's point of view."..."They often strive towards technical excellence instead of technical-economical optimization." (Client)

Smaller Permanent Client Organizations

Another change related to organizational structure is that many permanent client organizations have decreased in size, hence they have become much more dependent on consultants from a great variety of companies, entailing that continuity and experience exchange between projects is affected negatively. However, it is easier for the client's project manager to appoint the most appropriate resources for each project instead of being forced to pick resources from internal staff. The main driver for this development seems to be to save costs by being able to continuously adapt the organizational size to the actual project portfolio. Three interviewees representing the client side in this study were consultants.

"One thing that is obvious, is that client organizations have become much slimmer" …"The need for external competence has increased, in areas such as project management, risk management and technical competence. Earlier, this kind of competence was more often found in-house" (Client).

Organizational Units in Other Countries

The international competition in the field has increased somewhat, though most international competitors are still from northern Europe. Indirectly, this development also entails that the execution of projects require interaction with units abroad. Swedish contractors and consultants have also benefitted from the increased internationalisation. It has become more common that contractors purchase materials directly from abroad using an internal organizational unit specialized on international purchasing, often with offices abroad. Another strategy, which is similar but not as common, is to outsource design to low cost countries.

Business Relations

Contractual Aspects

The use of Design-Build contracts has increased, and according to some interviewees working for the Swedish Transport Administration (STA) their plan is to actively continue this trend as regards infrastructure projects to further engage the contractors in the design of roads, bridges, harbours and similar.

"As we in the future further shift from Design-Bid-Build to Design-Build contracts we will need to organize ourselves in a different way, with more design competence available also in the production phase." (Client)

This is a bit contradictory to the occurrence of construction management solutions in the area of large building contracts where it has become a bit more common to split the construction work into smaller contracts. According to one interviewee on the contractor side, this make planning and resource allocation problematic for the involved contractors since they lack overview and are often engaged much later in the process.

Over the years, the Swedish standard contracts for construction work (AB, ABT, etc.) have gone through a series of changes and adaptations to better suit the purpose, e.g. in the distribution of responsibility and risks between the parties. Despite the globalization of the entire society, international contracts are rarely used.

Partnering and Collaboration

The most frequently mentioned change was partnering and similar collaborative approaches. Most interviewees were enthusiastic, but some argued that partnering is more of a political trend and a fashionable word rather than a real change in how the parties collaborate:

"Partnering approaches requires more people and more time spent."..."We are caught in the trap, right now partnering is the preferred approach" (Client)

"From time to time, different themes are diffused throughout the sector; quality, green buildings, health & safety, and right now partnering" (Contractor)

"In reality, this is not a partnering project, we do not have that kind of dialogue, and I believe that there is no formal partnering facilitator." (Design Manager)

There are many variants of partnering used, stretching from an ambition of open communication between the client and the main contractor, to full partnering with joint economy and incentives covering most parties involved. This variety of partnering setups generates confusion for the people working in projects. Partnering requires a larger organization to deal with all the necessary communication and the continuous joint decision-making. Another effect mentioned was that partnering approaches make it possible to wait longer for certain decisions and that the tendency is that decisions are more often changed, creating stress and tensions. It has become more common that people shift role/party within the industry, creating a better mutual understanding and dialogue between the parties, making the introduction of partnering easier. The empirical material suggests that the introduction of partnering is an attempt to overcome problems with poor communication and fighting over change orders and similar, and as regards tax funded projects a way to meet complaints from the public on how money is spent, though the full explanation is most likely more complex and full of nuances.

Additional or Intensified Scope and Requirements

Environmental Focus

Environmental requirements on buildings and specified low energy consumption have become more common in contracts, often specified by demanding specific environmental certificates such as: LEED, BREEAM, and Green Building. These contract requirements cause additional pressure on the design and build processes including increased amount of

documentation, new stakeholders to manage, and a need for new competence and engagement on-site.

"The strong focus on the environment is the greatest change."..."Low energy consumption too, but today it is even more important to e.g. avoid health-endangering materials" (Design Manager)

"The amount of administration has increased enormously the recent 15 years."..."Foremost due to new routines covering areas such as environment and health & safety" (Contractor)

Interaction with the Public

The level of interaction with the public has increased, mainly because the public in general have become more informed, educated, engaged and demanding. Indirectly, urbanization also causes this trend since construction sites more often than before are situated in urban areas. An increased environmental interest in society together with a lowered tolerance regarding disturbances as noise amongst people living or working near construction sites create new expectations and requirements on projects. The number of stakeholders increases accordingly, and the demands from the public are not as defined as project goals, or the requirements set by authorities. Indirect effects are increased demands on documentation and planning, and intensified focus on non-disturbing production methods. To cope with the situation, more people are needed in the organization, with expert knowledge in communication, but also in specific technical areas. However, these effects seem not to be taken into account to a high enough extent in the bid phase, causing a strain on project management not to increase the cost for personnel, thus increasing the pressure on the existing organization.

"An increasing awareness and knowledge in the surrounding society and by people in general has made us rethink and change focus"..."We as contractors meet many more specialists today, not at least specialists working for the client" (Contractor)

"The society has changed in a way that everything is more intense today, everything goes faster."... "The large projects are supposed to be built without being visible or making any disturbances for the public." (Contractor)

Investment Strategies

Buildings are more often than before produced after the end customer is contracted instead of speculative production to stock. Even though the scope is not increasing, an intensified pace is required in the construction phase due to shortened production time available following the fact that the end customer most often wants the building rapidly once the investment decision is made.

"One increasingly important aspect in all construction projects that impacts on how to organize and manage site activities is time pressure. Previously, more houses were built on speculation, whereas today the client most often wants to have contracts with tenants in place before the project is fully initiated." (Client)

"Today contractors aspire much more to get the client's customer satisfied."..."Some change orders are too easily accepted, entailing time pressure and stress." (Contractor)

Politics, Legislation and Authorities

Construction activities have become more dependent on political decisions, which are often hard to predict in terms of time and content. Planning has become more difficult, and since the finalization date is often fixed the time available for production decreases, causing a need for higher pace in the production phase.

"Politics has to a much larger extent become crucial for this kind of projects during the recent 20 years. Sometimes local politicians have a great impact, and in other cases projects are dependent on regulations e.g. regarding taxes." (Contractor)

The Public Procurement Act (PPA) that was originally introduced in Sweden in 1992 and then went through a major revision in 2008 also imposes great changes to the field, e.g. by regulating the conditions for communication between the parties during the tender phase.

In the 1990´s the Swedish construction law went through a major revision, changing the distribution of responsibility for quality control. The role "Construction inspector" representing the client was eliminated and replaced with an administrative routine called "self-control", giving the contractors both the responsibility and authority to control their own work, using documentation and checklists. However, one client argued the control efforts by the clients have started to increase again.

"The client requires more information in written format; oral agreements are not as valid as before."..."The production journal kept on-site is almost worthless today in juridical terms, the client refuses to make any economic decisions based upon the information in the journal, but still urges that the information in it must be correct." (Contractor)

Although most of the interviewees talked positively about the focus on health and safety, they also emphasized some complicating effects: more people on-site are required including specific H&S-coordinators, more focus on precautionary measures is expected, and more documentation is required to fulfil requirements from Swedish Working Environment Authority. Similar effects were mentioned to be the result of the increased requirements of interaction with, and dependency on decisions by other authorities such as County Boards and the Environmental Court. The entry to the European Union has also imposed new regulations, norms and legislation.

Technology, Methods and Tools

Industrialized Construction

Focus on productivity and effective construction processes has increased over the years. The use of prefabricated solutions and industrialized approaches now seems to be a trend, and large contractors have introduced a set of standardized technical solutions for certain construction details based upon experience.

"Prefabricated solutions, that production is made off-site, has in my opinion increased, and will continue to increase, for example with prefabricated installation rooms and similar, not only structural frames." (Design Manager)

Information Technology

The use of information technology has become more common, and the variety of IT-solutions and tools have grown: Computer aided design work including advanced structural engineering tools, Building Information Models (BIM), project document databases, E-mail, and knowledge seeking as well as spreading information using intranets and the internet. Most interviewees were positive and saw good opportunities in these developments.

"The use of project document databases makes my job much easier." (Design Manager)

However, some interviewees argued that this development requires new specialist competence on-site and a strict and consistent use of the appointed IT-tools and systems or there is a risk of delusive imaginary accuracy.

"We are today working much more with 3D-design and with collision control using Navis Works"…"One indirect problem with this is that the increased level of details required in the model makes people believe that things that are not present in the model should not exist in reality at all. The model looks exact and definite even when the structure presented is not at all detailed designed. This urges us to be far more thorough."

Moreover, BIM requires an adapted flow of decisions in the design phase; hence a new design process with less flexibility. Some concern was raised on whether the variety of IT-tools and systems support the production or if they only cause more administration. One driver behind this change is technological development, but also that people who have grown up with computers and internet are now working in the field.

Logistics

Logistics have increased in importance: The increasing urbanization entail smaller areas for storage on construction sites and increased dependency on the traffic situation. Cost consciousness has also forced contractors to optimize logistics, and the focus on health & safety has increased the requirements on safe transports, unloading, and handling of materials. Accordingly, the sophistication and the competence in the area of logistics have increased.

New Materials and Technical Solutions

Over the years several new materials and technical solutions have been introduced to the construction industry. The reasons for this development are a mix of business related mechanisms, but also indirect as a response to e.g. legislation and increasing environmental care No matter the reason, the effect is that the technical complexity and the variety of competencies required in the construction process have increased.

HR-Related

Internationalization of the Workforce

It has become quite common that contractors deploy work forces from abroad, most often in different subcontractor setups. These developments have led to more complicated communication due to language barriers and cultural aspects, shift work, and demands on documentation in multiple languages increase the workload and is an additional source of errors.

"The internationalization creates specific problems, with cultural differences regarding the content and process of design activities as well as production". (Client)

However, it was also emphasized that internationalization is a catalyst for change and development and the introduction of new methods and approaches. Of the 23 interviewees in this study 11 had worked abroad.

Age, Experience, Gender, and Education

Many people in the industry have retired during the recent 10 years, leaving a gap of experience in many areas and a lowered average age of people working as project managers and in similar supervising roles (the average age of the 23 interviewees in this study was 41 years). The newcomers are often better in open communication and dialogue, but sometimes have difficulties in decision-making.

"One striking change is "shift of generations" and a new age structure. It seems as if we in the younger generation are less interested in doing as one has always done and are instead more interested in establishing good cooperation and production." (Client)

As an effect of the financial crisis in the early nineties in Sweden, many people left the construction industry resulting in a lack of people born in the sixties which makes the current intensive pace of retirements more problematic. Furthermore, many interviewees expressed that the lack of experienced supervisors is aggravated due to that supervisors with university degrees often look for new challenges after 1-2 years. As a result, it has become more common to recruit supervisors and site managers with craftsmen backgrounds. This development is starting to erode the boundaries between supervisors and craftsmen, but traditions and unions were mentioned as strong resistors of this potential unification of work forces. A majority of people working in project management positions have a Master of Science degree in Civil Engineering, though the variety of university educations present in construction projects is increasing. The amount of women have increased slightly, though there were e.g. only three female interviewees in this study. Most women active in the construction industry are not involved in the on-site production; rather they hold positions related to centralized support functions.

Gender Equality and Family Responsibilities

Expectations from society regarding shared responsibility for family related matters and gender equality have increased dramatically in Sweden. Considering the demographic changes mentioned above, this creates tensions, a need for more flexible working hours, and alternative ways of coping with daily tasks. More than half of the interviewees expressed rather strong examples of tension between work and private life – and most of those had young children. Amongst the interviewees that expressed that there was no tension between work and private life few had young children. Some interviewees even explicitly mentioned grown-up children as a main reason why their situation was satisfactory. Two of the largest issues expressed were that the inter-

viewees are expected to be reachable at all times, and that the daily commuting is time consuming.

"I am currently on parental leave two days a week."…"My wife is also working in the construction industry, she is a contractor."…"We have discussed how our private life suffers from this, but it is an active choice to enable work with stuff that is interesting." (Client)

"We represent the modern family, I get the children from kindergarten now and then and sometimes I drop them off."…"However, my wife is currently working 60 % of full-time so she takes a greater responsibility for family related tasks."…"I do bring work home; I think of it and elaborate on different issues and tasks; it takes energy, and it is easy to lose focus on kids and family."(Contractor)

"There is not much time left for private life, which is tough, I quite often feel tired."…"We have a subcontractor that works 7-22 in weekdays and 7-15 on Saturdays"…"I have a wife and one small child." (Contractor)

TRANSITIONS FROM SOCIETAL CHANGES TO NEW CONDITIONS FOR THE FIELD

To achieve an overview of the transitions from changes in the surrounding society, through the defined change categories, and further to changed conditions for managing large construction projects, further analyses were conducted. First, societal changes that were commonly mentioned by the interviewees were identified and then summarized into seven different blocks. Second, an analysis of changed conditions for managing large construction projects that are common for different change categories as described by the interviewees were conducted. Third, a mapping of the transitions was conducted, presented in Table **2** and Table **3**. It is important to understand that there might be non-societal drivers behind the changes, e.g. business driven. However, this research focuses on societal change forces mentioned in the empirical material. Moreover, the study gives no information as regards the level of connection between the different changes.

CONCLUDING DISCUSSION

This study sets out to investigate if and how changes in the surrounding society have changed the conditions for how large construction projects are executed, in order to increase our understanding of how to manage current and future projects. Although many interviewees spontaneously said that the construction industry is conservative, all of them presented and discussed a fair amount of changes after thinking a while. Accordingly, the stories presented in the results section clearly show that substantial changes have taken place in the field of Swedish large construction projects over the years. The conditions for the organization and management of large construction projects have changed accordingly, which is summarized in Table **3**. These findings contrast previous research that argues that there are a lack of changes in the Swedish construction industry [9]. However, the finding that many changes within the field have evolved at least partly as a reaction to external changes rather than as a proactive encouragement of innovation, indicate conservative thinking and behaviour. Some conditions have changed in a way that creates opportunities whereas some seem to make management more complicated, though the empirical material does not provide information enough to make a proper evaluation of the effects. The important conclusion is that the new conditions need to be taken into account when executing current and future large construction projects. The new conditions will affect decisions of organizational structure and delegation of authority, as well as allocation of resources, and appointment of key personnel including the project manager.

The specialization and use of matrix organizations lead to that different functions within the parties react to different external changes, and sometimes in different ways to the same external change. This entails a lack of overview and control of the responses, and to potential sub-optimization where positive effects of one response gets eroded or even eliminated by other responses. One specific perspective that seems often to be forgotten is the effect that these uncoordinated responses mean to the people working in the field. In the spirit of development, new routines, processes, and ways of working are introduced without taking enough into account the summarized effect on the workforce in terms of increased workload and complexity, lack of motivation and unsatisfied personnel.

Another possible effect of new ideas being implemented as responses to external changes is that new solutions or ways of working are being implemented without proper analyses of the business case. Similarly, the establishments of trends in the field may also entail broad implementation of certain solutions and ways of working without proper analyses of the benefits in the specific project. This kind of concern was raised by some interviewees as regards partnering and certain information technology. In their study from 2002, Greenwood, Suddaby and Hinings [27] conclude that professional associations has an important though complex role to play in terms of legitimizing changes in highly institutionalized fields. In their view, the often suggested conservative role is on one hand true in some stages of change, but in other stages the role shifts to the opposite. Nevertheless, professional associations have a great impact on what ideas that becomes trends in the field, and how these trends are presented.

According to Dacin, Goodstein and Scott [18], many changes require a de-institutionalization to take place to make ground for the new ideas. It seems as if the swift changes in demography of the people working in the construction industry and the increased diversity of educational backgrounds have contributed strongly to the de-institutionalization of many prevailing ways of working, enabling alternatives to be developed. For example, the increased use of information technology, industrialized approaches and improved logistics, international procurement of both material and services, and the use of more collaborative contractual approaches. However, there are also examples where institutions have prevailed even when legislation has changed. One example of this is the use of construction-site journals that on one hand no longer has any contractual meaning or power, but on the other hand seems to still be in use and sometimes requested by clients. This phenomenon is very similar to what Harry Sminia [19] refers to as "institutional continuity".

Table 2. Transitions Between Societal Changes and Change Categories

Societal Change	Change Categories
Globalization All aspects of the world becoming more integrated: International suppliers, global politics, harmonization of legislation and regulations, and integration of labour markets.	Organizational units in other countries
	Politics, legislation and authorities
	Internationalization of the workforce
Urbanization The increasing proportion of the population living in urban areas results in more challenging logistics in cramped construction sites and interaction with neighbours.	Interaction with the public
	Logistics
Demographical processes Changes of different attributes of the population entail direct effects in terms of new attributes of the workforce. Indirectly, new forms of collaboration and new tools are enabled, but a need for more interaction with the public is also an indirect effect.	Partnering and collaboration
	Interaction with the public
	Information Technology
	Internationalization of the workforce
	Age, experience, gender and education
Values and Attitudes Different societal processes that entail changes of values and attitudes amongst the population, sometimes enable alternative and new approaches and solutions, but often cause increased workload as well as complexity in terms of working hours and similar	Partnering and collaboration
	Environmental focus
	Interaction with the public
	Politics, legislation and authorities
	New materials and technical solutions
	Age, experience, gender and education
	Gender equality and family related responsibilities
Democratic processes Processes that lead to increasing transparency, and more power to the public. Some effects are direct, whereas some effects are indirect through legislation and regulations.	Interaction with the public
	Politics, legislation and authorities
	Gender equality and family related responsibilities
Technological developments All aspects of technological development: products, solutions, and methods for design and production. Indirectly these developments require a greater diversity of competencies, often enabled by the use of matrix organizations.	Matrix organizations and Specialization
	Industrialized production
	Information Technology
	Logistics
	New materials and technical solutions
Productivity and revenue All aspects of increased focus in the society on productivity and revenue. This focus is part of the explanation to many of the change categories, though most of them also originate from other societal changes.	Matrix organizations and Specialization
	Smaller permanent client organizations
	Organizational units in other countries
	Contractual aspects
	Partnering and collaboration
	Investment strategies
	Industrialized production
	New materials and technical solutions
	Internationalization of the workforce

Table 3. Transitions Between Change Categories and Changed Conditions

Change Categories	New Conditions for Managing Large Construction Projects
Matrix organizations and Specialization	Increased dependency on project external stakeholders An increasing number of different stakeholders entailing: more controlled processes leading to pro-activity but also less flexibility, less control of decisions leading to sudden changes of requirements, increased workload in terms of documentation and communication, and sometimes contradictory and vague expectations.
Smaller permanent client organizations	
Organizational units in other countries	
Environmental focus	
Interaction with the public	
Politics, legislation and authorities	
Gender equality, family related responsibilities	
Matrix organizations and Specialization	Larger and more complex project organizations More people required with an increased mix of age, experience, competencies and backgrounds, and also a greater variety of companies and parties involved in large construction projects. The globalization requires project managers than can lead multicultural organizations including different languages.
Smaller permanent client organizations	
Organizational units in other countries	
Contractual aspects	
Partnering and collaboration	
Environmental focus	
Politics, legislation and authorities	
Information Technology	
Logistics	
New materials and technical solutions	
Internationalization of the workforce	
Age, experience, gender and education	
Contractual aspects	Increased pace and tempo in construction phase The intensity in production has increased, with many parallel interdependent activities in a shorter time frame.
Partnering and collaboration	
Interaction with the public	
Politics, legislation and authorities	
Investment strategies	
Organizational units in other countries	More flexible working conditions required To be able to recruit and keep personnel, companies need to offer more flexible working conditions than before, including flexible working hours and possibility to split responsibilities and appoint deputies. In addition, interaction with parties in other time zones requires flexibility.
Internationalization of the workforce	
Age, experience, gender and education	
Gender equality and family related responsibilities	
Partnering and collaboration	Improved openness, collaboration and communication Improved openness, collaboration and communication between the people representing different parties within large construction projects in general.
Interaction with the public	
Information Technology	
Age, experience, gender and education	
Smaller permanent client organizations	Increased variety of contractual setups Increased variety of contractual setups and distribution of risks and responsibilities between the parties within large construction projects in general.
Organizational units in other countries	
Contractual aspects	
Partnering and collaboration	
Internationalization of the workforce	
Investment strategies	
Environmental focus	Increased variety of methods and solutions New technology and methods introduced that on one hand improve and help the work in many ways, but on the other hand sometimes entail negative effects often not anticipated prior to the decision to change approach. Predictability of performance and quality decrease, as well as uncertainty of fulfilling requirements. Industrialized construction has a potential of decreasing the uncertainty, but simultaneously imposing a risk for repetitive errors.
New materials and technical solutions	

The reputation of the construction industry being conservative seems to have become institutionalized as such. There are several statements by the interviewees showing that many professionals in the industry believe that the industry is conservative by nature. It might be that this kind of statements is of habitual nature and that the continuation of this institution is unintended [19]. Nevertheless, following the principles of institutional theory, this imposes a risk of a self-fulfilling prophecy blocking innovation and developments to take place and making the construction industry less attractive to people prone to development and change.

According to the empirical material the increased pace and tempo in the field can be traced back to societal changes. However, there are also some concerns raised over the workload generated by new technology and new methods used in the field. These concerns can be interpreted as conservative thinking, but it is important not to take that assumption for granted. Instead one may consider the possibility that some developments in areas such as logistics, production methods, and information technology generate increased pace and tempo rather than being the solution to externally imposed requirements on increased tempo.

It seems clear that a strong trend is industrialized approaches including prefabrication and standardization of certain components. The aim is to gain effectiveness and productivity, but also to improve control of quality. These standardization processes do decrease the variety of solutions and should bring down uncertainty, but ironically this development simultaneously imposes a risk of repetitive errors similar to what is traditionally associated with e.g. the car industry. One related issue is how insurances will cover repetitive errors in the construction industry?

It is a bit of a paradox that the organization required to execute a typical large construction projects as of today is larger and more complex containing many more specialists than before, and that at the same time clients have shrunk their permanent organizations. This has opened up a great market for consultant companies, but also some concerns regarding continuity and knowledge sharing within client organizations. Furthermore, one must consider how this situation affects the implementation of partnering approaches where the client representatives are in reality contracted by the client in a separate commercial agreement: Do those people feel they can be open enough, and do they have enough mandate from the client to really make the swift decisions necessary for progress in a partnering project?

There is potentially a tension between globalization and the ambition and societal change to share the responsibility for family matters. Having organizational units in other time zones require availability before and after normal working hours, and contractors and subcontractors from abroad often prefer to work long days in longer periods and then stay home for a week or so. Even though the latter is often regulated in contracts, both situations make it even harder for supervisors and project managers to leave work in time and then stay off-line.

A limitation with this qualitative research is that it does not provide explicit information on the magnitude of each change, nor does it provide an answer to the aggregative nature of each change though some effects mentioned in the change stories are obvious to be positive or negative. To achieve such validating results a more quantitative approach would be encouraged in future research. More research is also required to further investigate how the changed conditions for executing large construction projects presented in this study affect project management as regards e.g. governance structure, and project manager's personality, education, experience, and managerial style. Furthermore, considering the successive development of gender equality in different parts of the world and the fact that gender equality is rather strong in Sweden [28], it would be interesting to further investigate how the development of gender equality and shared responsibility for family matters has influenced the field and the industry as a whole.

CONFLICT OF INTEREST

The author(s) confirm that this article content has no conflicts of interest.

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Paper II

Managing short-term efficiency and long-term development through industrialized construction

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Managing short-term efficiency and long-term development through industrialized construction

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There is a strong need for a productive and innovative infrastructure sector because of its monetary value and importance for the development of a sustainable society. An increased level of industrialization is often proposed as a way to improve efficiency and productivity in construction projects. In prior literature on industrialized construction, there are however neither many studies addressing more long-term aspects of innovation and sustainability nor studies within the infrastructure context. Organizational theory suggests that firms need to be ambidextrous and focus on both long-term exploration of new knowledge and technologies and short-term exploitation of current knowledge and technologies, in order to achieve sustainable development. Therefore, an investigation of how both short-term exploitative performance objectives and long-term explorative development can be addressed when implementing industrialized construction in infrastructure projects was conducted. A case study consisting of four infrastructure projects shows that the main drivers for increased industrialization are of an exploitative nature, focusing on cost savings and increased productivity through more efficient processes. The main barriers to increased industrialization are however related to both explorative and exploitative activities. Hence, by managing the identified barriers and explicitly addressing both exploitation and exploration, industrialized construction can improve both short-term efficiency and long-term innovation and sustainability.

Keywords: Ambidexterity, efficiency, industrialization, infrastructure, sustainability.

Introduction

Increased industrialization of construction processes is often suggested by both researchers and practitioners to be a promising approach to improve construction project performance (Abdul Kadir *et al.*, 2006; Höök and Stehn, 2008; Girmscheid and Rinas, 2012). The basic argument is that the construction industry has much to learn from manufacturing industries in terms of product development, production processes and supply chain management (Gann, 1996). Yet others warn that management practices that are successful in manufacturing contexts cannot be readily transferred to the construction industry without major adaptations to fit the project-based context (Bresnen and Marshall, 2001; Riley and Clare-Brown, 2001). Nevertheless, prior findings highlight many different benefits that drive the interest in implementing industrialized construction, such as time savings, improved cost efficiency, improved safety, and better quality (Abdul Kadir *et al.*, 2006; Alinaitwe *et al.*, 2006; Girmscheid and Rinas, 2012).

Most of the earlier studies on industrialized construction highlight productivity improvements achieved in production processes in the housing sector (e.g. Gann, 1996; Abdul Kadir *et al.*, 2006; Höök and Stehn, 2008), whereas the concept is less actively considered and is also more difficult to transfer successfully to, and implement in, the infrastructure sector (Winch, 2003). The inherently one-off nature

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of the infrastructure sector means that each project is different, making it difficult to achieve the degree of repetition and routinization necessary to make the most of this kind of manufacturing concept (Bresnen and Marshall, 2001). Having said that, improved productivity in the infrastructure sector is especially urgent from a societal perspective since the efficiency of large public spending in infrastructure investments is crucial for development and economic growth in many countries (Caerteling *et al.*, 2011). This is because an efficient infrastructure system can reduce transaction costs and enhance opportunities for access and exchange in a society (Rose and Manley, 2012). The rationale for the application of industrialized construction in the infrastructure sector is yet to be investigated. In order to study how the concept of industrialized construction might be applied within the context of the infrastructure sector, it seems relevant to investigate the drivers for and barriers to increased industrialization in infrastructure projects.

Prior studies have found that efficient and productive performance in infrastructure projects is a challenge and that many projects suffer from cost and schedule overruns (Flyvbjerg *et al.*, 2003; Minchin *et al.*, 2011; Cantarelli *et al.*, 2012). Other authors note that innovation is central both for improving efficiency and for achieving high quality, added value and sustainable development in infrastructure projects (Eriksson and Westerberg, 2011; Gil *et al.*, 2012; Rose and Manley, 2012). Although previous studies in the infrastructure sector have highlighted the urgency of addressing either short-term efficiency or long-term innovation they have not acknowledged their mutual importance and the tension between them.

In organizational learning literature, this tension is pinpointed in research on exploration and exploitation (March, 1991). The challenge of achieving both short-term efficiency based on exploitation of existing knowledge and technologies and long-term adaptation and innovation based on exploration of new knowledge and technologies is central in both theory and practice (Gupta *et al.*, 2006). Tiwana (2008) argues that project-level investigations, in which exploration and exploitation and their effects on performance are studied within projects, are very few. This gap may be due to the fact that prior studies on this topic mainly have focused on manufacturing industries (Adler *et al.*, 1999; Katila and Ahuja, 2002) rather than project-based industries such as construction (Eriksson and Westerberg, 2011). Owing to decentralization and short-term project focus, the difficulty of achieving both exploration and exploitation is, however, especially evident in project-based industries (Eriksson, 2013).

Prior research on exploration/exploitation has found that process management models (e.g. Six Sigma and total quality management), which have been widely diffused in many manufacturing industries, are efficiency oriented while their variance-reducing focus hampers exploratory innovation (Benner and Tushman, 2003). As industrialized construction is based on a process-focused perspective transferred from manufacturing industries, it may drive the infrastructure sector towards improved exploitation and efficiency but further away from exploratory innovation. In addition, infrastructure clients' common focus on lowest cost in competitive bidding pushes suppliers towards cost orientation based on short-term exploitation, rather than on explorative innovation (Caerteling *et al.*, 2011). Hence, industrialized construction inflicts a major risk that an already strong focus on exploitation becomes even stronger at the expense of even weaker focus on innovation. It therefore seems urgent to improve our understanding of the concept of industrialized construction in the infrastructure sector and how it is related to exploration and exploitation.

This research addresses the abovementioned shortcomings in prior research by explicitly analysing both explorative and exploitative aspects of industrialized construction in the infrastructure sector. The research was initiated by a Swedish parliamentary investigation with the purpose of investigating how the infrastructure sector could achieve greater efficiency. One area that was identified as important was a higher degree of industrialization. The Ministry of Enterprise, Energy and Communications assigned two research teams the task of investigating how industrialized construction could be implemented in the infrastructure sector. When comparing the teams' research results it became apparent that there were many interesting and relevant reflections to be made from the two studies. This paper combines the two studies with the aim of improving the understanding of how project actors can balance the sometimes contradictory short-term exploitative performance objectives with long-term explorative development when implementing industrialized construction. The studies focused on investigating how explorative and exploitative aspects of drivers for, and barriers to, increased industrialization affect the implementation of industrialized construction in infrastructure projects.

Organizational ambidexterity

Exploration and exploitation

Exploration includes concepts captured by the terms diversity, adaptability, risk taking, experimentation, flexibility, innovation and long-term orientation, whereas exploitation involves refinement, alignment, control, constraints, efficiency and short-term orientation

Table 1 Aspects related to exploration and exploitation

Aspects related to exploration	Aspects related to exploitation
Heterogeneity and diversity	Homogeneity and alignment
Adaptability and flexibility	Formalization and constraints
Experimentation and risk taking	Control and risk avoidance
Creation and change	Refinement and reuse
Innovation and development	Efficiency and productivity
Long-term orientation	Short-term orientation

(March, 1991; Gibson and Birkinshaw, 2004; Andriopoulos and Lewis, 2010); see Table 1. The organizational capability of simultaneously achieving both exploration and exploitation is sometimes termed organizational ambidexterity (Duncan, 1976). Accordingly, ambidexterity involves the capability both to exploit existing knowledge and technologies for short-term profits and to explore new knowledge and technologies to enhance long-term development (O'Reilly and Tushman, 2008).

In his pioneering article on organizational learning, March (1991) argues that firms focusing on exploitation may obtain short-term efficiency gains based on current competences, leading to success and thereby more exploitation. As a result of the direct benefits of exploiting current competences, firms may get stuck in a competence trap. In a quantitative study of 279 US companies, Uotila *et al.* (2009) found that most organizations focus more on exploitation than on exploration. This is because of exploration's greater uncertainty and distance in time and space between the locus of learning and the locus of realization of returns (Uotila *et al.*, 2009). This may result in short-term success but long-term stagnation and failure (O'Reilly and Tushman, 2008). Finding a suitable solution to the ambidexterity dilemma is therefore crucial for a firm's sustainable competitive advantage (Gupta *et al.*, 2006).

Different solutions to organizational ambidexterity

There are three main types of ambidexterity solutions:

(1) Structural ambidexterity separates exploration and exploitation activities in different business units (Duncan, 1976; Tushman and O'Reilly, 1996; Benner and Tushman, 2003).
(2) Sequential ambidexterity separates the exploration and exploitation through focusing on first one type of activity and then the other (Duncan, 1976; Adler *et al.*, 1999; Gupta *et al.*, 2006).
(3) Contextual ambidexterity is based on a capability to simultaneously and synchronously pursue exploration and exploitation within a business unit or work group (Gibson and Birkinshaw, 2004; Gupta *et al.*, 2006).

Most prior studies focus on one or another of these three solution types, but recent research has found that a combination of different solutions may be the most practicable (Raisch *et al.*, 2009; Andriopoulos and Lewis, 2010).

Sequential separation can be achieved by focusing more on exploration in the early stages of a project and on exploitation at the end of the project during production/implementation (Raisch *et al.*, 2009; Andriopoulos and Lewis, 2010). However, previous investigations in the construction industry suggest that the structural and sequential separation of design and construction results in a prolonged project duration (Elfving *et al.*, 2005), poor buildability since construction planning cannot affect design, and poor innovation and poor implementation of explorative solutions during the construction stage due to lack of joint problem-solving (Korczynski, 1996). Accordingly, Eriksson (2013) argues that structural and sequential ambidexterity solutions are not sufficient in the project-based construction industry. Because of interdependences between different actors and their explorative and exploitative activities, distinct separation of exploration and exploitation may be unsuitable. Instead contextual ambidexterity within projects is required in order to obtain sufficient focus on both exploration and exploitation (Eriksson, 2013).

Exploration and exploitation in infrastructure projects

In a quantitative study of 258 transport infrastructure projects in 20 countries it was found that nine out of 10 projects suffer from cost overruns and that the average project in the sample had a cost overrun of 28% (Flyvbjerg *et al.*, 2003, 2004). Another similar study of 78 Dutch transport infrastructure projects found that new infrastructure projects on average had a 21% cost overrun whereas projects involving extensions of existing infrastructure suffered from 9% cost overrun (Cantarelli *et al.*, 2012). In light of these studies it is not surprising that much prior research into the infrastructure sector has investigated causes of design changes and cost and time overruns (Flyvbjerg *et al.*, 2004; Wu *et al.*, 2005; Han *et al.*, 2009) and means for improving productivity and efficiency (Minchin *et al.*, 2011;

Giezen, 2012). In a Dutch case study of a metro extension project, Giezen (2012) describes how project management succeeded in maintaining the budget and the schedule in this mega project by keeping it simple, that is, by exploiting old and proven technologies and by avoiding building underground constructions. This is an illustrative example of how a public infrastructure client discourages exploration in order to achieve exploitative project objectives.

The abovementioned studies are of an exploitative nature, pinpointing the need for more efficient project management and control. The opposite aspect (i.e. exploration) is often downplayed. Because infrastructures are public spaces that require durability and safety, public clients often discourage innovation and prefer staying with familiar technologies with predictable quality levels in order to avoid taxpayer and media scrutiny (Keegan and Turner, 2001; Caerteling *et al.*, 2011; Rose and Manley, 2012). In addition, the project-based nature of the infrastructure sector discourages investment in research and development that cannot be earned back on single projects (Caerteling *et al.*, 2011). Nevertheless, innovation in infrastructure projects cannot be neglected since it is central to improving both efficiency and quality (Tawiah and Russell, 2008; Gil *et al.*, 2012). Hence, it seems urgent to investigate how industrialized construction might affect both short-term project performance and long-term sustainable development, in order to obtain a more balanced perspective on exploitation and exploration in infrastructure projects.

Research methods

The Swedish Ministry of Enterprise, Energy and Communications initiated the research presented in this paper by assigning two teams to investigate industrialized construction in the infrastructure sector. Both empirical studies focused on how industrialized construction was implemented, on identifying and discussing the drivers and barriers that affected the implementation, and *how* and *why* these drivers and barriers interplayed. The empirical data collection was performed as a case study investigating four ongoing infrastructure projects. In line with arguments put forward by Yin (2003), a case study approach was deemed appropriate to develop deep and detailed knowledge related to how and why the phenomena under study occurred and affected each other. In addition, case studies are especially suitable when collecting and analysing data from processes (Pratt, 2009), such as the implementation of industrialization in infrastructure projects.

One research team carried out a multiple case study (Cases 1 to 3) in which the construction projects were selected through theoretical sampling in order to enhance external validity and analytical generalization (Eisenhardt, 1989). The other research team chose to study one other construction project in more detail (Case 4). All four projects were procured by different regional organizations of the Swedish Transport Administration (STA), the main client in the Swedish infrastructure sector. An advantage of the chosen approach is that observed differences related to industrialization can be more clearly associated with differences in how projects were procured, managed and governed on a local level rather than with contextual and organizational differences on a national or international level. The four cases represented a variety in terms of different contractors and contract forms, which enhances analytical generalization. Cases 1 and 2 were performed as design-bid-build projects, with the exception of bridges that were separately procured as design-build contracts. Case 3 was based on early involvement of contractors in a design-build contract. Case 4 was a design-build-operate contract where the contractor was responsible for operating and maintaining the facility for 20 years. In addition, Case 4 had the specific aim of promoting new and innovative methods of production. Hence, the chosen projects illustrate both traditional and more innovative approaches when contracting and carrying out infrastructure projects. This selection of cases made it possible to compare the effects of different contract forms on the implementation of industrialized construction as well as supporting the analysis of short- and long-term aspects from a number of perspectives.

In order to enhance construct validity, a variety of data collection methods and information sources was utilized (Yin, 2003; Gibbert *et al.*, 2008). Empirical data were collected mainly through 14 semi-structured interviews with the client's project manager (in Case 4 there were two project managers), the contractor's project manager and the design manager (in cases in which this person was not the same as the project manager). Furthermore in Case 4, the contract manager and the dispute resolution manager were interviewed. Of the 14 respondents one was female and two were hired consultants, whereas the others were employed directly by the client or contractor organizations (see Table 2).

In addition, contracts and documents describing project organizations were studied before or after interviews. Study visits were also conducted in order to develop a deeper understanding of the case study projects. These two data collection methods

Table 2 Case study projects and respondents

Case	Object (size)	Contract	Contractor	Respondents
1.	Roads and bridges in a dense urban area (~ €90 million)	Design-bid-build	Medium sized, focused on civil engineering	1. Client, project manager 2. Contractor, project manager 3. Consultant, design manager
2.	Roads and bridges in suburban area (~ €50 million)	Design-bid-build, but design-build for bridges	Large, comprising both civil engineering and other areas	1. Consultant, client's project manager 2. Contractor, project manager 3. Contractor, design manager for bridges
3.	Highway and connection roads in the countryside (~ €50 million)	Design-bid-build, but design-build for bridges	Large, comprising both civil engineering and other areas	1. Client, project manager and design manager 2. Contractor, project manager
4.	Roads and bridges in the countryside (~ €180 million)	Design-build-operate	Large, comprising both civil engineering and other areas. The same contractor firm as in Case 3	1. Contractor, contracts manager 2. Contractor, project manager 3. Contractor, manager of dispute resolutions 4. Contractor, design manager 5. Client, 1st level project manager 6. Client, 2nd level project manager

complemented the interviews and provided opportunities to triangulate the interview data (Denzin, 1978).

An analysis was conducted for each case. To enhance transparency and future replication, case study protocols were constructed together with case study databases, containing case notes, documents, and the narratives collected during the study, all with the aim of facilitating retrieval for future studies (Yin, 2003). The qualitative process data formed empirical data patterns, describing drivers for and barriers to increased industrialization in the case study projects. These empirical patterns were first analysed within each case and subsequently compared among cases in cross-case analysis in order to improve external validity (Eisenhardt, 1989). From the analysis of each case it was apparent that the overarching reason for problems concerning industrialization and innovation was the difficulty of balancing short-term project goals with long-term objectives on a company or sector level. The next step of the analysis was then to combine the results of each case in order to obtain explanations for sources of these barriers and, further, to analyse the respondents' views of how to enhance the drivers for a more long-term perspective.

Empirical results

Case-specific results

Case 1

The client's project manager took an early initiative for industrialized construction. The main idea was to seek repetition effects and predictability so that it would be easy and convenient for the contractor. The client's project manager stated that 'industrialized construction involves a specific template or model that is consistently used; we should do it like this in order to proceed'. Although the client was the driving force, the implementation of industrialized construction was undertaken in collaboration. Thanks to this, the project's actors came quite far with their industrial thinking and were satisfied with this approach, although further improvement was possible. Many methods and technologies were developed by the client and the consultant before the contractor was appointed but some technical solutions and methods were developed and implemented during the construction phase by contractor initiatives, so all three parties made significant contributions to industrialized construction.

Efficient and rational production was achieved through careful planning by the contractor, the client and the client's consultants. The cable trenches were not blasted separately after the tunnel section which is the conventional way. Instead, the contractor made the whole tunnel section a bit larger to make room for cable trenches directly in the section. This saved time and made possible more efficient production without duplication of work. Automation was also utilized in terms of a new efficient curb casting machine purchased from abroad specifically for this project. It was an expensive investment (€40 000) but it paid off thanks to the extensive length of curb in the project (> 4km).

The project's actors also achieved standardization and repetition in several ways. They used predetermined and standardized options for rock reinforcement and grouting by a limited number of predefined reinforcement and grouting classes. This reduced the number of approaches and work methods, and the contractor knew in advance what methods to use. Tunnelling work was standardized by making the tunnel section the same size throughout. This enhanced robustness at the expense of oversizing some parts of the tunnel. They also made use of one type of well with three chambers instead of three different types of well.

Prefabrication has been used to quite a large extent, mostly thanks to initiatives taken by the contractor. Standardization and prefabrication of the extractor fan foundations were undertaken instead of casting them *in situ*. Inside, the wall linings consisted of prefabricated concrete elements. The design manager described this approach as: 'we build a tunnel inside the tunnel'. Thus, the inner walls and ceiling in the tunnel constitute a standardized and uniform shell that protects the tunnel road from leakage, instead of working with rock drainage. The downside is that water may drip a little without drainage. In addition, pre-processed reinforcement was bought and transported from abroad. The reinforcement was ready to use upon arrival, and in some cases also assembled into prefabricated reinforcement cages, which saved time at the construction site.

Case 2

In this project, industrialized construction was not implemented as explicitly and systematically as in Case 1. The client's project manager, who came quite late into the project, has not worked actively with industrialized construction: 'We have not deliberately pushed this issue, but we use common sense and strive to obtain repetition of work methods'. Although the respondents did not think they had much industrialized construction, at least some practices and solutions related to industrial construction have been implemented.

Rational production has been achieved, for example by reusing the shuttering on a bridge (superstructure on the existing road bridge), and using foam instead of lightweight aggregate to minimize tongue. In terms of prefabrication, noise barriers and retaining walls were prefabricated instead of being cast *in situ*. The contractor pushed this issue because it was possible to save money and time while maintaining quality. The client agreed to the change. The client and the consultant also designed and planned for an opportunity to roll out lengthy reinforcement, but they later decided to adopt the traditional way. They have tried to create opportunities for economies of scale and repetition of tasks. One example is the use of the same shuttering beneath edge beams for several bridges, but time constraints interfered with its implementation so that complete repetition was not possible.

In regard to contracts and procurement forms, the client's project manager did not think it had any impact: 'we have not introduced any industrialized construction so it has not affected anything'. The contractor's project manager is of a different opinion and said that 'if it had been a turnkey contract, we would have felt a greater opportunity to find our own solutions'. Design-bid-build contracts may also work if the client drives the issue more from the start of pre-planning, but it takes longer to implement any changes proposed in retrospect by the contractor.

Case 3

In this project there was not an explicit focus on industrialized construction, although rational production and prefabrication were still significant aspects of the project. The industrialization work was mainly driven by the client and the consultant at the design stage. At the time of the interviews, the construction stage had not progressed very far so the contractor's achievements in the implementation of industrialized construction were rather limited.

Rational production was stimulated in a number of ways. Owing to the large surplus of clay, much effort was devoted to finding suitable landfills and minimizing transportation. More shift work was encouraged to achieve better utilization of machines and equipment. They also used mastic asphalt joints instead of milling with a cutter close to the edge beams before coating. An intentional repetition effect was achieved by having only two types of edge beam on a total of 16 bridges.

There were several examples of prefabrication. Four bridges for the passage of wildlife were based

upon prefabricated drums instead of cast *in situ* structures. These did not however lead to any significant savings. Noise barriers were designed in the form of modules consisting of 3m sections from a factory that could easily be hooked on to a site-built steel structure. The same noise barriers were used for a long stretch of road. A prefabricated bridge from Germany was suggested by the contractor. The aim was to reduce production costs and share the savings with the client. Economic reasons and curiosity drove the contractor to test this new solution. However, after analysing the suggested solution and its consequences, the client decided not to agree to this change, since the economic benefits were considered too small. Reinforcement was prefabricated abroad into three sizes of cage for assembly in a temporary factory enclosure at the site.

The client's project manager did not think that contract and procurement forms affected the opportunity to implement industrial construction: 'it did not affect anything: all the examples of prefabrication and standardization we conducted were part of the contract; that is, they were designed and planned before the contractor was procured'. The contractor's project manager had the opposite opinion, and felt that 'design-bid-build contracts were useless from an innovation perspective'.

Case 4

In line with the client's choice of procuring the project as a design-build-operate contract, there was the ambition of seeking a long-term relationship with the contractor. Since the contract concerning operation and maintenance lasts for 20 years the risk of implementing new methods and products that may prove to be inferior mainly lies with the contractor. Client representatives saw this as 'an opportunity to approve alternative and new methods within the project'. One example of this was a new method of stabilizing the soil, which made the excavation works more effective in some areas of the project. The long-term nature of the contract also fostered a culture within the project that was focused on collaboration rather than confrontation. Both client and contractor respondents expressed the view that the limit for more industrialized efforts rested on a higher organizational level, mainly the client. However, client representatives expressed the need 'to maintain a level of control'.

The respondents, both client and contractors, mentioned prefabrication of bridges as the most applicable form of industrialization, at least on a short-term basis. Although the contract did not prohibit prefabricated bridges, just two out of 39 bridges were prefabricated. The contractor argued that 'barriers, foremost the early specifications and the norms and regulations of STA, prevent the use of prefabrication to a large extent'. Other examples of industrialized methods were GPS controlled excavation machines where the work was carried out with the help of 3D visualization and planning tools connected to 3D models that enabled the project manager to obtain an overview of the whole project and, thus, a more efficient production process.

In conclusion, although the contract took the form of design-build-operate it should have enabled a higher degree of flexibility, resulting in the adoption and use innovative methods for the production process and the end-product. This was not the case. From the contractor's point of view, the reason was that the project specification was, to a large extent, decided at an earlier stage of the project by the client. From the client perspective, there was the difficulty of finding the right balance between control and flexibility, which often resulted in a higher degree of control than was felt necessary.

Results from the combined case analysis

The concept of industrialized construction

The respondents exhibited two fundamentally different views concerning their familiarity and knowledge of the concept of industrialized construction. Some respondents were unfamiliar with the concept and its content, while others were quite comfortable in both thinking about industrialized construction and discussing it from a professional viewpoint. The general view of industrialized construction was that it involves some sort of repetition in the use of production methods and production input. More specifically, three core elements were mentioned as defining the concept: (1) prefabrication; (2) efficient and rational production; and (3) standardization and repetition of products, processes and methods.

The concept of *prefabrication* was basically viewed as a means to transfer production hours from the construction site to a factory where prefabricated components are manufactured and then delivered to the construction site where work on site consists mainly of assembly. In general, there was an attitude among the respondents that it is more difficult for the infrastructure sector to adopt prefabricated methods than for the housing sector where prefabrication is more commonly used, because of a perceived view that infrastructure projects a more unique in nature. *Efficient and rational production* is a wide concept, exemplified by well-planned projects, improved predictability of the contractor's activities and a better

flow of production activities in order to reduce waiting and idle time. It also includes automation, that is, an increased use of machinery and equipment in order to make the production process more efficient. *Standardization and repetition* were deemed relevant to processes and production methods as well as products and components. Another aspect of repetition is learning across projects, which makes it possible to apply lessons learned and best practices over a number of projects.

Drivers for implementing industrialized construction

The two most important reasons mentioned for increasing the level of industrialization in infrastructure projects were time and money, that is, the need to lower cost and shorten lead times in construction. Almost all respondents gave these as the major drivers and related them to efficiency and productivity. Another driver is increased predictability, arising from more standardized procedures, which may improve clarity of expected performance as well as achieve a lower level of uncertainty.

Some respondents mentioned drivers at an industry level although they were not considered as influential as the abovementioned project-level drivers. The potential lack of skilled construction labour in the future was mentioned by some respondents. More industrialized production of products and components, in terms of higher extent of automation and prefabrication, may reduce the need for construction labour on site. Furthermore, industrialized production might improve the working environment when hazardous working operations can be performed under more safe conditions in a factory. Another aspect that is believed by some respondents to drive development of industrialization is the need for change within the construction industry towards a better innovative climate for promoting the development and use of new products, processes and production methods. A reason for this was given in terms of improving the image and attractiveness of the sector so it could be viewed as forward-looking and innovative instead of conservative and problematic

Barriers to implementing industrialized construction

When it comes to barriers, the respondents were not in agreement to the same extent as they were in regard to drivers. Several different types of barrier were mentioned, most of which were firm-level barriers related to the client organization, STA. One of the main barriers cited by the respondents concerned the client organization's procedures when executing infrastructure projects. Especially among the contractors, the procurement procedure was seen as a major barrier since STA, together with its consultants, decides upon the design, whereas contractors have little or no ability to suggest alternative solutions to project design, production methods and materials in design-bid-build contracts. The incentive for contractors in this case is simply to focus on short-term project cost rather than a longer-term lifecycle perspective. When contractors are not involved in the design stage, consultants sometimes try to minimize the amount of material and components, which may lead to savings in material costs but increased costs for manpower due to low buildability.

The client's own norms, rules and regulations were found to be major obstacles to innovation in general and industrialized concepts in particular. The main argument was that STA is sceptical about new and untested solutions. Hence, even when it is possible for contractors to suggest alternative technical solutions these are often turned down. These firm-level norms and regulations thereby prohibit the contractor from adopting new and innovative processes, production methods and products. However, a change has been initiated in STA. A design manager stated 'thankfully, STA has now come out with a new edition of its regulatory framework, which provides the possibility to find alternative solutions'.

The main barrier at the project level was considered to be the lack of opportunity for standardization and repetition. Most respondents felt that investments in the development of new solutions have to pay off in the project at hand since the contractor cannot count on using the solution in the next project. Hence, each project must provide sufficient opportunity for standardization and repetition. However, two of the contractors' project managers felt that development might, on rare occasions, be allowed to increase costs for an individual project if there were an opportunity for increased profitability on a long-term basis. Prefabrication of bridges was a commonly mentioned example related to repetition. In the design phase there has to be an understanding of the conditions that need to be met in order to use prefabrication. A project manager on the client side felt, however, that 'architects and consultants can be negative regarding repetition of technical solutions. Consultants make money by developing new and unique solutions: that is the basis of their work'. Lack of repetition is also related to lack of learning across projects. One contractor stated that 'it is difficult to find a way to handle experience feedback. Each project is viewed as a separate and isolated case, instead of one stage in a long process'.

At the industry level, the perceived conservative industry culture was also put forward as a barrier to

industrialized construction in particular and to innovation and change in general. Two respondents especially perceived that Swedish contractors are too traditional in their 'way of working' compared to some of their larger and international competitors, and thus less open-minded about new trends and developments, including industrialized construction.

Discussion

The case study projects investigated in this research achieved varying degrees of industrialization. Elements of industrialized construction that were implemented in the four projects are related to prefabrication of components and modules in factories instead of onsite construction, efficient and rational production (through careful planning and automation), and standardization and repetition of both processes and products. The degrees of industrialization that were achieved in the four projects are related to barriers to industrialized construction. Some barriers affect all projects in similar ways whereas others are more project-specific. Yet the drivers for increased industrialization seem to be similar across projects.

The empirical results show that opportunities for improved productivity and efficiency in terms of lower project costs and shorter duration are driving project actors' interest in implementing industrialized infrastructure construction. More long-term and macro-level drivers, such as an improved working environment and the need for change and innovation, were considered of less importance. From an ambidexterity perspective, the project actors' focus is thus on exploitation, whereas the interest in exploration is much slighter. This finding is in line with Benner and Tushman's (2003) argument that the implementation of process management may result in efficiency gains based on exploitation, while long-term innovation and exploration suffer. However, industrialized construction may in itself be regarded as a process innovation and, as such, it might spawn and/or require developments in other areas, such as product innovation or organizational/contractual innovations (Tawiah and Russell, 2008). In order to achieve a broad perspective on the possibilities and requirements for innovation, it is of utmost importance to explicitly relate the concept of industrialized construction to both exploration and exploitation, otherwise, there is a risk that the focus on exploitation will likely prevail.

In addition, the empirical results show that there are barriers to increased industrialization in infrastructure projects: traditional procurement methods and contract forms; the lack of possibilities for standardization and repetition; a conservative industry culture; and the client's norms and rules. These barriers inhibit not only short-term efficiency and exploitation but also long-term innovation and exploration. Hence, when dealing with these barriers, both exploration and exploitation can be addressed. The perceived conservative industry culture is a barrier not only to industrialized construction, but to change and innovation in general. Many previous studies have found similar results in Sweden (Kadefors, 1995; Eriksson *et al.*, 2008; Vennström and Eriksson, 2010) and other countries (Winch, 1998; Riley and Clare-Brown, 2001; Blayse and Manley, 2004), pinpointing the need for a long-term culture change at the industry level. The case study findings presented in this paper show that the degree to which industrialization was addressed was affected by key individuals whose views could not be characterized by conservative attitudes. In projects where the client's project manager explicitly drives an industrialization agenda (e.g. Case 1), a high degree of industrialization may be achieved through purposeful design work. However, in order to involve contractors as well and incentivize industrialization on a broader scale in the production phase, the other barriers must also be addressed.

In terms of the opportunities for standardization and repetition, Alinaitwe *et al.* (2006) and Tawiah and Russell (2008) argue that industrialized construction requires initial investment in technology and equipment. Large-scale projects and repetition possibilities are therefore crucial (Alinaitwe *et al.*, 2006; Tawiah and Russell, 2008) since investment in research and development has to be earned back on single projects (Caerteling *et al.*, 2011). Hence, in order to motivate suppliers to invest in explorative developments, the opportunity for exploitation of the investment must be put in place. The clients' common approach in dividing large projects into smaller parts in order to increase competition is counter-productive in terms of opportunities for combining exploration and exploitation.

Many infrastructure projects in Sweden are procured with design-bid-build contracts. There is a rational explanation for this based on STA's rules and regulations where control of the design process has to be maintained within the client organization. Some clients in the case projects did not perceive design-bid-build contracts as problematic from an innovation perspective. Clients and consultants worked together to develop the design and new technical solutions. However, the contractors perceived these contracts as a barrier to the development of the infrastructure sector, by inhibiting innovation in general and the use of industrialized concepts and processes in particular. This view is in line with that of Eriksson (2013), who

argues that the structural and temporal separations of exploration and exploitation that occur in design-bid-build contracts are not working well, because of the interdependencies among different actors and their activities.

Empirical findings in this study suggest that the client should focus on developing its role in establishing the prerequisites for a good end-product and not concern itself with the contractor's choice of input components and production methods. Since inflexible product specifications hinder contractor innovation (Rose and Manley, 2012), clients should focus on what to do through functional requirements, not how to do it by detailed specification of methods and materials. Results from this study thereby support prior studies arguing that there is a need to develop and use new forms of procurement: see, for example, Pakkala (2012) and Han *et al.* (2009). Contextual ambidexterity can be facilitated through integration of design and construction by involving the contractor early in the design phase (Eriksson, 2013). This facilitates efficiency through improved constructability and enhances opportunities for joint innovation. Design-build-operate contracts, where contractors are responsible for the function of the facility over a number of years, may give them incentives to invest in exploring new processes, production methods and products that would ensure a good end-product from a lifecycle perspective rather than just pursuing the aim of cutting production costs.

The norms and rules of STA hinder the implementation of new solutions. This firm-level barrier hinders both industrialized construction and innovation in general. The reluctance to accept new technology and methods decreases the risk of implementing solutions that are not sustainable (Caerteling *et al.*, 2011), but it also hinders innovation and development (Rose and Manley, 2012). STA needs to find a balance between radical innovation and continuous development, which requires an attitudinal change and also new procurement methods. Present procurement methods focus on short-term efficiency and do not incentivize more radical supplier-led innovations. In addition, the client should be more open to alternative solutions and more trusting of the contractor's suggestions. However, this lays the responsibility on the contractor to develop new products and production methods that meet the demands of the client. In a quantitative study of 115 US suppliers in the infrastructure sector, it was found that government-championed behaviours enhanced performance in technology development projects (Caerteling *et al.*, 2011). This supports our argument that public clients, like STA, have to change their norms and rules in order to encourage suppliers to develop new exploratory innovations that are crucial for sustainable development of the infrastructure sector.

Conclusions

This study has identified several critical barriers to increased industrialization of the infrastructure sector (i.e. traditional procurement methods and contract forms, the lack of possibilities for standardization and repetition, a conservative industry culture, and clients' norms and rules). These barriers inhibit not only short-term efficiency and productivity (exploitation) but also long-term innovation and change (exploration). The main argument put forward in this paper is that when planning for implementation of the concept of industrialized construction an ambidextrous perspective should be considered. Prior literature on industrialized construction and project actors implementing the concept mainly focus on exploitative productivity gains by enhancing efficient use of existing technologies and resources. This one-sided focus carries the risk of increasing the already strong emphasis on exploitation at the expense of exploration and sustainable development.

Prior literature has focused on either explorative or exploitative aspects of construction management. Through the adoption of an ambidextrous frame of reference we have contributed to construction management literature by showing how industrialized construction can provide opportunities for both exploration and exploitation in the infrastructure sector. More specifically, we have elaborated on the interplay between exploration and exploitation when implementing industrialized construction. By developing exploitation of prior explorative investments on a larger scale by standardization and repetition, both exploration and exploitation can be enhanced. This requires repetitive production in large projects, procurement procedures that make it possible to incentivize project actors to adopt contextual ambidexterity when collaborating in integrated design and construction, and public clients that act as champions of innovation instead of opponents to new and untested technology. By systematically addressing the barriers to industrialized construction, project actors might actually improve their capabilities and possibilities for organizational ambidexterity, which is critical for sustainable development. The discussion on how to release the tension between exploration and exploitation and achieve both simultaneously at the project level is an important contribution to the literature on ambidexterity within organizational theory.

The main practical contribution of the paper is a suggestion that project actors need to adopt an explicit ambidextrous perspective in order to fully benefit from implementing increased industrialization. Clients can enhance suppliers' explorative investments and developments by facilitating repetition and large-scale exploitation of successful explorative solutions. Hence, by adopting an ambidextrous perspective and dealing with the barriers to industrialized construction project actors can achieve a focus on both short-term efficiency and long-term innovation. If actors fail to acknowledge the importance of combining short- and long-term perspectives they risk missing the opportunities for exploration since the perceived drivers for implementing industrialized construction are mainly related to short-term efficiency.

To achieve a balance between a long-sighted innovation process (exploration) and a more short-sighted efficiency perspective (exploitation), there is a need for an attitude change among both clients and contractors. The innovation process for an increased level of industrialization in the infrastructure sector is affected by the development and use of more innovative forms of procurement that promote a more long-sighted focus on cooperation between clients, designers and contactors in order to achieve an innovation process that is driven from both suppliers as well as clients.

A limitation of this study is its explorative and qualitative nature based on four cases. Generalizations regarding, for example, the identified barriers should be made cautiously. In spite of this, we believe that many of our general arguments hold for the infrastructure sector as a whole. However, large-scale quantitative studies in both the infrastructure sector as well as other sectors of the construction industry should be encouraged in order to investigate the drivers for and barriers to industrialized construction on a more general level. There is also a need for further studies on the balance between explorative and exploitative efforts when implementing industrialized construction. A practical as well as theoretical challenge is to improve our understanding of how we can encourage both improved exploitation and exploration through new forms of procurement and changes in attitudes and behaviours.

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Paper III

Managing the tensions between exploration and exploitation in large construction projects

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Managing the tensions between exploration and exploitation in large construction projects

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Introduction

Prior organization research has shown that companies in various industrial contexts need to achieve both exploitation of current knowledge and technologies to make profits today, and exploration of new knowledge and technologies to adapt to changing conditions enabling profit on tomorrow's demands (March, 1991; Benner and Tushman, 2003; O´Reilly and Tushman, 2013). Due to the inherent differences between exploration and exploitation and the fact that they mostly compete for scarce resources and managerial attention, the tension between exploration and exploitation is of paradoxical nature (Andriopoulos and Lewis, 2009; Smith and Lewis, 2011; Papachroni et al., 2015), meaning that although both elements make sense, they seem impossible to combine. The organizational capability to manage this paradoxical tension and to simultaneously achieve both exploration and exploitation is called organizational ambidexterity, which was first coined by Duncan (1976). Due to its theoretical importance and practical relevance, organizational ambidexterity has received an escalating interest in organizational theory during recent years (Jansen et al., 2008; O´Reilly and Tushman, 2013).

Earlier ambidexterity studies have mostly investigated the performance effects of exploration and exploitation (e.g., He and Wong, 2004; Uotila et al., 2009), whereas there is a lack of knowledge about how to manage ambidexterity and achieve exploration and exploitation in practice (Birkinshaw and Gupta, 2013; Turner et al., 2015). Furthermore, many studies have focused on the firm- or business unit level (O´Reilly and Tushman, 2004; Uotila et al., 2009; Junni et al., 2013), for example by establishing a separate R&D-department focusing on explorative innovation. Koza and Lewin (1998) were first to adopt the exploration/exploitation paradox in an inter-organizational context when investigating strategic alliances. Later investigations have similarly suggested that ambidexterity is a highly relevant concept not only internally within firms but also externally in relationships among firms (Lin et al., 2007; Tiwana, 2008). Furthermore, Tiwana (2008) and Junni et al. (2013) argue that research on project-level ambidexterity, in which the tension between exploration and exploitation within projects is investigated, is even scarcer. This literature gap may be due to that ambidexterity research has mainly focused on various high-tech manufacturing industries (He and Wong, 2004; de Visser et al., 2010; Lin et al., 2013) rather than project-based organizations, such as construction firms and their inter-organizational projects (Eriksson and Westerberg, 2011).

Due to decentralization, short-term project focus, and interdependencies between different actors and their activities it is especially difficult to achieve both exploration and exploitation in project-based organizations (Rose and Manley, 2012; Eriksson, 2013; Turner et al., 2014). Organizations in the construction industry are mostly project-based and project-oriented work methods have long been the norm in this empirical setting. Prior studies have highlighted efficiency and innovation related aspects of managing construction projects. On the one hand, a long list of studies has found that time and cost overruns are common and that there is a need for improved efficiency and productivity in construction projects (e.g., Iyer & Jha, 2005; Assaf and

Al-Hejji, 2006; Cantarelli et al., 2012). On the other hand, the habitual view is also that construction firms are reactive and lack the ability to proactively pursue innovation (Rutten, 2009; Holt, 2015; Suprun and Stewart, 2015). Hence, many studies pinpoint the need for improved innovation capabilities in construction projects (Tawiah and Russell, 2008; Ozorhon, 2013). Although these two strands of literature have highlighted the urgency of addressing either short-term efficiency or long-term innovation, they have not investigated the mutual importance of, and the paradoxical tension between these two fundamentally different improvement agendas.

In addition, in prior project management literature the need to break down barriers to innovation and the need to resolve conflicts between project actors are generally revealed as conclusions rather than starting points (Harty, 2008; Vennström and Eriksson, 2010). Previous research has thereby focused on what should be done, while managers are in more need of understanding of how it can be done. Hence, it is vital to develop an improved understanding of how exploration and exploitation can be combined and simultaneously achieved in construction projects.

This study addresses the abovementioned literature gaps and managerial challenges by investigating exploration and exploitation in interorganizational projects in the construction industry. Thus, the purpose of the paper is to study how ambidexterity may be managed and how exploration and exploitation may be achieved in construction projects. The research identifies some drivers and barriers to exploration and exploitation and also sheds light on how various governance and management approaches interact and affect exploration and exploitation activities. Empirical data was collected through interviews with clients, contractors and consultants in seven ongoing large construction projects.

Literature review

Organizational ambidexterity - achieving both exploration and exploitation

Organizational ambidexterity involves the capability to both exploit existing knowledge and technologies for short-term efficiency and also explore new knowledge and technologies to enhance long-term development (O´Reilly and Tushman, 2008; Raisch et al., 2009). Exploration includes aspects illustrated by the terms diversity, adaptability, risk taking, experimentation, flexibility, innovation, and long-term orientation, whereas exploitation involves refinement, alignment, control, constraints, efficiency, and short-term orientation (March, 1991; Gibson and Birkinshaw, 2004; Andriopoulos and Lewis, 2010). Due to the low risk and direct benefits of exploiting current knowledge, firms may get stuck in a competence trap. In general, organizations focus more on exploitation than on exploration (Uotila et al., 2009), because of exploration's greater risk and distance in time and space between the locus of learning and the locus of realization of returns (March, 1991). This imbalance may result in short-term success but long-term stagnation and failure, for which reason an ambidexterity perspective is critical (O´Reilly and Tushman, 2008).

Prior research has identified three main types of ambidexterity solutions to manage the tensions between exploration and exploitation: 1) Structural ambidexterity separates exploration and exploitation activities in different business units or work groups so that one group focuses on one type of activity and another group focuses on the other type of activity (Duncan, 1976; Benner and Tushman, 2003). 2) Sequential ambidexterity separates the exploration and exploitation through focusing on first one type of activity and then on the other one (Duncan, 1976; Gupta et al., 2006). 3) A third way of dealing with the tensions between exploration and exploitation is through

contextual ambidexterity, based on a capability to simultaneously and synchronously pursue exploration and exploitation within a business unit or work group (Gibson and Birkinshaw, 2004; Gupta et al., 2006). Contextual ambidexterity embraces the paradoxical nature of the tensions (Lewis 2000; Smith and Lewis, 2011) in its simultaneous focus on both elements.

Most studies focus on one of these different types of ambidexterity solutions but some scholars argue that combinations of different solutions may be most practical (Raisch et al., 2009; Andriopoulos and Lewis, 2010). In line with this argument, Eriksson (2013) contends that structural and sequential ambidexterity solutions at firm or project portfolio levels are not sufficient in the project-based construction industry. One reason for this is that innovation typically does not take place in separate R&D departments in PBOs, but within their project portfolios (Blindenbach-Driessen and van den Ende, 2006). Furthermore, due to interdependences between project actors actors and their explorative and exploitative activities, distinct separation of exploration and exploitation in time and space may be unsuitable in PBOs. Contextual ambidexterity within projects can therefore be required in order to complement the other solutions to obtain sufficient focus on both exploration and exploitation (Eriksson, 2013). In this study we investigate how project managers make use of these three ambidexterity solutions when managing exploration and exploitation in construction projects.

Exploitative efficiency and explorative innovation in construction

As mentioned in the introduction, a lot of studies have reported a common existence of cost overruns (e.g., Iyer & Jha, 2005; Cantarelli et al., 2012) and schedule delays (e.g., Faridi and El-Sayegh, 2006; Sambasivan and Soon, 2007) in construction projects. This has spurred prior research to investigate causes of cost and time overruns in construction projects as well as factors that enhance productivity and efficiency. For example, in two quantitative studies of budget performance, Chua and colleagues first investigated 75 construction projects and secondly the perceptions of 20 industry professionals and obtained similar results. They found that critical success factors for budget performance are: complete design before construction, project management experience on similar technical scope, incentive-based payment, constructability program, and frequency of site inspections, budget updates and control meetings during construction (Chua et al., 1997; Chua et al., 1999). Other studies have found that common causes of time overruns are late end-user interventions, inadequate contractor experience, inadequate early planning, acceptance of lowest bid, poor site management and supervision, and low speed of decision making (Assaf and Al-Hejji, 2006; Faridi and El-Sayegh, 2006; Sambasivan and Soon, 2007). Taken together, these studies indicate that short-term efficiency, in terms of cost and time performance in line with budgets and schedules, is enhanced by exploitation of existing knowledge and by alignment through planning and control.

Another strand of literature has found various drivers and barriers for innovation in construction. For example, in a study of barriers to innovation in the Australian infrastructure sector, Rose and Manley (2012) found that project goal misalignment, client pressures, weak contractual relations, lack of product trialling, inflexible product specifications, and product liability concerns are major barriers to product innovation. Furthermore, in a case study of the construction of Heathrow Terminal 5 it was found that time pressure was a critical barrier hindering project actors to perform innovation work (Gil et al., 2012). Similar to these findings several studies have found that project objectives connected to sustainable development, client

championing, incentive-based payment, and economies of scale, are drivers for investments in innovation (Barlow, 2000; Tawiah and Russell, 2008; Ozorhon, 2013) whereas collaboration and early involvement of key actors, end-user involvement, and internal R&D-efforts, are enablers of innovation (Rutten, 2009; Bröchner, 2010; Ozorhon, 2013).

From these two strands of literature we learn that most drivers for and barriers to short-term efficiency are quite different or even contrasts to those related to innovation, whereas some drivers and barriers affect exploitation and exploration similarly. Project management practices thereby need to be tailored to achieve exploration and/or exploitation. Prior project management studies have however found that explorative development projects in project-based organizations were managed in the same control focused way as the regular exploitative business projects, which stifled innovation (Keegan and Turner, 2002; Blindenbach-Driessen and van den Ende, 2006). This suggests that there is a need to develop the understanding of how different strategies, governance principles, and project management practices can be designed and implemented to simultaneously enhance both exploration and exploitation in construction projects.

Research method

In line with the suggestions of O´Reilly and Tushman (2013), who call for more qualitative and in-depth studies on how to achieve exploration and exploitation, this paper is based on a qualitative interview study involving seven large construction projects in Sweden.

Sample

When selecting projects to study we found it important to extend the emerging theory to a broader range of organizational settings (Eisenhardt, 1989; Eisenhardt and Graebner, 2007) and obtain sufficiently rich and comprehensive empirical material, from which to gain insight and illustrate different ways of how to manage exploration and exploitation in different project settings. Hence, using a purposive selection (Silverman, 2006; Baxter and Jack, 2008) seven projects was chosen that together represented both house building and transport infrastructure work in the Swedish construction industry (see Table 1). The seven cases thereby represented a variety in terms of different clients, contractors, types of work, and types of contracts, which enhance analytical generalization.

Table I: Information about the seven case projects

#	Object	Type of work	Design responsibility	Client type
1	Infrastructure; Road + Tunnel	Civil Engineering	Client & Contractor (tunnel)	Public
2	Infrastructure; Road + Bridges	Civil Engineering	Client & Contractor (bridges)	Public
3	Infrastructure; Road + Bridges	Civil Engineering	Client & Contractor (bridges)	Public
4	Office Building	Building	Contractor	Private
5	Process Industry	Civil Engineering & Building	Client	Public
6	Hospital	Building – incl. refurbishment	Contractor	Public
7	Office Building Structure	Building	Contractor	Private

The main categories when selecting cases of different organizational settings were: 'type of work - transport infrastructure or building', 'design responsibility – client or contractor', and 'type of client - private or public'. The seven projects were all located in Sweden, had an original contract sum above 50 million Euros each, a production phase that lasted over several years, and together they comprised production of roads, bridges, office buildings, process industry, and refurbishment and production of a hospital. The logic behind using a stratified sample (Flyvbjerg, 2006) in terms of project size and duration is that a larger size and longer project duration may increase the importance of achieving both exploration and exploitation. In addition, because scarce resources have been found to hinder simultaneous management of exploration and exploitation in smaller organizational settings (March, 1991; Lin et al., 2007; 2013), large projects were deemed to improve the possibilities for managing ambidexterity in various ways (structural, sequential, or contextual ambidexterity) within each project.

Data collection

The primary data source is 23 semi-structured interviews with managers representing the client, the contractor, and the designer involved in each of the seven large construction projects in the sample. The interviews were conducted in the midst of the production phase, investigating how aspects related to exploration and exploitation were addressed in the projects. Following Andriopoulos and Lewis (2009), the interviews began with broad and general questions covering the topics: project description and structure, key actors and their relationships, and typical day to day activities. After that, more specific questions regarding refinement and development of new methods and solutions were asked. Although the interviews explicitly covered the exploration/exploitation topic, these particular terms were not used when asking questions to the respondents. Instead the aspects related to exploration/exploitation, mentioned in Section 2.1 were utilized as they are more commonly and widely used in practice, for example innovation and flexibility (exploration) and short-term efficiency and continuous developments (exploitation). The interviews were recorded digitally and conducted at the project site offices using a semi-structured approach with open-ended questions. The site visits were conducted in order to develop a deeper understanding of the case study projects. In addition, document studies of contracts and project plans were performed ahead or after interviews. These data collection methods complemented each other and provided opportunities to triangulate the interview data (Denzin, 1978).

Data analysis

The analysis was inspired by Eisenhardt (1989), using 'within case analysis' to establish patterns in the views expressed by respondents in each project. Case study protocols were constructed together with case study databases, containing case notes, documents, and the narratives collected during the study, all with the aim of facilitating transparency and future replication (Yin, 2003). The qualitative data formed empirical data patterns, describing examples of exploration and exploitation, drivers for and barriers to achieving exploration and exploitation, and ambidexterity solutions to manage the tensions between exploration and exploitation in the case study projects. These empirical patterns were firstly analysed within each case and secondly compared among cases in cross-case analysis in order to improve external validity (Eisenhardt, 1989). Due to space limitations the within case analyses are not

presented in this paper. The empirical results presented below focus on overall findings from the cross-case analysis.

Empirical findings

Organizational ambidexterity in the construction context

When discussing the importance of exploitation and exploration with the respondents many stated that continuous developments (exploitation) are more important than more radical innovations (exploration). The contractor in Project 3 stated that "*New solutions and work practices are most important to the industry, but for the project, it is more important to refine what we are already good at, it feels safer*". Others argued that exploration was most important in their particular project but that exploitation may be more important in other projects. Several respondents pinpointed the need of focusing on both innovation and efficient use of existing knowledge, which supported the notion that ambidextrous behaviours are critical in large construction projects. Some respondents highlighted the sequential importance and argued that it is vital to focus on larger developments and innovation in the early stages of the project and then gradually switch focus to efficient production based on previous experience and knowledge in later project stages. The contractor in Project 3 highlighted this aspect of timing: "*The client feels innovative. I hope we can find some innovative things we can agree on during the start of the project. It is extremely important that we develop the right things in the first quarter of the project, after that it is too late, then there is no turning back, we have to build according to the documents*".

The distinction between exploration and exploitation was not completely clear to the respondents. Some of them argued that it is difficult to distinguish between larger and more radical development work on one hand and more incremental development and fine tuning on the other hand. The design manager in Project 1 expressed this question as: "*What is innovation and what is in the consultant's normal work, where is the line between what is normal design and an innovation*"? In fact, many respondents expressed an attitude that any type of development is related to exploration, no matter how small the fine tuning is, while the other alternative is to do as usual. Hence, the choice is often crude; to develop or not, rather than sophisticated in terms of deciding the extent of development.

Exploitation in construction projects

Fine-tuning and incremental developments (exploitation) were not performed to a large extent in the projects, at least not in a formalized manner. However, it was mentioned that certain fine-tuning is occasionally conducted on craftsmen level although these developments are most often not documented. Furthermore, on repeated request, some respondents could mention development efforts that were more related to fine-tuning than innovation. A client in Project 6 pinpointed the importance of collaborating with others during incremental developments: "*Small adjustments to existing solutions are important. It is not the first project we do; we believe we are good at this. But when we fine tune a solution together with other actors with other skills and experiences, it becomes better*".

Most respondents mentioned that utilizing existing knowledge and technologies as they are without any development was dominant. The design manager in Project 1 expressed this as: "*We are bad at fine-tuning and continuous developments, we often do as we always have done*". Some respondents mentioned that exploitative developments are enhanced by long-term relationships in which fine-tuning and

continuous development can be performed from project to project based on previous experience.

A commonly mentioned barrier to continuous development in the projects was time pressure. In many projects the schedule was so tight that the respondents among both clients and contractors felt that there was little time to spend on fine-tuning and continuous development. Project 5 was especially haunted by time pressure, affecting development efforts. The client stated: "*The schedule is so tight that there is no time for further developments*" and the contractor had a similar view: "*Unfortunately, we have too little time; it becomes very difficult to find time to refine anything*". This is because it is faster to adopt a conventional method as it is than to try to improve and develop it before implementation. Another barrier that was mentioned and which is closely related to time pressure is that even slight fine-tuning or developments may influence the distribution of risk and liabilities to the actor suggesting the developed solution.

Exploration in construction projects

Some respondents mentioned that clients can drive innovation by encouraging the other actors to conduct development work and also by being open to adopt new solutions suggested by the other actors. In projects where clients are not encouraging an innovation agenda, consultants often do not focus on exploring new solutions. Innovation is then perceived to be dependent on initiatives by contractors, which are largely affected by the delivery system and type of contract. Respondents representing all three types of actors (client, contractor, and design manager) argue that the commonly used competitive tendering strategies based on Design-bid-build (DBB) contracts and fixed price payment are a main barrier to innovation. In this approach exploration and exploitation are separated and conducted by different actors, since the client together with their consultants decide upon the main features of the design long before contractors are engaged. This leaves contractors with little or no possibility to suggest alternative solutions to project design, production methods and materials. The incentive for the contractors in DBB-contracts is just to focus on short-term project cost rather than a more long-term life cycle perspective. The client in Project 1 stated that: "*The contractor often has difficulties to rethink; detailed specification will program a contractor to think that these are the rules*". The contractor in Project 1 had similar thoughts: "*An approved design in DBB-contracts makes us hesitant to suggest new design solutions for which we have to take responsibility*". Instead of this contractual separation some respondents pinpointed the importance of collaboration when conducting more radical development work, as highlighted by one of the clients in Project 5: "*The major problems and the more radical aspects were solved by gathering a large group of experts*".

Another barrier to innovation that was mentioned was time pressure, which was a common issue in many projects. Tight project schedules discourage contractors from thinking outside the box. It is less time consuming to do things the conventional way than to try to come up with new and better ways to do it. The contractor in Project 1 described the situation as: "*It might be difficult to find time to think in alternative ways in a project, because you always have the requirement that you must be finished in time. Should I start thinking and find new methods, estimate prices, finding suppliers and find consultants who can calculate - it takes too much time. You are often understaffed; you don't have one excessive man on a project*". However, the contractor in Project 3 also argued that time pressure can serve as a double-edged sword: "*Time pressure is both good and bad. When we feel time pressure we try to see*

what shortcuts we can make. But it also makes us inclined to follow old tracks that are known and safe, there is a trade-off. I can see a risk that we will use old tracks here because we do not want to increase the risk that we lose time, due to faulty shortcuts; we rather choose a safe bet".

In the three projects involving public infrastructures the clients' own norms, rules and regulations were experienced to be major obstacles for innovations. The main argument was that the Swedish transport agency (STA) is sceptical towards new and untested solutions, they want proven technology that they have first-hand experience of. Hence, even when it is possible for contractors to suggest alternative technical solutions these are often turned down by the client. The client in Project 2 exemplified this by describing STA's hesitation towards new solutions: "*Changing the technology to a solution that is not commonly accepted in the industry is almost impossible, because STA is so conservative. Within the boundaries of a single project, you have no opportunity to come up with a completely new solution*".

Also in Projects 4 and 5, the clients discouraged innovation. The contractor in Project 4 stated: "*The client's sharp opinion is that nothing that is newer than a decade is worth anything. They are very clear that they want solutions that have been proven to work, and are sustainable from an operational perspective. They don't want any innovations that no one has tested; they don't want to be the first to try*". The client explained that the focus on conventional solutions were especially strong in this project due to the nature of the tenant; a high-tech manufacturing company, which is extra ordinary technically competent and directive. "*With a tenant of this nature you dare not choose solutions that are more innovative, unless you are damn sure that they work*".

However, it was not only the clients that were hesitant of implementing new technologies; also some contractors showed a resistance towards innovation due to an inherent risk aversion. The contractor in Project 7 stated: "*We strive to use the company's existing technical solutions to prevent later emerging quality defects*". Also one of the contractors in Project 6 expressed similar thoughts, based on concerns for the customer and the facilities: "*It is extremely important for the hospital to have a carpet that is proven with regard to cleaning and maintenance. We cannot just put in 22,000 squares of a new untested carpet because we may believe it's better; it feels better to have a proven solution*".

Due to the one-off nature of construction projects contractors cannot count on using a newly developed solution in the next project. Hence, contractors mostly are of the opinion that investments in development work have to pay off in the project at hand, for which reason each project must provide sufficient possibilities for repetition and large scale utilization of an innovation. This is exemplified by one of the contractors in Project 6, implementing building information modelling (BIM) technologies for the first time: "*For our company, this is the biggest project we have had and the first time we are using BIM technology. The project is large so we can implement this in a profitable way. The project can take the development cost*". However, two of the contractors' project managers meant that development may, in rare occasions, be allowed to increase costs for an individual project if there is an opportunity for increased profitability on a long-term basis.

Discussion

In several of the projects studied, there was an apparent awareness that both long-term innovation and short-term efficiency are of crucial importance, both for the performance of the particular project and for the industry. The challenge, however, is to implement project governance and project management approaches that address the paradoxical tensions between exploration and exploitation and that enhance the achievement of both. The empirical findings support prior literature in that the tensions between exploration and exploitation may be managed through three types of ambidexterity solutions (i.e., structural, sequential, and contextual ambidexterity) (Gibson and Birkinshaw, 2004; Gupta et al., 2006). All three ambidexterity solutions were utilized in the studied construction projects, but the effectiveness and relevance of structural and sequential solutions were weak. In line with earlier construction research findings, the findings highlight that competitive tendering based on Design-bid-build contracts can hinder innovation (Tawiah and Russell, 2008) and result in poor buildability and production efficiency due to the structural and sequential separation of explorative design and exploitative production capabilities (Eriksson, 2013). Furthermore, structural and sequential separation of exploration and exploitation in different projects in a project portfolio is often not suitable since contractors mostly perceive that they need to exploit the benefits of exploration investments within a single project. Accordingly, large-scale projects or long-term contracts can 1) motivate contractors to invest in explorative innovations since these then can be exploited either within the same project or in subsequent projects and 2) enhance continuous developments across projects or stages/activities within a large project. Hence, sufficiently large and/or long contracts are important from an ambidexterity perspective.

Instead of the structural and sequential ambidexterity solutions that prior studies have recommended in other industries (e.g., Benner and Tushman, 2003; O´Reilly and Tushman, 2004), a contextual ambidexterity solution seems more appropriate in the construction project context (Eriksson, 2013). This can be based on early involvement of and collaboration among key actors, enhancing both exploration through joint innovation and exploitation through improved buildability. The empirical findings highlight that a contextual ambidexterity solution based on collaboration among actors with different capabilities and experiences enhances both incremental and radical development work. In fact, collaborative development work is especially important in this empirical context due to the systemic nature of innovations in the construction industry (Ozorhon, 2013; Kähkönen, 2015).

In prior ambidexterity research, which often has focused on high tech industries, exploration is related to radical innovation and exploitation is related to continuous innovation and development (Cao et al., 2009; de Visser et al., 2010). This study highlights the important empirical finding that exploitation within the context of mature industries such as construction very often involves conducting activities based on existing knowledge as it is, without any development at all. In fact, the respondents in this study seem to perceive that continuous development efforts are more closely related to exploration than exploitation, although these efforts are based on existing knowledge. This perception is potentially very harmful due to the importance of recognizing the significant differences in risks when comparing explorative and exploitative developments. Explorative developments typically require much more development time, capital investment, risk taking, and failure tolerance than exploitative developments (March, 1991; Lin et al., 2013). Hence, it may be

strategically important to rely on incremental improvements to achieve more continuous development, instead of passively adopt existing technologies as they are and then occasionally be forced to perform larger and more risky radical developments to adapt to changing circumstances. The introduction of a contextual ambidexterity perspective can therefore pinpoint the need for continuous developments as part of an exploitative strategy, instead of merely implementing products and processes just the way they are when striving for exploitative efficiency.

Prior research has shown that time pressure is a main barrier to innovation. Tight project schedules hinders project actors both to conduct innovation work and to assess potential pros and cons with a new solution, resulting in rejection of the solution due to uncertainty of its benefits (Gil et al., 2012). The empirical findings show that time pressure is not only a barrier to innovation, but to continuous improvements too. In situations characterized by time pressure many actors will choose to implement conventional solutions as they are instead of spending time on explorative or exploitative developments. However, similar to the findings of Barrett and Barrett (2006) and Andriopoulos and Lewis (2010), time pressure can in some circumstances be a driver for innovation, since "difficult constraints can push creative workers out of their comfort zone" (Andriopoulos and Lewis, 2010, p. 110). When actors are facing a situation where conventional solutions or methods are perceived to be too time consuming they feel the need to develop new methods that are faster, in order to keep the time schedule. A key element if time pressure is to serve as a driver for innovation is therefore that an upcoming shortage of time is identified early in advance, enabling proactive actions during the design stage. Hence, early involvement of contractors is key for making the most of time pressed projects.

The empirical findings support prior research that has shown that client championing is a main driver for innovation (Gil et al., 2012; Ozorhon, 2013), but that clients in project-based industries often are conservative and sceptical towards innovation (Keegan and Turner, 2002). This study highlights the importance of not only encouraging supply-side actors to perform innovation activities, but even more importantly for clients to accept and embrace new solutions with verifiable functions. Client championing can be especially important in situations characterized by time pressure. When a client procures a project with an explicit tight time schedule and simultaneously demands innovative time saving solutions, project actors can be especially motivated to focus on exploration.

Conclusions

This paper presents a study of how the paradoxical tensions between exploration and exploitation are managed in large construction projects. The empirical findings provide several theoretical contributions and practical implications presented below. Prior ambidexterity research, which previously has focused mainly on high-tech industries, suggests that exploration involves radical innovation and that exploitation involves continuous development and incremental innovation (de Visser et al., 2010; Lin et al., 2013). A contribution to the ambidexterity literature is that in mature industries, such as construction, the exploitation concept may often involve the utilization of existing knowledge just as it is rather than continuous developments of existing knowledge. This distinction is important, since implementation of existing knowledge and technologies without any development efforts may further increase efficiency and lower risks from a very short-term project perspective, but decrease efficiency and increase inertia by missing opportunities of continuously refining and

improving solutions that can provide a better function in subsequent projects or during the lifetime of the facility.

Another contribution to the ambidexterity literature is that the traditional ambidexterity solutions based on structural and sequential separation of exploration and exploitation that has proven successful in the high-tech manufacturing contexts (Benner and Tushman, 2003; O´Reilly and Tushman, 2004), don't work as well in project-based contexts. In construction projects it is instead better to adopt a paradoxical perspective, by accepting and embracing the paradoxical nature of the tensions between exploration and exploitation (Lewis, 2000; Smith and Lewis, 2011). Accordingly, contextual ambidexterity based on early involvement of contractors and collaboration among different actors with varying capabilities and experiences throughout the project stages, may enhance both incremental and radical development work. This is also an important contribution to the construction innovation literature. Due to the systemic nature of construction innovations (Kähkönen, 2015), it is critical to involve key actors early and make them interact in design and development activities to improve both efficiency and innovation. Hence, the clients' procurement strategies are central for enhancing explorative and exploitative developments.

Another contribution to the construction innovation literature is the importance of recognizing the double-edged sword nature of time pressure in relation to innovation. This is because time pressure can serve as both a driver and a barrier to innovation (Barrett and Barrett, 2006). Hence, it is important to distinguish among different forms of time pressures; both regarding their causes and their effects. For instance, an early identification that the schedule is tight may spur clients to adopt early contractor involvement strategies, which increase contractors' possibilities and incentives to engage in joint innovation efforts to develop improved time saving solutions.

An important managerial implication of this research is that the adoption of an ambidextrous perspective can facilitate strengthened focus on continuous development rather than merely utilizing existing knowledge as it is without further development. By becoming aware of the importance of, but also the distinction between, radical and incremental development, contractors can realize the significantly lower risk associated with incremental improvements of existing knowledge and technologies compared to more radical developments. Accordingly, by proactively and systematically performing incremental improvements instead of adopting existing technologies as they are, construction actors may become somewhat less dependent on larger and riskier radical developments in their quest to adapt to changing demands and requirements in the industrial context.

Another implication is that some mechanisms that influence project actors' time frames and their possibilities to adopt a long-term perspective, such as early involvement of key actors, large-scale projects with long duration, and/or long-term contracts and framework agreements are core for managing the paradoxical tensions between exploration and exploitation. Hence, managers can enhance organizational ambidexterity in construction projects by implementing such mechanisms that enhance both short-term exploitation and long-term exploration.

A limitation of this study is that only people working in management positions were interviewed. On the one hand this is an important group of people to talk to since these managers have an overall view of how to handle exploration and exploitation, and also the authority to implement changes that enhance organizational ambidexterity. But on the other hand the results indicate that there might be many unrevealed examples of minor and more informal exploration and exploitation efforts

conducted by craftsmen or site supervisors. One suggestion for future research is therefore to interview more roles in one or several projects. Another relevant aspect is to investigate how different forms of time pressure affect project actors' motivation and needs to conduct explorative innovations and exploitative developments.

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Paper IV

Paradoxical organizational tensions between control and flexibility when managing large infrastructure projects

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Case Study

Paradoxical Organizational Tensions between Control and Flexibility When Managing Large Infrastructure Projects

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Abstract: Recent socioeconomic changes have created and intensified paradoxical organizational tensions that companies in numerous industries, including the construction sector, need to address when organizing and managing their activities. The nature of these tensions has not been sufficiently explored in the existing construction management literature. Thus, this study analyzes tensions between control and flexibility at different organizational interfaces, as perceived by the managers of three large infrastructure projects that were parts of two different megaprojects in Sweden. The empirical findings highlight several tensions within three types of interfaces, that is, external, intra-organizational, and interorganizational tensions, that are important for both project managers and project owners to understand. This paper contributes to the project and construction management literature by illustrating the importance of a systemic paradox perspective, which is obtained by combining the paradox literature and principal–agent theory. A systemic paradox perspective is required to understand how tensions between control and flexibility are interpreted by different parties and how tensions in different organizational interfaces are interrelated and may be addressed to avoid suboptimization. **DOI: 10.1061/(ASCE)CO.1943-7862.0001081.**

Author keywords: Paradoxical tensions; Principal–agent relationships; Project management; Construction management; Megaprojects.

Introduction

In recent years, major technological developments accompanied by increases in the complexity and globalization of social structures have pressured companies to modify the organization and management of their activities (e.g., Jaafari 2003; Riot and de la Burgade 2012; Drucker 2013). According to Smith and Lewis (2011), such changes in organizing practices often entail various organizational tensions, which require applying a paradox perspective (Beech et al. 2004; Lewis and Smith 2014). This means that one does not choose a side in organizational tension but instead promotes a both/and perspective.

An organizational tension that is central in organization studies occurs between control and flexibility (e.g., Aaker and Mascarenhas 1984; Sethi and Sethi 1995; Adler et al. 1999). Control aspects within and between organizations have traditionally been integral parts of organization research (e.g., Ouchi 1979; Gencturk and Aulakh 1995). An influential body of literature addressing both intra- and interorganizational control is principal–agent theory, which analyzes the relation between two parties under the assumption that the principal needs to apply some degree of control over the agent to obtain expected outcomes (Eisenhardt 1989a; Aulakh and Gencturk 2000). However, according to Englehardt and Simmons (2002), a changing world requires increased organizational flexibility because creativity and innovation are stifled by rigid frames and control (Keegan and Turner 2002). A paradox perspective, arguing that organizing and management activities simultaneously require both control and flexibility, is thereby of importance (Smith et al. 2010).

Actors in the construction sector are no exception; they need to adapt to changes, such as increases in the number of stakeholders whose interests must be considered, in the complexity of contracts, and in demands for working conditions and operational procedures that are more flexible (Szentes and Eriksson 2013). In addition, Puerto and Shane (2014) highlight the impact of changes in the cultural and sociopolitical context of large infrastructure projects, such as new regulations and funding principles and an increase in refurbishment projects. These changes suggest that both increased control and flexibility are required, resulting in emergent paradoxical tensions.

Project management practitioners and theorists have often focused on various means to control projects through planning and coordination (Atkinson et al. 2006; Perminova et al. 2008; Lenfle and Loch 2010). Accordingly, extensive research in the construction sector has highlighted control-related aspects, such as project planning and monitoring (e.g., Chua et al. 1997, 1999; Sambasivan and Soon 2007). Other studies, however, stress the importance of addressing uncertainties in construction projects, such as unforeseen ground conditions, slow decision making, and client-initiated variations (Chan and Kumaraswamy 1997; Assaf and Al-Hejji 2006; Sweis et al. 2008). There are also studies showing that variations and change orders decrease labor efficiency in construction projects (Hanna et al. 1999a, b), indicating a need for greater flexibility when managing construction projects. However, most relevant previous studies discuss the importance of either control or flexibility, not both.

One exception is the study by Koppenjan et al. (2011), which suggests that project managers of large engineering projects need to combine control and flexibility while recognizing the paradoxical nature of the tension between the two. The RandstadRail project in the Netherlands, which is studied by Koppenjan et al. (2011), does in many aspects fulfill other researchers' definitions of so-called megaprojects. According to Flyvbjerg (2014), an important characteristic of megaprojects is that they are "trait making" rather than

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"trait taking"; hence, they are so large and impacting that in many aspects they change the structure of society, influencing a wide range of stakeholders and creating immense complexity. In a broad sense, megaprojects may be defined as "large-scale, complex ventures that typically cost US$1 billion or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people" (Flyvbjerg 2014, p. 6). In a study of infrastructure projects, Van Marrewijk et al. (2008, p. 591) narrow the scope by defining megaprojects in our particular empirical context as "multibillion-dollar mega-infrastructure projects, usually commissioned by governments and delivered by private enterprise; and characterized as uncertain, complex, politically-sensitive and involving a large number of partners." Hence, in megaprojects, there are both strong societal demands to ensure that taxpayer money is spent efficiently (Bruzelius et al. 2002; Van Marrewijk et al. 2008) and impose strict requirements for flexibility to adapt to uncertain and changing circumstances during long project durations (Koppenjan et al. 2011). Megaprojects and their subprojects are especially relevant from a principal–agent perspective because they involve both intra- and interorganizational principal–agent relationships, such as those between governance forums and project managers (intra) and clients and contractors (inter). The tensions between control and flexibility need to be managed at these interfaces. Overall, there seems to be insufficient knowledge about the paradoxical tensions between control and flexibility that arise at different organizational interfaces and that managers within megaprojects need to address.

The objective of this paper is to identify and analyze paradoxical tensions between control and flexibility that arise at different organizational interfaces, influencing project managers when they are organizing and managing large infrastructure projects that are parts of a megaproject. The empirical findings underpinning our contributions are drawn from an explorative multiple-case study, focusing on the production phases of three large infrastructure projects that were part of two different megaprojects in Sweden.

To enable the desired multifaceted analysis, the paper starts with the theoretical framework including paradoxical tensions, control versus flexibility, and principal–agent theory, followed by a method section. The empirical findings are then presented, organized by the three types of interface that were identified. In the discussion section, an overview of the identified tensions is presented and compared to previous relevant research, and a systematic approach to analyzing organizational tensions is discussed. The conclusions highlight the contributions to the project and construction management literature and important managerial implications.

Theoretical Framework

Paradoxical Tensions

Paradoxical organizational tensions have recently received increased attention in studies that are generating an evolving analytical and theoretical framework to discern, elucidate, and manage them. Paradox perspectives have been used to discuss how to manage change (e.g., Beech et al. 2004) and contradictory strategies (e.g., Smith et al. 2010) and to highlight tensions between opposing views and explanations derived from different organization theories (Poole and Van den Ven 1989; Lewis and Smith 2014). Lewis (2000) argues that paradox perspectives may be used as a theoretical framework to examine surprising and opposing findings in a way that complements analyses based on existing organization theories, and Lewis and Smith (2014) propose that a paradox perspective can be considered part of the foundations of the next generation of organization theories.

Lewis (2000) notes that a paradox emerges from elements that are contradictory yet interrelated—each element is logical when studied separately, but when combined, the elements seem irrational or even absurd. Although the elements seem inconsistent and impossible to reconcile, they coexist simultaneously. Based upon an extensive review of the paradox literature, Smith and Lewis (2011, p. 382) highlight the time perspective and define paradoxical tensions as "contradictory yet interrelated elements that exist simultaneously and persist over time." Paradoxical tensions often stem from organizing activities, and Smith and Lewis (2011) emphasize that any organizing activity will create tensions between what is implemented and what is not.

Control versus flexibility

One type of underlying tension creating paradoxes when organizing is between control and flexibility, often in terms of mixed messages from management and contradictions in processes and systems (Lewis 2000). Alternatively, these are described as paradoxes stemming from centralization versus decentralization (Beech et al. 2004). In a seminal work by Burns and Stalker (1961), two opposing ways of managing organizations are discussed: the mechanistic approach based on a high degree of control and the organic approach that includes more flexibility. Subsequent research has used slightly different terminology to discuss control-related tensions in different settings, e.g., differentiation and integration in chemical process industries (Lawrence and Lorsch 1967), flexibility in manufacturing industries (e.g., Sethi and Sethi 1995; Adler et al. 1999) and how restaurant chains can achieve both flexibility and efficiency simultaneously by creating enabling controls (Ahrens and Chapman 2004).

Many project management scholars have discussed how to control project outcomes through planning and coordination (Atkinson et al. 2006; Perminova et al. 2008) and by dividing projects into predefined subsequent phases (Lenfle and Loch 2010). Other scholars have emphasized the need for increased flexibility in project management, especially when creativity, innovation, and adaptation are required (Keegan and Turner 2002). In a multiple-case study of 18 large investment projects in Norway, Olsson (2006) highlights that both product and process flexibility are needed during the project execution phase owing to continuously changing project environments and scope changes from project owners as well as their end users. Furthermore, in their study of a large infrastructure project and a hospital project, Walker and Shen (2002) emphasize that although planning and control skills of construction management teams are important, their ability and desire to incorporate flexibility into plans and decision making during production are equally important. However, project-based organizations often lack these attributes despite their need for flexibility and adaptability to cope with the high inherent uncertainty of projects (Brady and Maylor 2010). Hence, there is a need to complement the traditional focus on control in construction management with a focus on flexibility to address uncertainty and related changes.

Principal–Agent Theory

In principal–agent theory, the contract is the unit of analysis (Eisenhardt 1989a). Depending on the type of principal–agent relation, the contract may be a commercial agreement, an employment contract, or a role description defining responsibilities for, for

example, a project manager. The central assumption in principal–agent theory is that one party in a relationship (the principal) needs to exert a certain level of control over the other party (the agent) because of goal conflicts or differences in desires and risk aversion and to verify the actions and performance of the agent (Eisenhardt 1989a). Moreover, this level of control is affected by the costs of monitoring the behavior of the agent and costs of measuring outcomes when transferring risk to the agent. Over the years, principal–agent theory has been used to analyze and discuss a broad range of relationships in various contexts, both intraorganizational (e.g., Eisenhardt 1985; Anderson and Oliver 1987) and interorganizational (e.g., Aulakh and Gencturk 2000; Tiwana 2010). Eisenhardt (1989a) argues that principal–agent theory is particularly well suited for studies of cooperative relations but that it is often helpful to combine principal–agent theory with complementary theories. In this study, we combine the perspectives of principal–agent theory and paradoxical tensions between control and flexibility.

Applying principal–agent theory to construction projects suggests that the client's project manager is an agent for the project owner (Müller and Turner 2005). A similar intraorganizational principal–agent relationship exists between the contractor's governance forum and the project manager. Furthermore, there is an interorganizational principal–agent relationship between the client and the contractor (Eriksson 2006). Hence, project managers have several principal–agent roles to address simultaneously. Jensen et al. (2006) suggest two dimensions when analyzing interorganizational relationships: a vertical dimension referring to hierarchical relations with typical principal–agent features and a horizontal dimension referring to actors in the environment on which the focal project is dependent, for example, authorities and the public. Similarly, Tuuli et al. (2010) suggest a more holistic view beyond the principal–agent relation between the client and contractor to fully understand the control exerted by different stakeholders. Hence, it would be beneficial to study simultaneously several principal–agent relations within a construction project as well as relations to stakeholders in the greater society.

Method

This paper is based on explorative case studies of three large infrastructure projects that were part of two different megaprojects. Qualitative case studies were used because they are especially suitable for investigating how tensions emerge and unfold (Eisenhardt 2000; Beech et al. 2004; Jay 2013). Van Marrewijk et al. (2008) emphasize the need to investigate ambiguities and paradoxes in future studies of infrastructure megaprojects and that it is essential to study actual management practices rather than idealized views. Accordingly, an explorative approach was chosen to identify new views on tensions as perceived by project managers, and information about the connections between each megaproject and the three large infrastructure projects is limited to what each project manager chose to describe during the interviews. Many prior studies on megaprojects focused on the preplanning stages to investigate political and budgetary aspects (e.g., Bruzelius et al. 2002; Flyvbjerg 2005). However, because we want to capture project managers' views of tensions between control and flexibility, this study focuses on the production stage.

Selection of Case-Study Projects

The case-study projects were all located in Sweden; they had a contract sum of at least 50 million Euro, and they were all based on a mixture of design-bid-build (DBB) and design-build (DB) contracts (Table 1). Moreover, they were part of two different infrastructure megaprojects, each with a budget exceeding 1 billion Euro and comprising more than 10 large and several minor projects with content similar to the three case-study projects described subsequently. The client was the Swedish Transport Administration (STA), a government agency obliged to follow the Swedish Public Procurement Act (PPA).

Table 1. Summary of the Three Studied Infrastructure Projects

Project	Object type	Part of megaproject	Location	Number of interviews
1	Tunnel, roadwork, and concrete	Megaproject A	Dense urban	6
2	Road, overpasses	Megaproject B	Suburban	8
3	Road, overpasses	Megaproject B	Rural	6

Project 1 involved tunneling through bedrock and associated road and concrete works. The main contract was DBB with adjustable quantities, but parts of the scope were procured as a DB contract. The location was a dense urban area with a complex traffic situation and local residents near the construction site.

Project 2 involved roadwork (broadening an existing road), including extensive soil stabilization, several overpasses, and complex bridge construction over railway and roads. Road works were mainly procured as DBB contracts with adjustable quantities, whereas overpasses and bridge construction were procured using DB contracts. The location was a suburban area with intense traffic near the construction site, and temporary traffic arrangements were a substantial part of the workload in the project. The presence of local residents affected the project, but their influence was less intense than in Project 1.

Project 3 involved highway construction, additional minor roads, and a number of overpasses. Road works were mainly procured as DBB contracts with adjustable quantities, whereas the overpasses were procured using mainly DB contracts. The location was a rural area, where a large portion of the work was conducted in pristine territories, meaning that there were few local residents to deal with, although addressing alternative and temporary road crossings and logistics was a substantial part of the daily work.

Data Collection

Three rounds of interviews were conducted over 4 years: one semistructured interview in the middle of project execution when the outcome of the project was unknown, a second less structured interview when projects were more or less completed, and a third interview 1–2 years after project completion. In total, 20 interviews were conducted with the project managers representing the client and the contractor and, in Rounds 1 and 2, the design managers working for either the client (DBB) or contractor (DB). In Project 1, there was a change of client project manager during the production phase. See Table 2 for more information about the respondents.

In Round 1, all interviews were conducted at the project offices using a semistructured approach with open-ended questions. The aim was to obtain an understanding of each project in terms of scope, contracts, organization, progress, and status, as well as a view of each interviewee's background and opinions about project management. All interviews were recorded digitally, but after weighing the pros and cons of transcription (Kvale 1997; Alvesson 2011), the recordings were not fully transcribed. Instead, detailed field notes with time notations were used for the initial analysis, allowing easy review of the recordings.

In Round 2, the researchers interviewed the same respondents. To avoid directing the interviewees, following the explorative

Table 2. Information about the Interviewees

Number	Role	Gender, age (years)	Education	Years in industry	Previously employed by other types of actors	Consultant or employee of client or contractor	Total interview time
1	Client 1	Female, 33	M.Sc. Civil Engineering	8	Contractor	Employed	165 min
2	Contractor 1	Male, 54	M.Sc. and Economy	24	No	Employed	190 min
3	Designer 1 (DBB)	Male, 41	M.Sc. Civil Engineering	17	No	Consultant	150 min
4	Client 2	Male, 38	B.Sc. Construction	18	Contractor	Consultant	205 min
5	Contractor 2	Male, 39	B.Sc. Construction	17	No	Employed	220 min
6	Designer 2 (DB)	Male, 39	M.Sc. Civil Engineering	15	No	Employed	155 min
7	Client, Designer 3 (DBB)	Male, 29	M.Sc. Civil Engineering	6	Structural engineer	Employed	165 min
8	Contractor 3	Male, 37	M.Sc. Civil Engineering	13	Structural engineer	Employed	230 min

approach, respondents were first asked to describe their perceived project results and then to elaborate on the reasons and explanations for the outcome (good or bad). Follow-up questions were asked regarding the influence of the other party, their own management, and contextual factors. Owing to the volume of rich, unstructured empirical material obtained in Round 2, all recordings were fully transcribed.

In Round 3, the interviewees were again asked to briefly elaborate on the project outcome, especially in terms of function now that the end product had been in use for 1–2 years. However, the main aim was to ask them to describe in more detail how they perceived the control exerted and flexibility exhibited by (1) the authorities, (2) the public, (3) the other party, and (4) their project governance board and management. Owing to the volume of rich empirical material obtained in Round 3, all recordings were fully transcribed.

Analysis

Abductive thematic analyses of the extensive empirical material inspired by Braun and Clarke (2006) led to the identification of overarching themes related to critical organizational tensions. The analysis started inductively with a qualitative content analysis of Round 1, first by within-case analysis and then by cross-case analysis. This resulted in tentative themes related to organizational tensions. The analysis of Round 2 yielded additional tentative tensions and specified information regarding previously identified tensions. During analyses of Round 2, it became apparent that many of the identified organizational tensions represented conflicts between various aspects of control and flexibility, and it was decided to focus on this type of tension. After prioritizing, an unstructured list of organizational tensions regarding control and flexibility remained, which were frequent themes in the data set (Eisenhardt 1989b) or were deemed interesting and relevant (Dyer and Wilkins 1991).

During these analyses, it became evident that organizational tensions could be identified at various interfaces between different actors. It was decided to apply a paradox perspective (Lewis and Smith 2014) to analyze these tensions of control and flexibility between different sets of actors and then compare the constructs derived with analyses using principal–agent theory (e.g., Eisenhardt 1989a). Accordingly, extensive literature reviews focusing on paradoxical tensions and principal–agent theory were conducted between interview rounds, especially before Round 3, to gain knowledge about previous empirical findings on tensions between control and flexibility. In an additional analysis, the themes were grouped into the following three types of organizational interface: surrounding society–infrastructure project, governance forums–project manager, and client–contractor.

Empirical Findings

This section begins by describing tensions between external control of projects and flexibility in production and organizing. Then tensions between control by project governance forums and flexibility for the project manager are described. This section concludes by describing tensions between control by the client and flexibility for the contractor.

External Control versus Flexibility in Production and Organizing

The relevant authorities and the public, two major external stakeholders, had differing requirements and demands regarding how the focal projects should be executed and concerning their outcomes. The project managers experienced tension between this external control and their flexibility to choose production methods and organize activities needed to meet performance specifications. One of the roles of authorities is to protect the interests of the public, but in addition to regulations, many of the interviewees stressed that project execution had to be continuously adapted to meet further demands from the public.

Control by Authorities versus Flexibility in Detailed Design and Production

Regulations related to health and safety (HS) and environmental issues strongly influenced the design and productivity of the projects, although the regulations were followed, monitored, and enforced to varying degrees. For instance, at certain stages of the tunneling work for Project 1, it was difficult to achieve proper illumination. “At some stages it was almost impossible to illuminate the entire work area at reasonable costs and time frames, although it is a requirement” (Contractor 1). The client in Project 2 stressed that environmental regulations sometimes had clearly suboptimal consequences: “From both an economic and environmental perspective it is rather stupid to expend enormous effort on saving some poor frogs while at the same time choosing to transport a million cubic meters of soil and rubble to a dump 40 kilometers away.” Moreover, regulations sometimes made adjustments to the design to improve quality or save on expenses more complicated or even impossible. “You want to be accommodating and adjust the solutions according to the client’s wishes and the contractor’s needs, but at the same time, you are quite restricted by laws and norms” (Designer 1).

The need to make early decisions regarding road routes and various elements of design to navigate through statutory planning processes and acquire authorization to proceed implicitly imposed strong control and little scope for flexibility in detailed design and

production. “In the detailed design, we tried to provide durable solutions and minimize transport, but different policies and decisions from early stages blocked many of them” (Designer 1).

STA also performs a regulatory function through a separate centralized branch, with technical experts acting as an authority involved in defining and monitoring the implementation of specific technical regulations related to road construction, bridges, and traffic control systems. Numerous interview statements indicate that this element of control is strong, negatively affecting design and (indirectly) productivity. “The review process conducted by the technical experts on the STA staff in Borlänge is still about controlling details regarding design. There is great potential to give technical experts in the projects more freedom” (Designer 2).

The aim of the PPA implemented by the Ministry of Finance is to prevent corruption within contracting authorities. However, a side effect of the PPA is that it imposes indirect control over production, complicating the organizing process. The resources that will be available for a project and the combination of competencies and abilities of the team are affected by the regulated, and somewhat inflexible, procurement process. The clients stated that they often choose suppliers based on the lowest price rather than their competencies or resources because of the fear that appeals will delay the project. The client in Project 2 highlighted the issue by contrasting these conditions with the greater freedom of contractors in their organizing process: “The situation is a bit peculiar because the contractor usually appoints a well-organized team in which the key personnel have worked together on other similar projects. However, as a public client we have to cope with a sort of incongruent team of strangers, corresponding to the Foreign Legion, who happened to have the lowest prices.”

Control Imposed by Public versus Flexibility in Design and Production

The public can exercise control in many ways to ensure that the execution of a specific infrastructure project does not impose negative effects on the surrounding community. Almost all interviewees highlighted the need to engage with the public in terms of providing information and adapting plans and production methods to meet local concerns. “Society has changed; everything is faster, and society demands that we must be invisible and not make any noise or disturbance whatsoever. For instance, traffic is expected to flow as usual with no disturbances by the project. This trend entails less effort being expended on the project execution as such” (Contractor 2). In Project 3, protests and appeals by the public resulted in delays, which forced the client to hire the contractor before the project was approved and adapt the production plans to increase the speed of execution. In Project 1, the participants had to continuously engage in public relations activities, partly to enable smooth production and partly because it was expected by society. “We have tried to create a mutual understanding between us and the public, we have tried to take into account their needs and wishes, for example, when planning the blasts and other disturbing activities” (Client 1).

Control by Governance Forums versus Flexibility for Project Managers

On the client side, the project manager of each focal project reported to the corresponding megaproject manager, while on the contractor side, project managers often reported to several forums with varying levels of control over their project. Several interviewees expressed a belief that sufficient flexibility must be given to project managers from their respective governance forums to enable effective production. Otherwise, the governance forums could hinder effective decision making, resource management, and efforts to implement optimal solutions.

Control of Decisions by Megaprojects versus Flexibility for Client Project Managers

In Megaproject A, the project management team, including Client 1, met on a regular basis to discuss common issues and make decisions. “Everyone gets briefed about the different subprojects, contributes opinions. And we have good discussions. The megaproject manager has the final word, but decisions are taken after long discussions” (Client 1). According to the design manager working for the client in Project 1, the Megaproject A manager gave all project managers working for him substantial freedom. “Project managers have the freedom needed to govern their own assignments within the megaproject.”

Client 2 reported to the Megaproject B manager, who (according to Client 2) had a mission too extensive to manage fully. This could cause problems in terms of coordination, for instance, but it entailed a higher degree of freedom for the project managers. “I don’t need any assistance in making the right decisions. Any form of steering committee for my project would only have caused loss of flexibility and tempo” (Client 2). Moreover, Client 2 stated that the management of Megaproject B usually worked in a pragmatic manner. “They were goal-oriented and did not usually get stuck in fixed positions. Instead, they were prepared to compromise on some principles to fulfill the project objectives.”

Interestingly, Client 3, who also reported to the Megaproject B manager, mentioned and reflected upon the project management team meetings for the megaproject far more than did Client 2. The impression is that Client 2 wanted more flexibility in his daily work than Client 3, who seemed to consider the requirements of the megaproject as a whole to a greater extent when making decisions. “We have a forum in which the different subproject managers meet to discuss interpretations of technical requirements and descriptions and how to manage different kinds of financial requests from the contractors in a uniform way” (Client and Designer 3). Contractor 3 had a clear opinion about the management of Megaproject B. “The Megaproject B manager controlled his subproject managers quite a lot, and my counterpart seemed to accept this control to a large extent owing to his relative inexperience.”

Control by Contractor Companies versus Flexibility for Contractor Project Managers

Contractor 1 reported to several governance forums, partly because he managed resources from a consortium of two contractors. He emphasized that there were differences in how the consortium and the two separate contractors conducted administrative routines and delegation of authority, which sometimes doubled the reporting routines and created tensions. “The two owners have totally different views on how to report progress and financial forecasts” (Contractor 1). However, there seemed to be no lack of delegation of authority. Instead, the contractor stated that it was sometimes difficult to receive attention and communicate effectively. “Decisions take a long time, which creates delays before the highest manager acts. If you don’t get a response within a week, you simply have to assume that they agree and continue along the path you believe is correct” (Contractor 1).

Contractor 2 reported to a formal steering committee headed by his superior, although there was also an informal forum with a partly different membership in which financial matters and change orders were discussed. However, according to Contractor 2, this was not a source of control problems because he and his superior had worked together for several years, during which time they had built up trust.

Contractor 3 mentioned that he reported to several forums. A project steering committee met on a quarterly basis and seemed to have provided very strong direction. "In the internal steering committee, we discuss the budget, risks, and I can get advice, help, and second opinions. The dialogue is good; they are perceptive but also sometimes assertive. Sometimes I have to do things that I or the project team doesn't think are right. On those occasions, it is a comfort to have support from the steering committee. The contract manager is in charge" (Contractor 3). In addition to the project steering committee, more frequent meetings were held with his superior and the contract manager. Another indication of strong control was that the superior was often present at weekly meetings with the client.

Control by Clients versus Flexibility for Contractors

The balance between control and flexibility between clients and contractors in the focal projects was partly dictated by the contractual arrangements, but there were also approaches agreed to later on by the project managers on how to control and monitor contractor activities.

Strict and Controlling Contracts versus Loose and Flexible Contracts

All the focal projects included both DB and DBB contracts. Hence, each project organization had to simultaneously manage contracts with substantial variations in the balance between control and flexibility. The use of a DBB approach excluded opportunities to utilize contractors' experience and knowledge when designing solutions. In Project 2, this led to extensive change orders because the design was not compatible with smooth production, sometimes to the extent that construction work was nearly impossible. "We had an immense numbers of changes and amendments owing to poor design, which generated numerous challenges during the construction phase. We continually took two steps forward and one back in dealing with all the changes. The project grew by 34%" (Contractor 2).

In Project 1, the design was also refined by the contractor, but almost exclusively regarding items covered by one of the DB contracts. Several statements by Contractor 1 indicate that his team did little to consider ways to improve solutions in the DBB contracts. "Most of the project is procured as a design-bid-build contract, so we just do what we're told" (Contractor 1). Client 1 expressed similar sentiments. "Although the contractor had an opportunity to share savings on production, they often had difficulties thinking of alternative solutions in DBB contracts. A finalized design seems to make them think that everything is permanently set and decided."

A specific way to control progress in large infrastructure projects is to impose fines for delays in delivery of critical intermediate milestones. However, the contractor in Project 3 suggested that such fines often lead to conflicts late in projects and after project completion. The threat of receiving fines for intermediate delays forces the contractor to accept the client's views regarding, for instance, payments for ambiguous items or tasks, but as the project is delivered, the contractor makes claims for items that the contractor believes have been unfairly dealt with by the client. "We have milestones with defined penalties if not met on time. We feel that keeping to the schedule has been at our expense throughout the project and that the client has not compromised even once. To avoid the risks of missing the specified milestones, we chose to continue anyway and bear the costs for the moment" (Contractor 3).

Control through Monitoring and Documentation versus Flexibility, Trust, and Self-Control

The way in which progress and quality were controlled by the client varied not only between projects but also within each project, depending on the subject. The client in Project 2 claimed that the level of control in large infrastructure projects is increasing: "The amount of control activities by the client has increased. Nowadays, we ask for much more detailed data. We are going from self-control by the contractor to control mechanisms by the client." However, the client in Project 3 claims there is a trend in the opposite direction regarding control activities by the client: "We call it a new client role. We are going from a situation where we thoroughly control everything in detail to spot checks. We decide in advance to what extent we shall monitor and control different parts of the construction, but we also adapt the control program during project execution based on how well the contractor performs."

Flexibility was often applied in daily work on the construction site, but control was subsequently applied by the use of formal notifications or documentation in meeting minutes. This approach was practiced in all three projects, as exemplified by the following quotation from Project 1: "According to present contract regulations, everything shall be documented in formal notifications, although I try to communicate with the client informally in advance" (Contractor 1). In Project 2, the participants adapted the level of documentation as the project evolved: "Early in the project we probably formally documented most issues as soon as they were identified, but over time, as we got to know each other and trust was built up, we documented only the outcome of discussions. But everything is still documented in a gigantic amount of formal notifications" (Contractor 2).

Discussion

The empirical findings of the present study revealed descriptions of several tensions between control and flexibility at different organizational interfaces (Fig. 1). Various stakeholders in the surrounding community, foremost among them the authorities and the public, exert control over the infrastructure projects. On the client side, project managers experience additional control by the megaproject management, while on the contractor side, project managers are continuously being subjected to various types and levels of controls by the client and by company-specific governance forums. The various tensions between control and flexibility at different organizational interfaces are listed in Table 3.

External Control and Project Flexibility

Previous research highlighted the importance of stakeholder management for the smooth execution of construction and infrastructure projects (Olander and Landin 2005; Hu et al. 2015). The empirical findings presented in this article highlight the paradoxical tensions between control exerted by the various external stakeholders and the flexibility required to meet project objectives. Specifically, project managers must simultaneously meet the design and production requirements imposed by several authorities while retaining the flexibility in production needed to meet performance requirements. The empirical findings indicate that this paradoxical tension may have clearly suboptimal consequences, which raises two important questions. What, if any, administrative mechanisms are in place to coordinate the control exerted by different authorities? If control is not coordinated, does the authority that exerts the most control also most strongly affect project decisions in practice? If so, such indirect and random prioritization may not best protect societal interests.

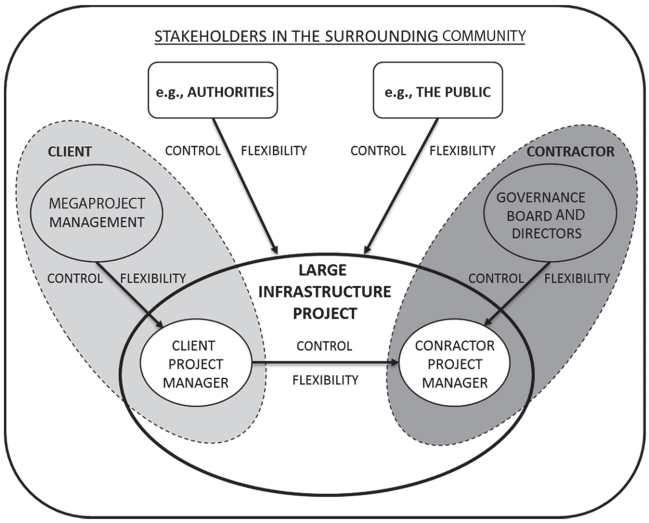

Fig. 1. Schematic organizational interfaces with tensions between control and flexibility

Table 3. Tensions between Control and Flexibility in the Different Organizational Interfaces

Organizational interface	Tensions between control and flexibility
Authorities–project	Regulations concerning HS and environment versus flexibility in design and production Statutory planning processes versus flexibility in design Review process by the STA's technical expert branch versus flexibility in design Public Procurement Act versus flexibility in organizing processes
Public–project	Noise reduction and minimizing of disturbances versus flexibility in design and production Demands for continuous traffic flow versus flexibility in production Protests and appeals of plans versus flexibility in production Efforts to address the public versus more focus on production
Megaproject management–client project manager	Harmonizing technology in megaproject versus flexibility in design Optimizing megaproject schedule versus flexibility in production planning Optimizing megaproject schedule versus flexibility in resource utilization Harmonizing megaproject contract management versus flexibility to negotiate
Contractor company–contractor project manager	Controlling governance forum or manager versus flexibility in decision making Contradictory decisions by different governance forums versus flexibility in decision making
Client–contractor	Contract specificities versus flexibility in design and production Fines for missing intermediate milestones versus flexibility in production planning Monitoring and spot checking versus trust and self-control Formal notification and protocol versus trust and informal communication

Moreover, the empirical findings strongly corroborate previously expressed beliefs that today's large infrastructure projects are highly dependent on the smooth management of public relations. This is not only to avoid appeal processes during early stages (Olander and Landin 2005) and to ensure accountability in decision processes (Bruzelius et al. 2002) but also to facilitate effective production through the daily management of local residents, road users, and pedestrians who are affected by construction activities.

The PPA creates a paradoxical tension during the procurement phase by restricting how public clients choose suppliers, which profoundly affects the entire production process. However, this problem lies not in the PPA per se but in how public clients interpret and implement it (Eriksson and Hane 2014). The authors' empirical findings show that clients often procure suppliers based on the lowest price owing to their fear of appeals and the resulting delays. However, the PPA does not stipulate that bid evaluations must be based on the lowest price; other softer criteria can be applied, but if they are, the evaluations must be as transparent and objective as possible. Nevertheless, the PPA does control the organizing process for public-sector clients as applied currently, thereby indirectly affecting the principal–agent relationship between client and contractor.

Intraorganizational Management Control and Project Manager Flexibility

The empirical investigation presented here also identified critical tensions in the intraorganizational principal–agent relationships that emerge for both client and contractor. Despite the strong

increase in construction megaprojects worldwide (Hu et al. 2015), the authors' research shows that such projects also create paradoxical tensions that may cause problems if not appropriately managed. However, the empirical findings presented here suggest that some tensions are not perceived as paradoxical but merely as hindrances or problems from the perspective of a client project manager. From a megaproject manager's systemic perspective, it makes sense to control certain decisions regarding design, financial matters, and scheduling, whereas for some client project managers, full flexibility would be preferred, and they seem to treat all aspects of control by superiors as problematic for their assignment. Such a simplistic perspective is especially unfortunate in megaprojects because it is important to apply a systemic perspective to avoid suboptimizations in included projects.

On the contractor side, all the interviewed project managers reported to many different governance forums. They had to apply different reporting routines simultaneously and continually, and the control exerted by the various governance forums was sometimes contradictory. The character of these tensions is thus paradoxical and relates to centralization and decentralization issues (Beech et al. 2004). It is a bit puzzling that reporting routines and governance forums were not more coordinated, implying that line managers and directors are not sufficiently flexible to accept alternative reporting standards. Instead, they feel the need to control their projects according to their own best practices, implying a lack of trust (Atkinson et al. 2006) in project managers as well as in other colleagues.

Interorganizational Client Control and Contractor Flexibility

This empirical investigation identified critical tensions in interorganizational principal–agent relationships between clients and contractors, which are affected by the fact that all three projects examined here included both DB and DBB contracts. This mixture is not surprising because there was substantial variation within each megaproject, for example, in the level of uncertainty and in the importance of harmonizing technology. However, it raises questions about the optimal distribution of contract types. A DB contract will transfer risk to the contractor and simultaneously trigger an expense for the client (Eisenhardt 1989a). Thus, the cost of using DB contracts for very uncertain elements will be high, and accordingly, the clients in the studied projects used mainly DBB contracts for elements such as ground works and blasting, with adjustable quantities for easier regulation of uncertainties in scope. However, this also means that the competency and experience of the contractor are excluded from the design process, entailing numerous change orders and associated problems, as experienced in Project 2. An alternative approach would be to hire the contractor very early in the project based on a preliminary design and then to collaboratively produce a detailed design for which the client takes full responsibility in a DB contract. Such a solution, however, is not very common partly because the STA is currently shifting to more DB contracts to improve utilization of contractor competencies (Eriksson et al. 2013). This change in contracts does not seem to have changed behaviors, as many interviewees stressed that the STA is still exerting strong control of design in DB contracts. Hence, there seems to be a chasm between strategy and daily operations. The tension related to contract type is also connected to tensions at other interfaces. When technical solutions and measures to meet certain requirements are highly restricted by external authorities, it may not be appropriate to rely on flexible DB contracts.

Although fines and penalties often support the achievement of intermediate schedule milestones, the pressure to deliver on time often seems to lead to subsequent conflicts related to cost, schedule, and quality. Hence, controlling progress too rigidly during execution could create a need for flexibility by the client later to finalize the project and address financial issues. In large projects with high uncertainty and many change orders, intermediate penalties connected to schedule may therefore be ineffective.

Conclusions

Several critical paradoxical tensions between control and flexibility have been identified in the empirical evidence, some of which seem especially challenging in large infrastructure projects that are part of megaprojects, which are strongly affected by external stakeholders, the Swedish Public Procurement Act (PPA), and megaproject governance.

This paper contributes to the project and construction management literature in several ways. First, the present findings support recent arguments raised in previous research (e.g., Keegan and Turner 2002; Walker and Shen 2002; Olsson 2006) that the traditional focus on control in terms of planning, scheduling, and supervisory aspects of construction management needs to be complemented by an explicit focus on flexibility. Hence, a paradox perspective is required (Lewis and Smith 2014) because project managers on both the client and contractor sides would benefit from simultaneously promoting control and flexibility in megaprojects (Van Marrewijk et al. 2008; Koppenjan et al. 2011).

Second, this study shows that a systemic paradox perspective is essential for identifying and analyzing connections and interdependencies among tensions related to control and flexibility in three types of organizational interface: external, intraorganizational, and interorganizational. Analysis of these tensions in isolation is likely to result in limited understanding, and it is not sufficient to address several tensions simultaneously for a single organizational interface. Because the tensions at one interface (e.g., external) are often related to tensions at another interface (e.g., interorganizational), all three types of tensions need to be analyzed simultaneously within a systemic paradox perspective.

A third and related theoretical contribution is that a systemic paradox perspective may be based on a combination of the paradox literature and principal–agent theory to produce insights into tensions at the system level. Principal–agent theory may describe and explain interorganizational control–related tensions between client and contractor (Jensen et al. 2006) as well as intraorganizational relations with megaproject management, and contractor governance forums acting as principals and each project manager acting as an agent (Müller and Turner 2005). However, although principal–agent theory may be used to analyze both intra- and interorganizational relationships, such dualistic studies seem uncommon. Most studies investigate either intraorganizational (e.g., Eisenhardt 1985; Anderson and Oliver 1987) or interorganizational relationships (e.g., Aulakh and Gencturk 2000; Tiwana 2010). Moreover, in addition to managing both types of relationship simultaneously, project managers involved in megaprojects need also to simultaneously manage control and flexibility aspects imposed by external parties outside of the dual principal–agent relationship, such as authorities and the public. Hence, this paper contributes to the project and construction management literatures by combining a paradox perspective with a dualistic principal–agent perspective to fully capture the complexity of the interconnected tensions between control and flexibility experienced by project managers in megaprojects.

The findings also have several managerial implications. Primarily, in accordance with what is explained previously about

the need for a systemic paradox view, it is essential for project managers and people involved in project governance to recognize that control and flexibility are required simultaneously in an optimal balance and at multiple interfaces. Inappropriate balance may quickly lead to suboptimal outcomes. In addition, strong initial control often engenders the need for more flexibility later on, and vice versa. For instance, strong control of design in early stages often engenders a subsequent need for flexibility in terms of the numerous changes required to simply achieve constructability, while high flexibility regarding design in early stages often engenders a need for strong control subsequently to avoid complex and expensive maintenance. One way to include contractors' competencies and experiences in the management of contextual uncertainties without having to pay for the transfer of risk would be to procure uncertain elements based on a preliminary design and then collaboratively develop a detailed design for which the client takes responsibility. Finally, public clients need to develop more competence in how to use soft parameters in partner selection because PPA does not prescribe acceptance of the lowest bid, regardless of circumstances. Another intriguing conclusion is that if controls by different authorities are not prioritized and coordinated, there is a risk for suboptimization in terms of spending considerable sums of money securing control over minor issues while other more critical aspects from a societal perspective are neglected.

A limitation of this study is that it is based on an explorative multiple-case study of three large infrastructure projects, all located in Sweden. Although globalization tends to homogenize societies around the world, more research is required to assess the generalizability of the presented conclusions and to extend the findings. Moreover, future studies would benefit from interviewing both project managers and corresponding megaproject managers to enable comparisons of different views. It would also be interesting to investigate the applicability of the findings to large infrastructure projects that are not part of a megaproject or to construction projects in general. Additional research is needed to investigate the extent to which project managers and people in governing positions are aware of paradoxical tensions between control and flexibility and to improve understanding of appropriate managerial actions. Moreover, other types of paradoxical tensions in large infrastructure projects may be highly significant and thus warrant attention.

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Paper V

Inter- and intraorganizational paradoxical tensions when managing large construction projects

Henrik Szentes

Further developed version of a paper that was submitted to a Journal in March 2016

Inter- and intraorganizational paradoxical tensions when managing large construction projects

Henrik Szentes

Abstract

In recent years, scholars have shown a growing interest in combining control and flexibility when organizing and managing large construction projects, which is in contrast with the traditional focus on control via planning and coordination. Prior research recognizes that there is a paradoxical tension between control and flexibility, meaning that while both approaches make sense individually, they seem impossible to combine. Large construction projects are interorganizational, which means that tensions between interorganizational control and flexibility coexist with tensions between intraorganizational direction and empowerment. This multiple case study of four large construction projects investigates how such tensions interplay over time, using a paradox perspective to identify and analyze reinforcing cycles engaging both types of tensions. The empirical findings show how intraorganizational direction/empowerment influence interorganizational control/flexibility and vice versa. Moreover, both vicious and virtuous reinforcing cycles involving the two types of tensions are described. This paper contributes to the construction management literature by illustrating the importance of employing a systemic approach when studying interorganizational projects. A systemic paradox perspective can reveal interdependency between tensions at different organizational interfaces, and how reinforcing cycles emerge and develop, which is important to recognize when organizing, staffing, and managing large construction projects.

1. Introduction

In recent years, scholars have become interested in ways to exercise flexibility when organizing and managing large construction projects (e.g., Ford et al., 2002; Olsson, 2006; Shahu et al., 2012) despite a prevalent tendency in the project management field to focus on control through planning, coordination, and monitoring (Atkinson et al., 2006; Lenfle & Loch 2010). Other researchers emphasize the importance of combining control and flexibility in project management practices, highlighting the influence of attitudes and leadership (e.g., Walker & Shen, 2002; van Marrewijk et al., 2008; Osipova & Eriksson, 2013). Similarly, Koppenjan et al. (2011) stress that it is necessary to apply both control and flexibility, but they add that there is a paradoxical tension between the two and that failing to combine them properly can compromise the success of large construction projects.

Large construction projects are most often interorganizational in the sense that a client holds a contractual agreement with a contractor to deliver a project of a specific scope. As a

result, there are several different organizational interfaces at which organizational tensions can simultaneously emerge and grow (see Figure 1). For example, tensions related to control and flexibility between client and contractor, and tensions between direction and empowerment within both client and contractor organizations. The former include tensions related to uncertainty, risk allocation and trust between the client and contractor (Atkinson et al., 2006; Jensen et al., 2006). The latter include tensions related to project governance within each party and may stem from, e.g., contradictory company- and project-level objectives (Ahola et al., 2014; Too & Weaver, 2014) or from contradictions in overarching governance structures and from top managers' attitudes (Müller et al., 2015).

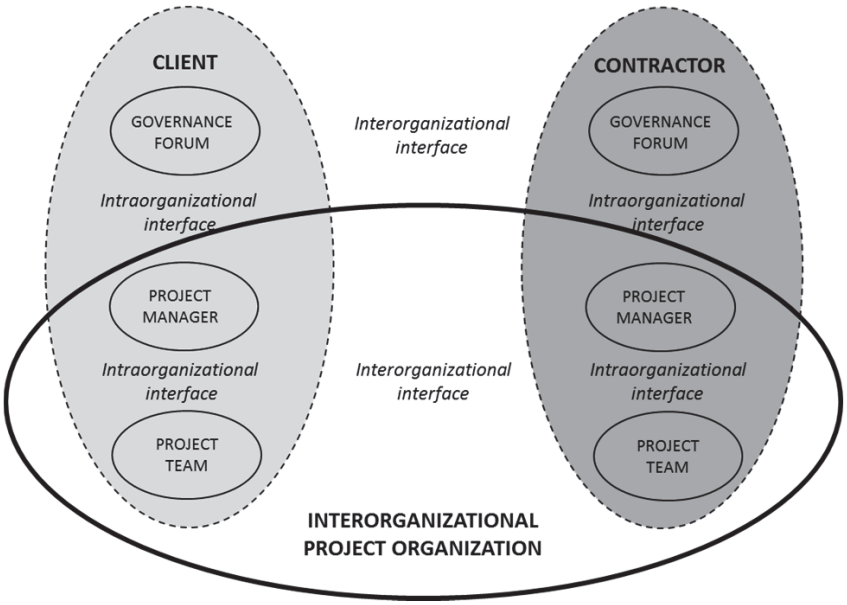

Figure 1. Inter- and intraorganizational interfaces in interorganizational projects

Although seldom specified in previous research, Tuuli et al. (2010) recognize that in construction projects, control at the interorganizational interface can trigger intraorganizational reactions. Similarly, Lazar (2000) illuminates that interorganizational trust is dependent on intraorganizational trust in construction projects. Moreover, there are prior studies that implicitly show that there are dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment in large construction projects, although these studies often use different terminology. For example, the importance of interorganizational flexibility to deal with intraorganizational changes such as variation orders on the client side is implicitly illuminated in studies by Walker and Shen (2002), Olsson (2006), and Cui and Olsson (2009). Moreover, it is noted by Greasley et al. (2005) that in large construction projects, initiatives to implement intraorganizational empowerment are aggravated by the temporal and fragmented nature of interorganizational project teams. Van Marrewijk et al. (2008) highlight that while intraorganizational direction and control is needed

in large construction projects due to issues related to budget size, media exposure, and societal impact, a lack of intraorganizational project autonomy can hinder interorganizational cooperation between involved parties. Similarly, Koppenjan et al. (2011) argue that in large construction projects, opportunities for projects to combine interorganizational control and flexibility are often constrained by, e.g., intraorganizational decisions made by governing forums and indirectly by politicians that the governing forums report to. The above-described studies indicate that an insufficient understanding of dependencies between tensions at different organizational interfaces can hinder the development of trust and empowerment, limit capacities to address scope changes, and aggravate interorganizational collaboration. However, there is a lack of explicit studies on dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment in large construction projects.

Moreover, the abovementioned studies include few details on how dependencies between interorganizational control/flexibility and intraorganizational direction/empowerment emerge and evolve over time. For instance, it is not clear whether the two types of tensions are not only dependent but also interdependent, thus influencing each other back and forth in both directions. Accordingly, recent studies applying a paradox perspective highlight a need for more holistic views (Lewis & Smith, 2014), recognizing that tensions can be multi-layered as well as nested across different organizational levels (Clegg et al., 2002; Andriopoulos & Lewis, 2010). More specifically, Szentes and Eriksson (2015) call for a systemic analysis of paradoxical tensions between control and flexibility within large construction projects as well as between projects and society.

Prior research argue that interdependencies between organizing activities can interplay within reinforcing spirals (Eisenhardt, 2000), or reinforcing cycles as they are referred to in the paradox literature (Lewis, 2000). One-sided and consistency seeking responses to organizational tensions may spur vicious cycles whereby negative effects are reinforced, leading to organizational decline (Smith & Lewis, 2011). On the other hand, an acceptance of tensions embracing both sides may create virtuous cycles leading to sustainable development (Sundaramurthy & Lewis, 2003; Smith & Lewis, 2011).In elaborating on the abovementioned implicit dependencies and potential interdependencies in large construction projects, it seems that vicious cycles that reinforce direction and control can lead to diminishing trust, poor collaboration, and an inability to incorporate scope changes, whereas vicious cycles that reinforce empowerment and flexibility can negatively affect scope fulfilment outcomes, schedules and budgets. Therefore, being able to combine both approaches in a thoughtful way appears to be important. Altogether, it seems urgently necessary to further our knowledge of potential reinforcing cycles that simultaneously involve both interorganizational control/flexibility and intraorganizational direction/empowerment.

This paper focuses on organizational tensions in large construction projects. The aim is to investigate whether and how the practice of intraorganizational direction and empowerment influences interorganizational control and flexibility and vice versa, and to specifically identify reinforcing cycles involving the two types of tensions at different organizational interfaces. This aim is accomplished by studying the interplay over time between client

project managers and contractor project managers and between each project manager and their respective governance forums, applying a paradox perspective. Empirical materials are drawn from a multiple case study on four large construction projects in Sweden involving 30 in-depth interviews in which three rounds of interviews were held with both parties' project managers over a four-year period.

After this introduction, a theoretical section describing the paradox perspective and relevant tensions follows. Then, the method used is described, including the sample, collection of empirical material, and analysis approach. The empirical findings provide descriptions of relevant tensions developing over time for each project, which is followed by descriptions of cross-case patterns and reinforcing cycles. In the discussion and conclusion section, contributions are discussed and referred to the existing literature.

2. Theoretical framework

2.1. Paradox perspective on organizational tensions

Research on paradoxical organizational tensions has been of growing interest, and a paradox perspective as a theoretical lens is emerging (Lewis & Smith, 2014). The paradox perspective has been used to discuss, e.g., theoretical contradictions (Poole & van de Ven, 1989; Lewis, 2000; Lewis & Smith, 2014), organizational change (Beech et al., 2004), simultaneous exploration and exploitation (Andriopoulos & Lewis, 2010), and, similarly, innovation occurring under complex business models and strategies (Smith et al., 2010). Lewis (2000) states that a paradox emerges from elements that are logical when studied separately but that seem irrational or even absurd when juxtaposed. Although such elements seem inconsistent and incompatible, they nevertheless coexist. Smith and Lewis (2011: p. 382) emphasize the time perspective and propose the following definition: "*Contradictory yet interrelated elements that exist simultaneously and persist over time*".

Management decisions that focus on, for instance, strategies, organizational structures, authority and policies often generate new or intensify existing paradoxical tensions (Lewis, 2000), e.g., direction/empowerment and control/flexibility (Smith & Lewis, 2011). Recent contributions within the paradox literature emphasize the importance of managerial practices that support both elements of underlying tensions, i.e., a both/and approach rather than an either/or approach (Lewis & Smith, 2014). An acceptance of paradoxes and balanced responses to paradoxical tensions can create virtuous cycles (Sundaramurthy & Lewis, 2003; Smith & Lewis, 2011), reinforcing cycles that enhance performance and sustainability. However, defensive responses that strive for consistency or that focus heavily on one element of tension can produce negative reinforcing cycles that hinder development, i.e., vicious cycles (Sundaramurthy & Lewis, 2003; Smith & Lewis, 2011).

Denison et al. (1995) highlight that leaders who can simultaneously work with both cooperative and competitive modes are better able to address complexities in many industries, and Beech et al. (2004) argue that paradoxes can be treated as invitations for managerial actions that develop organizations and that promote creativity. Indeed, Smith et al. (2010) and

Lewis and Smith (2014) highlight a need for research on leadership approaches required to integrate opposing views in paradoxical tensions. For instance, applying a paradox perspective on tensions requires leaders employing a holistic view to avoid suboptimal outcomes and vicious cycles (Lewis & Smith, 2014).

2.2. Control and flexibility, and direction and empowerment

The terms 'control', 'flexibility', direction' and 'empowerment' have been defined and combined in various ways in prior management literature. This sub-section briefly describes the wide range of applications in previous research and attempts to clarify whether interorganizational or intraorganizational tensions are addressed, or both. It is then explained how the terms are defined and used in this paper.

Early management research on tensions related to control and flexibility focuses primarily on manufacturing industries (Sethi & Sethi, 1990) and is mainly concerned with horizontal and vertical aspects of intraorganizational flexibility as tools for managing the external environment (e.g., Lawrence & Lorsch, 1967; Aaker & Mascarenhas, 1984; Abernethy & Lillis, 1995; Englehardt & Simmons, 2002). Others have investigated ways to combine flexibility and efficiency, stressing the importance of committed leadership and enabling administration and control systems (Adler et al., 1999; Ahrens & Chapman, 2004). Direction and empowerment are more consistently viewed as vertical intraorganizational aspects in prior research, although control is sometimes used to describe the opposite of empowerment. For instance, Lorinkova et al. (2013) distinguish directive leadership from empowering leadership, and Mills and Ungson (2003) define formal empowerment as a means of losing control and argue that empowerment is mainly a top-down phenomenon bestowed by management teams. Quinn and Spreitzer (1997) distinguish between 'mechanistic empowerment' and 'organic empowerment', where the former focuses on top-down approaches while the latter pertains to a more flexible bottom-up process. Moreover, these authors argue that while managers can create an empowering context, empowerment is much more about individuals developing a sense of self-determination, meaning, competence, and influence. Similar to the principle of 'organic empowerment', Wilkinson (1998) describes empowerment as an interest in engaging in upward problem solving and in listening to individuals to identify problems and solutions. Moreover, he stresses the importance of task autonomy and removing inspectors to enable empowerment. Applying a paradox perspective, Sundaramurthy and Lewis (2003) argue that for corporate boards, it is essential to combine empowerment and monitoring to achieve trust and collaboration as well as control. The importance of trust is also highlighted in Adler et al. (1999) and Ahrens and Chapman (2004), and by Mills and Ungson (2003) who emphasize that it often takes a long time to achieve basic emotional trust between people in addition to mere trust in routine or competence.

In the project management field, a large body of prior research has focused on intraorganizational tensions between project owners and project organizations headed by a project manager. These tensions are sometimes elaborated upon using the terms control and flexibility (e.g., Lenfle & Loch, 2010; Zwikael & Smyrk, 2015), whereas others tend to discuss project governance (e.g., Too & Weaver, 2014; Müller et al, 2015) or empowerment

(e.g., Tuuli & Rowlinson, 2010; Daniel, 2010). Moreover, in problematizing the project manager role, Turner and Müller (2003) argue that there is a need for control between project owners and project managers and between project managers and project teams. Other existing research focuses on interorganizational tensions related to control and flexibility between clients and contractors (e.g., Bresnen, 2007; Osipova & Eriksson, 2013; Liu et al., 2014). In addition, several studies elaborate on trust related to flexibility and empowerment, e.g., Atkinson et al. (2006), Bresnen (2007), and Zwikael and Smyrk (2015). However, prior studies recognizing and addressing explicitly the coexistence of the abovementioned tensions at different organizational interfaces in interorganizational projects appear to be scarce. Yet, there are some examples of studies elaborating on dependencies between different organizational interfaces, as presented below.

Based on a review of both project governance literature and general governance literature, Ahola et al. (2014) argue that for projects involving several organizations, project governance can either be seen as internal to any project or external to any project, thus impacting on how to view and manage intraorganizational strategies and decisions. Similarly, Jensen et al. (2006) highlight that among projects involving several organizations, parallel attempts are often made by different governance forums to control the goals of interorganizational project teams. These authors also highlight the influence of trust and call for research on the interplay between vertical and horizontal relationships. Similarly, Maurer (2010) argues that in interorganizational projects, trust and collaboration between parties is dependent on intraorganizational approaches to project staffing over time. In their study on two large construction projects, Tuuli et al. (2010) note that interorganizational control can trigger intraorganizational reactions. Although they discuss control exerted by both interorganizational and intraorganizational stakeholders, there are insufficient analyses on how interdependencies across organizational interfaces develop over time. Moreover, dependency between interorganizational and intraorganizational trust is highlighted by Lazar (2000), who notes that trust develops overtime although pre-existing trust can be beneficial. Nevertheless, there appears to be insufficient knowledge on how interdependencies between tensions at different interorganizational interfaces emerge and evolve over time in interorganizational projects in general and in large construction projects in particular.

Note that in this paper, control/flexibility is viewed as interorganizational tensions between the client and contractor, and direction/empowerment is viewed as intraorganizational tensions within either party. Informed by the literature listed in this section and in the introduction, the key concepts of each element of the two tensions are summarized in two tables. These tables thus represent the author's overarching interpretation of the features of each element in the empirical context of large construction projects, based on the complex and often inconsistent terminology in existing literature. Table 1 summarizes the key concepts of interorganizational control/flexibility, while Table 2 summarizes the key concepts of intraorganizational direction/empowerment. These key concepts were used for guidance purposes when identifying relevant events, actions, practices and routines in the empirical material.

Table 1. Key concepts of interorganizational control/flexibility

Area	Control	Flexibility
Goal setting	Specified solutions and clear objectives	Functional requirements
Roles/Tasks/Resources	Required key personnel selected, resources for several functions specified	Minor requirements/actions by client, focus on the fulfilment of functional requirements
Change and Ideas	Design and methods specified, change process controlled	Ideas and creativity encouraged by the client, if the desired function is achieved
Communication	Limited information sharing; only information necessary or contracted	Open flow of broad information
Quality	Instructions, inspectors, monitoring, defined routines, standardization	Functional requirements, trust in the other party, autonomy, self-control
Decision making	Single point of contact between parties. Clarity on who makes decisions and how	Participation, collaboration, consensus, compromises, alternative decision routes
Administration	Vast and specified administrative routines	Few and vague administrative routines
Planning/Performance	Detailed schedule with milestones, performance measurements, minimize change orders, bench marking	Overarching schedule only and a focus on final objectives, trust in performance and self-control, change orders are accepted
Budget responsibility	Lump sum	Cost plus contracts

Table 2. Key concepts of intraorganizational direction/empowerment research

Area	Direction	Empowerment
Goal setting	Clear objectives	Vision, values
Roles/Tasks	Clear work tasks, clear and distinct roles, individualistic, specialization, management control resource allocation	Larger assignments, focus on output, role ambiguities are accepted, team building, cooperation, generalists, delegated resource allocation
Change and Ideas	Controlled by management	Ideas, change and creativity are encouraged
Communication	Specific and limited information required to address assigned tasks and mainly top-down negative feedback	Broad two-way information sharing and open dialogue on everything that individuals believe to be important, positive feedback
Quality	Instructions, inspectors, defined reporting routines, standardization	Training/competence, trust in others, autonomy, self-control
Decision making	Hierarchical, centralized, clarity about who makes decisions and how, functional focus	Network, decentralized, participation, consensus, compromises, alternative decision routes, cross-functional
Administration	Excessive administrative routines	Few administrative routines
Planning/Performance	Detailed schedule, performance measures, controls, continuity	Overarching milestones and tollgates rather than detailed schedules, trust in others
Budget responsibility	Centralized	Distributed/delegated

3. Method

The empirical material were drawn from qualitative case studies on four large construction projects in the production phase involving three rounds of in-depth interviews conducted over a four-year period, thus allowing the researcher to expose tensions and to explore managerial strategies to address paradoxes (Lewis & Smith, 2014). Moreover, multiple case studies with empirical material collected over several occasions are especially suitable for investigating the emergence and characteristics of organizational tensions, as they allows the researcher to identify cross-case patterns (Eisenhardt, 1989; Brown & Eisenhardt, 1997) and to follow the derived constructs over time (Sundaramurthy & Lewis, 2003; Beech et al., 2004).

3.1. Selection of case study projects

The objective was to study various types of large construction projects involving different types of contracts and governance structures. All of the case study projects were situated in Sweden with contract sums of at least 50 million Euros and a multi-year production phase. Generally speaking, both design-bid-build (DBB) and design-build (DB) contracts were held simultaneously with the same contractor, and all contracts required some level of collaboration. Projects A and B were transport infrastructure sub-projects managed under the same megaproject, Project C was an office building project, and Project D involved an industrial facility with a complex foundation and an office building. See Table 3 for further information on the projects examined.

For more than a decade, partnering and collaborative approaches have grown increasingly popular in attempts to improve relations within construction projects (Alderman & Ivory, 2007; Hartmann & Bresnen, 2010) and to enhance cooperation and trust between parties (Kadefors, 2004), i.e., to tamper with interorganizational control and flexibility. However, to achieve the desired effects of partnering, it is important to also consider company strategies and the extent to which company management supports partnering and is willing to hand over decision making to the project team (Bresnen, 2007; Mollaoglu et al., 2015). Therefore, large and long-lasting construction projects employing an outspoken collaborative approach seem particularly suitable for studies on how interorganizational control/flexibility and intraorganizational direction/empowerment interrelate over time.

Table 3. Summary of the four projects studied

Project	Object type	Governance – client	Governance – contractor	Contractual collaboration
A	Road, bridge, overpasses	Megaproject manager	Project board, contract manager	DB/DBB, collaborative approach
B	Road, overpasses	Megaproject manager	Project board, contract manager	DB/DBB, collaborative approach
C	Office building	Manager of real estate company	Project board, contract manager	DB, partnering
D	Industrial facility, office building	Project board, project director	Project board, contract manager	DB/DBB, partnering

3.2. Collection of empirical material

Three rounds of interviews were conducted over 4 years: one semi-structured interview was conducted in the middle of the project when outcomes were unknown; a second, less structured interview was held when the projects were nearly complete; and a third interview was held 1-2 years after completion. In total, 30 interviews (nearly 34 hours) were conducted with project managers who represented the clients and contractors and with the design managers as well (during Rounds 1 and 2). The client project manager for Project C changed during the production phase, and the contractor project manager for Project D changed during production. Due to these personnel turnover events and because some projects were managed by parallel project managers, 13 different individuals were interviewed. See Table 4 for more information on the interviewees. All interviews were digitally recorded. During Round 1, detailed field notes with time notations were taken, but the recordings were not fully transcribed after considering the pros and cons of transcription (Kvale, 1997; Alvesson, 2011). Due to the volume of rich unstructured empirical materials obtained during Rounds 2 and 3, these recordings were fully transcribed.

Table 4. Information about the interviewees

#	Role & Label in this paper	Gender Age (years)	Education	Years in industry	Consultant or employee	Interview duration	No. of interviews
1	Client A	Male 38	B.Sc. Construction	18	Consultant	205 min	3
2	Contractor A	Male 39	B.Sc. Construction	17	Employee	220 min	3
3	Designer A	Male 39	M.Sc. Civil Engineering	15	Employee	155 min	2
4	Client B	Male 29	M.Sc. Civil Engineering	6	Employee	165 min	3
5	Contractor B	Male 37	M.Sc. Civil Engineering	13	Employee	230 min	3
6	Client C1 (initial)	Male 35	M.Sc. Industrial Economy	8	Consultant	154 min	2
7	Client C2 (successor)	Female 42	High school, non-technical	15	Consultant	60 min	1
8	Contractor C	Male 55	M.Sc. Civil Engineering	30	Employee	145 min	3
9	Designer C	Male 45	High school, Engineer	25	Consultant	128 min	2
10	Client D1 (parallel)	Female 30	M.Sc. Mechanics	3	Employee	136 min	2
11	Client D2 (parallel)	Male 48	M.Sc. Civil Engineering	24	Consultant	222 min	3
12	Contractor D1 (initial)	Male 44	M.Sc. Civil Engineering	17	Employee	80 min	1
13	Contractor D2 (successor)	Male 52	High school, Engineer	32	Employee	120 min	2

For Round 1, interviews were conducted at each construction site using a semi-structured approach with open-ended questions. The aim was to grasp each project in terms of scope, contracts, organization, governance structures, and performance and to obtain an understanding of each interviewee's background. The focus, however, was on understanding how each project manager viewed their governance structures and on their relations with the other party's project manager.

During Round 2, the researchers interviewed the same respondents, but a new contractor project manager had been appointed for Project D. To avoid directing the interviewees, respondents were first asked to describe their perceived project results and to then elaborate on causes of these outcomes (good or bad). Follow-up questions based on an analysis of Round 1 results were then posed. These questions focused on relationships and modes of collaboration with the other party and with their own governance forum.

For Round 3, the aim was to allow the four client project managers and four contractor project managers to describe how they viewed 1) control versus flexibility exerted by the client on the contractor, 2) direction versus empowerment exerted by their own project governance forum, and 3) direction and empowerment that they had applied to their own project team. The focus was on identifying events that entailed changes in control versus flexibility or changes in direction versus empowerment. The interviewees were also asked to describe how they viewed their counterpart's governance conditions and leadership style. Moreover, follow-up questions created from analyses of the Round 1 and 2 results regarding organizational tensions, leadership and governance were also asked.

3.3. Analysis

The analysis began with a content analysis of the Round 1 results, which involved a within-case analysis followed by a cross-case analysis. The aim was to identify themes that were frequent in the empirical material based on the suggestions of Eisenhardt (1989) or that were deemed interesting and relevant following Dyer and Wilkins (1991). This resulted in the identification of several tentative themes related to leadership styles, project governance, and collaboration between clients and contractors.

The initial analysis for Round 2 showed that many of the issues highlighted during Rounds 1 and 2 could be interpreted as tensions between two opposing views or approaches. Before conducting detailed analyses, the researcher conducted an extensive review of the literature related to organizational tensions. As the detailed analyses progressed, it became apparent that many of the organizational tensions identified concerned various aspects of control, flexibility, direction and empowerment and that there were indications of interdependencies between these different aspects. It was decided to focus on these types of tensions and to apply a paradox perspective (Lewis & Smith 2014) to the analyses of interdependencies and to identify and analyse vicious and virtuous cycles. Accordingly, a literature review focusing on organizational paradoxical tensions was conducted prior to Round 3 with a focus on control and flexibility, and direction and empowerment.

The within-case analyses of the Round 3 results involved developing explicit descriptions of how direction and empowerment was played out by governance forums and by project managers. Comparisons made with Rounds 1 and 2 involved examining how control and flexibility developed over time. Analyses were concluded by searching for cross-case patterns (Eisenhardt, 1989) of organizing practices in terms of the actions, practices and routines of governance forums and project managers, and searching for reinforcing cycles

4. Empirical findings

This section is divided into five sub-sections, with a sub-section dedicated to each project (A, B, C, and D) and one section describing cross-case patterns and the reinforcing cycles identified. The project-specific sub-sections provide descriptions of direction and empowerment within each party's organization, of leadership styles and relevant personal traits of each project manager, and of control and flexibility patterns between the parties over time.

4.1. Project A: Suburban Infrastructure

According to the client project manager (Client A), the megaproject manager he reported to was directive on how to control the contractor in terms of scheduling and costs: *"My manager stated very clearly that we control everything because that is our duty as an authority: to see to that tax money is used properly"*. However, he empowered Client A to make several decisions as well. Client A is a very self-confident leader who had worked as contractor for several years before taking on this assignment as a consultant, and this seems to have mitigated the direction received from the megaproject manager. *"Their project manager was very strong and filtered and weeded out directions from above that were not in line with his common sense"* (Contractor A). Experience was important to Client A, and he believed that several people in his organization lacked the experience and competence needed to sufficiently control contractors. In general, he delegated considerable responsibility to his personnel and supported them when things went wrong, although he was also quite authoritarian and clear on how he wanted tasks completed.

According to the contractor project manager (Contractor A), both the project board he reported to and his manager empowered him considerably. He attended regular meetings with the project board at which he presented cost and scheduling information and allowed them to control progress. Nevertheless, Contractor A experienced great freedom in running his project: *"I feel they trusted me in how to manage the project. I got some questions and opinions, but mostly it was because they were engaged"*. According to Contractor A, this was because he and several of the people on the project board had worked together for many years and had developed mutual trust. Contractor A delegated considerable responsibility to his personnel but controlled quality and performance standards by frequently walking around the construction site. He is the same age as Client A and had similar experience, and they shared several views on leadership: "*From day one, we had a shared view on how to manage projects and on how to solve problems that arose"* (Contractor A).

Client A was appointed to become project manager because his predecessor did not manage the situation. It had become evident that the design used by the client was poor, requiring excessive discussions with the contractor on required changes, costs and scheduling. The contractor project board sought to control the situation by escalating the issue through a formal complaint that urged the parties to better understand the situation and to agree on a revised way forward. "*About one year into project execution, the contractor realized that things were not going well for them. They filed a claim under the lead of their contract manager, and this impacted relations severely*" (Client A). After a period of time, the client governance forum appeared to agree on several of the issues faced, and under the leadership of Client A and Contractor A, more flexibility was achieved by jointly revising the design and production methods to resume production. After these initial struggles due to the claim, an increasingly well-functioning combination of control and flexibility appeared to have emerged between the two project managers and their teams: *"The more we trusted each other, and trust is always earned, the more we discussed openly and documented only final agreements"… "Sure they did some spot checks on quality, but in general, I feel they balanced control in a reasonable way"* (Contractor A).

4.2. Project B: Rural Infrastructure

The client project manager (Client B) was also the design manager during the preliminary design phase, and he reported to the same megaproject manager as Client A. Client B appeared to agree that direction received from their manager was strict in regards to controlling costs and schedules: "*I did not get much flexibility from my manager, although I tried. The opening of the road was fixed in time*"*… "I was also directed to control the budget in detail because my manager had bad experiences with the same contractor on an earlier project".* Client B had little experience as a project manager, and he stated that he accepted direction from his manager. At the same time, Client B discussed the importance of empowerment in terms of handing over responsibility to his personnel, distributing information and showing trust. However, in practice, he appeared to be quite directive, e.g., emphasizing that he was the only one to make several decisions, although these decisions were based on background information provided by his team. This direction was also recognized by the contractor project manager (Contractor B), who claimed that it was common for client representatives to in meetings raise questions for discussion with Client B and that decisions were often revised afterwards. "*I guess their project manager delegated some authority to his personnel, but most often, they had to bring issues back home before we could get a firm response*" (Contractor B).

Contractor B reported to a project board, and although he expressed that he received their support, many statements from both Client B and Contractor B denote close direction from the project board on how to manage his personnel and the client (e.g., *"I believe that their project manager wanted to be fair and decent, but once things started to look not so good for them financially, the project board pressured him and gave directions on how to act*" (Client B)). Contractor B seemed to accept and even to appreciate this fairly directive governance due to his relatively limited experience as a project manager for such a large project. At the same time, Contractor B strongly emphasized the importance of empowerment in terms of the

delegation of authority, trusting his personnel, open communication and working as a team. Hence, there was a substantial difference between the direction that Contractor B was subjected to and the empowerment that he believed in.

Both Client B and Contractor B initiated the project with high and agreed upon ambitions for collaboration, communication, trust, and flexibility. However, over time, these ambitions vanished and turned into a control-based struggle: "*We intensified control over the contractor over time because we did not trust them*" (Client B). Client B claimed that the contractor often chose to question and argue about costs and variation orders, stalling decisions and creating trench warfare by checking and controlling information provided by the client. "*They spent a considerable amount of time identifying errors in our documents instead of trying to solve the problem and determine how to proceed*" (Client B). This solicited even closer control from the client, encouraged by the megaproject manager. *"We pressured their project manager, who got squeezed between us and his parent organization. He tried to do his best, but when he couldn´t resist the pressure from his managers, we intensified our control and pressure even further"* (Client B). Although Contractor B stressed that levels of collaboration and flexibility were, at least initially, higher in this project relative to those of many others, he gave quite revealing examples of control and inflexibility on the part of the client, forcing the contractor to give up their standpoint to avoid penalties for delays: *"The client's control over variation orders intensified over time, and during the last 7-8 months of production, we received no payments at all" (Contractor B).* However, Contractor B documented everything for future discussions and claims, as he was strongly encouraged to do so by his project board.

4.3. Project C: Office building

During construction, the client project manager (Client C1) was hired as a consultant, and also initially as the design manager during the preliminary design. He reported to the client contract manager, who was also the manager of the real estate company that developed the facility for a specific contracted tenant. The contract manager was very directive and did not leave much room for Client C1 to act or make decisions, and the contract manager occasionally intervened and simply changed decisions made by Client C1. Often, this behaviour originated from change orders initiated by the tenant, who seems to have had a strong contract with the real estate company. Client C1 was assertive and emphasized the importance of delegating responsibility, although he also argued that a project manager must be very clear about objectives to be able to make decisions. Over time, the situation became impossible for Client C1. He left the project, handing over the project manager role to Client C2, who had worked as the project's assistant project manager from the start. Client C2, who seemed less assertive, confirmed that the contract manager directed most decision making details and that he used joint meetings with the tenant and contractor to achieve cost transparency and to minimize risks to his own company: "*The contractual setup between the client and contractor and between the client and tenant was permeated by control. Flexibility was low, and direction was high*" (Client C2).

The contractor project manager (Contractor C) recognized that both Clients C1 and C2 were not being effectively empowered by the client contractor manager, and on many

occasions, this fact made it impossible to make decisions at the project manager level. Instead, it was necessary to escalate issues to make decisions at the contract manager level. Contractor C offered considerable experience in his role, and he was strongly empowered by the project board to which he reported. Intraorganizational communication within the contractor organization was informal, and the distribution of responsibilities was easy to adjust. This appears to have mitigated the negative effects of several points of escalation. "*I work so closely with my project board that it doesn´t really matter on what level decisions are made*" (Contractor C). Contractor C spoke about the importance of delegating responsibility but seemed to have also practiced control based on his own considerable experience with working on construction sites.

The DB contract included ambitions for partnering. However, all of the interviewees emphasized that many contract clauses did not support collaborative work, e.g., "*This contract is tough and controlling. Sure, there are paragraphs that promote collaboration, but in reality, the client has the right to decide everything*" (Client C2). The client controlled the detailed design closely, and while the contractor was welcome to suggest changes to decrease costs, the client only accepted changes that were fully accepted by the tenant. "*This is a triple-drama scenario between the tenant, client and contractor. It is supposed to be a collaborative approach, but in reality, the contractor has been driving everything and the client has not contributed at all to cost savings*" (Designer C). This tight control over the details and deviation from agreed upon partnering ambitions severely affected collaboration efforts, although the relationship between Client C1/C2 and Contractor C seems to have remained fairly positive throughout. It was obvious to them that these tight control measures were attributable to processes occurring higher up in the hierarchy: "*It is obvious that the decision-making approach employed far from production has been one of the most severe problems related to this project*" (Client C1). Contractor C claimed that he and the project board decided to pursue partnering ambitions, although they soon realized that the client did not intend to do so: "*We tried to continue driving this as a partnering project because my company wanted to show the market that we are trustworthy and believe in partnering*".

4.4. Project D: Industrial facility and office building

For Project D, there were two client project managers working in parallel. Client D1 was employed by the client and focused on communications with the overarching client project while receiving input from operations. Client D1 offered little experience with managerial roles, and when describing her leadership style, she expressed quite generic views on decision-making, openness and empowerment. Client D2 was a consultant who mainly managed the contractor and decision-making regarding design. Client D2 offered considerable experience with construction projects and with various roles, although mainly as a structural engineer and design manager. He stressed that a project manager must delegate, listen and change plans when needed but also that a manager must be able to make and follow through with decisions, e.g., to deliver according to schedule. Client D1 organized a forum of representatives of various types of operational personnel to determine their needs and to receive continuous feedback on the solutions designed. However, this forum was initiated when construction had begun, thus creating extensive additional work and variation orders.

The project director that Client D1 and Client D2 reported to was engaged and fairly directive in regards to obtaining additional requirements from operations within the scope of work, although he did generally not express strong opinions on how to proceed. According to Client D1, he was also directive in regards budget issues: "*I always bring up decisions on large costs with my manager. I feel we have good communication, and I get the support I need. However, beforehand, I have first discussed issues with my project manager colleague*".

The initial contractor project manager (Contractor D1) emphasized that he believed strongly in the concept of partnering and being flexible, and he described a leadership style influenced by empowerment. According to Contractor D1, communication with the project board he reported to was often open, entailing consensus. However, on occasion, the project board was much more directive, and he also expressed that his mandate was far from sufficient at enabling effective procurement. "*It is utterly strange; I have a mandate to sign purchasing contracts for up to 10 million SEK when I assume full responsibility for a 500 million SEK contract. This slows the purchasing process down; too many people have to be involved*" (Contractor D1). Due to parental leave, a new contractor project manager (Contractor D2) was appointed by the contractor project board approximately one year prior to the project's completion. At the time, Contractor D2 had no prior experience with partnering contracts, offered only minor experience with DB contracts, and expressed a belief in a combination of direction and empowerment approaches.

The contractual ambition was partnering, and the contractor received a fixed fee for their efforts. The client project board had very little experience with collaborative contracts, but initially, collaboration appeared to have been successful: "*Collaboration worked nicely to start with, and the contractor came up with some creative alternative solutions to problems that compromised the schedule*" (Client D2). However, according to Client D2, the team needed to apply more control over time schedules: "*The contractor performed their initial concrete works and similar activities well, but as their assignment gradually evolved into managing sub-contractors, they lost their grip, and we increased and deepened our control"*. Over time, collaboration disintegrated mainly due to intense discussions concerning the immense number of variation orders made by the client organization for which the contractor felt they were not compensated. "*We argued that when the volume increases as much as it did, the fixed fee does not cover all extra costs. I think that their project manager understood this, whereas their project director was perhaps not that familiar with our contract*" (Contractor D2). Trust between the parties diminished, further intensifying direction from the contractor project board. When Contractor D2 took over, tense relations were exacerbated already. "*The first project manager was very proactive, but the second one, he was reactive, coming to us when problems had already occurred and asking us for instructions*" (Client D2). In the end, the contractor project board intervened and escalated the final commercial settlement to the contract manager level.

4.5. Cross-case patterns and reinforcing cycles

After comparing the empirical findings of the four construction projects, a number of patterns emerged. In Projects B, C, and D, control exerted by the client seemed to intensify over time in what appeared to be a vicious cycle of control, whereas in Project A, a virtuous cycle that sustainably combined control/flexibility appeared to develop. Several actions, practices and routines related to direction and empowerment applied by governance forums seemed affect the emergence and development of these cycles, as did personal traits and practices of the project managers. Table 5 summarizes the empirical findings for each project in regards to control/flexibility, governance direction/empowerment, and traits and practices identified for each project manager deemed relevant.

For Project B, both Client B and Contractor B initially expressed an ambition to show that collaboration is possible and fruitful. However, as cost issues emerged and as tight schedules intensified pressures on production and exposed contractors to fine risks, both governance forums intervened and directed their project managers to revert to a more traditional, control-based ways of managing contracts. As a consequence, trust between Client B and Contractor B diminished, thus soliciting additional control from the client and intensifying attempts on the part of the contractor to retain flexibility. For Project C, client governance was highly directive from the start, while ignoring ambitions for collaboration and flexibility stated in the contract. This approach forced Client C1/C2 to thoroughly control the contractor in a way that they did not believe was optimal. Although control exerted by the client was not appreciated by Contractor C, such problems were partly mitigated by high levels of empowerment provided by the contractor governance board. Decisions made by Client C1 and Client C2 were repeatedly changed by the client contract manager, which diminished trust between the parties, although good relations between Client C1/C2 and Contractor C appeared to have persisted through open dialogue on the real reasons for the contra orders. In the case of Project D, both governance forums first combined direction and empowerment approaches, and control over the contractor seemed to have been combined with flexibility to achieve cost savings and to enhance buildability outcomes. However, as the number of variation orders accumulated and as commercial discussions intensified, client governance appeared to intensify direction levels to ensure that the revised scope of work could be incorporated into the project on time and on budget. This indirectly intensified control over the contractor, and contractor governance responded by directing their project manager more closely. While the relationship between Client D2 and Contractor D1 appeared to start off well, the lack of credit given to the contractor for being flexible to cut costs and endless debates regarding payments for variation orders appeared to weaken trust over time. Trust between Client D2 and Contractor D2 seemed non-existent from the start.

For Project A, the virtuous cycle combining both control and flexibility seems to be at least in part due to the extent to which Contractor A was empowered by his project board. In addition, directive client governance was evened out by Client A. The positive relationship and trust between Client A and Contractor A was enabled through empowering support that was openly provided by the contractor project board to Contractor A and by the fact that Client A defended his decisions when his governance forum attempted to direct him.

Moreover, the escalation event occurring early on in the project seems to have enabled the virtuous cycle by initiating the change of client project manager, and resulting in a revision to the strategy which execution was delegated to the project managers. Additionally, the fact that Client A and Contractor A had similar levels of experience and strong competencies in production indirectly contributed to the observed interorganizational trust and collaboration.

There is no clear relation between different combinations of directive or empowering governance within each party and the emergence of reinforcing cycles of control. However, a detailed analysis of Table 5 shows that project manager experience and self confidence levels influence the extent to which direction applied by each governance forum translates into control over the client, as elaborated on below.

For Project A, a virtuous cycle combining control and flexibility seems to have been enabled by the fact that Client A was experienced and self-confident, thwarting direction and indirect control from his manager. Client A ignored some directions, exerting control over the contractor at a level that he felt was appropriate. Contractor A was also experienced and self-confident, and this seems to have increased empowerment outcomes from his governance forum, thus also stimulating the virtuous cycle. For Project B, both Client B and Contractor B were relatively inexperienced and were not particularly self-confident in their project manager roles. This situation seems to have made them open to direction and to orders from their respective governance forums, thus causing them to more easily desert their own beliefs on collaboration and flexibility. For Project C, Client C1 was not particularly experienced but was an assertive and strong leader who believed in employing a combination of control and flexibility approaches. Initially, this seemed to thwart indirect control over the contractor, but over time, tensions between direction and empowerment within the client organization intensified and finally caused him to leave the project. His successor, Client C2, shared the same views but seemed less assertive and more receptive to direction, which entailed continued control over the contractor. However, it appears that negative effects of the vicious cycle of control were mitigated by Contractor C's experience, self-confidence and willingness to discuss issues with his governance forum (willingness to ask for direction). For Project D, the client project manager (Client D1) who mainly reported to the client governance forum was very inexperienced and lacked confidence as a project manager, whereas Client D2 who mainly interacted with the contractor was experienced and self-confident. This seems to have made Client D2 freer to control the contractor in a way that he believed was appropriate. Contractor D1 appreciated collaborative approaches and exhibited flexibility in suggesting alternative ways to improve buildability and solve problems, but when switching to Contractor D2, who offered less experience with collaborative approaches in a situation where commercial discussions were already intense, the vicious cycle of control intensified.

Table 5. Summary of empirical findings for Projects A, B, C and D

Project	Control versus Flexibility	Client Governance	Client PM	Contractor Governance	Contractor PM
A	Virtuous cycle of control and flexibility	Mainly directive but also empowering	Experienced, self-confident, both directive and empowering	Mainly empowering	Experienced, assertive, both directive and empowering
B	Vicious cycle of control	Mainly directive but also empowering	Inexperienced, hesitant, both directive and empowering	Mainly directive	Inexperienced, hesitant, empowering
C	Vicious cycle of control	Strongly directive	Client C1: Inexperienced, self-confident, both directive and empowering. Client C2: Inexperienced, less self-confident, mainly empowering	Mainly empowering	Experienced, assertive, both directive and empowering
D	Vicious cycle of control	Mainly directive but also empowering	Client D1: Very inexperienced, hesitant, mainly empowering Client D2: Experienced, self-confident, both directive and empowering	Mainly directive	Contractor D1: Experienced, self-confident, empowering Contractor D2: Experienced, self-confident, both directive and empowering

5. Discussion and conclusions

This paper presents empirical findings that show that management teams of each of the four large construction projects examined used both control and flexibility approaches; these findings are in accordance with e.g., Walker and Shen (2002), van Marrewijk et al. (2008), and Koppenjan et al. (2011). However, this paper distinguishes interorganizational control and flexibility from intraorganizational direction and empowerment, as shown in Figure 2 and then investigates how interdependencies between these two tensions develop over time. This study's overarching conclusion and theoretical contribution to the construction management literature is that it is fruitful and important to employ a systemic paradox perspective when analysing organizational tensions related to control, flexibility, direction and empowerment in large construction projects. As demonstrated below, by simultaneously reflecting on both intraorganizational direction/empowerment and interorganizational control/flexibility, new insights about theories on how to organize and manage large construction projects can be generated.

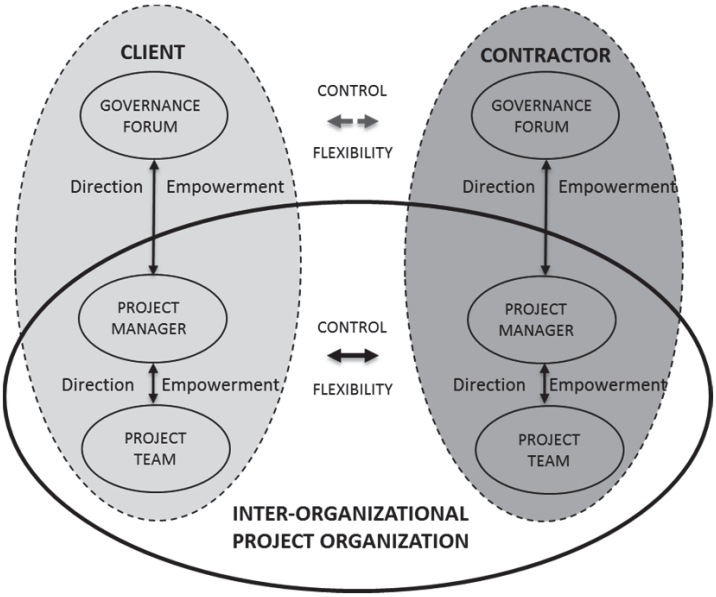

Figure 2. Schematic overview of control/flexibility and direction/empowerment emerging at different organizational interfaces in interorganizational projects

First, the empirical findings support previous conclusions made by Clegg et al. (2002) and Andriopoulos and Lewis (2010) that tensions can be nested across multiple levels in organizations, but the results add that for large construction projects, tensions can be nested not only across several intraorganizational levels but also simultaneously across the interorganizational interface between client and contractor. Accordingly, the empirical findings demonstrate how increased levels of control from the client initiate intensified direction from contractor governance teams, thus supporting conclusions by Tuuli et al. (2010) that interorganizational control can translate into intraorganizational reactions. However, this paper contributes by providing several examples of impact in the other direction as well. For instance, it is shown how direction from both client and contractor governance forums can translate into intensified levels of interorganizational control. Altogether, this shows that there can be interdependencies between tensions at different organizational interfaces, not only dependency in one direction.

Second, for three of the projects studied, vicious cycles involving increasing interorganizational control and intraorganizational direction emerged and reinforced over time, and for one project, a virtuous cycle combining control and flexibility as a result of combined direction and empowerment developed over time. Therefore, this paper expands existing literature on reinforcing cycles of paradoxical tensions (e.g., Sundaramurthy & Lewis, 2003; Smith & Lewis, 2011) by showing that reinforcing cycles can involve several types of paradoxical tensions at different organizational interfaces. Although not found in the empirical material, theoretically, other combinations of elements could evolve into a vicious cycle, for instance increasing intraorganizational direction within the client organization urging their project manager to decrease interorganizational control could entail similar

directions by the contractor governance forum, further increasing flexibility into a situation where lack of monitoring and control impose a risk to the fulfilment of the project objectives. Moreover, the empirical materials show the negative impacts of vicious cycles of control and direction in terms of losing trust, diminishing collaboration, sub-optimization, and weakened claim processes, and the benefits of the virtuous cycles in terms of open dialogue, method and solution optimization, and ultimately cost savings. These findings highlight the need to employ a systemic paradox perspective when analysing tensions in project contexts, in support of Szentes and Eriksson (2015), while illuminating this need further by demonstrating how interdependencies over time can develop into reinforcing cycles involving tensions at different organizational interfaces.

Third, trust was repeatedly mentioned during the interviews as a crucial underlying enabler for flexibility between the client and contractor, supporting similar notions regarding trust and flexible approaches in project management practices made by Atkinson et al. (2006) and Bresnen (2007). However, in line with Lazar (2000) and Maurer (2010), the empirical material further highlights that interorganizational trust is dependent on intraorganizational decisions and practices. More specifically, on several occasions, actions taken by a governance forum diminished or even destroyed trust between client and contractor project managers. These actions often initiated a vicious cycle, thus revealing interdependence between interorganizational and intraorganizational trust, and not only dependency in one direction. Moreover, both clients and contractors sought flexibility through collaboration, but some project managers tended to treat good relations and open communication as a means to control the other party as if they had trust in the other party's competence but not necessarily in their intentions. This is in line with notions by conclusions made by Mills and Ungson (2003) that there is a difference between routine trust and basic trust.

Fourth, this paper presents empirical findings showing that although direction/empowerment appears to be played out top-down by managers whose attitudes and views are therefore preponderant, the practical implementation and the result is strongly dependent on whom the receiver is. This is in line with similar notions in existing literature, e.g., Mills and Ungson (2003) and Lorinkova et al. (2013) who argue that empowerment is mainly provided top-down. Müller et al. (2015) argue that the attitudes of those occupying project governance positions influence the practical implementation of governance, and Quinn and Spreitzer (1997) and Tuuli and Rowlinson (2010) add that the practical implementation of empowerment depends on how the receiver perceives the empowering management practices. Other researchers have argued that leadership and management practices influence to what extent inherent complexities can be managed (Denison et al., 1995), and if and how both elements in tensions are simultaneously promoted, e.g., (Beech et al., 2004; Smith et al., 2010). However, this paper adds and emphasizes that to achieve fruitful combinations of direction/empowerment and control/flexibility in interorganizational projects it is necessary to reflect upon the combination of individuals in all managerial positions, thus calling for systemic analyses of experience and traits of all people appointed to govern and manage the project. This is because the experience and self-confidence of a project manager seem to partly determine how he or she perceives and responds to combined direction and

empowerment approaches practiced by governance forums. For example, governance direction can be offset by an experienced and self-confident project manager, whereas an inexperienced and less self-confident project manager may be entirely overwhelmed by a directive governance forum. In addition, to assess what combination of direction/empowerment in governance that is appropriate in a specific project, it is necessary to simultaneously reflect upon the combination of attitudes and leadership styles of the two project managers who are expected to manage interorganizational control/flexibility.

This paper also has managerial implications in which the overarching suggestion is that practitioners need to apply a systemic approach when organizing, staffing, and managing large construction projects. A failure to recognize interdependencies across organizational interfaces can lead to suboptimal outcomes and vicious cycles, whereas a systemic view can enable and nurture the development of virtuous cycles. For instance, when staffing a large construction project, it is not sufficient to appoint project managers who seem to collaborate well, as their capacities to combine control and flexibility are largely influenced by their respective governance forums. Instead, a favourable combination of project managers and governance members within both parties can nurture a virtuous cycle whereby control and flexibility are delicately combined. In addition, in line with conclusions presented by Greasley et al. (2005) and Maurer (2010), in regards to promoting continuity and using existing relationships in staffing processes, this study adds that for large construction projects that continue over several years, changing the project manager during execution should not be trivialized. If a shift of project manager is inevitable or necessary, a systemic view needs to be employed when management teams appoint a replacement. Moreover, in recognizing conclusions presented by Turner and Müller (2003) regarding control at two different hierarchical levels, this paper highlights that project managers' possibilities to empower their own project teams are to a large extent impacted by degrees of empowerment afforded to them. However, a self-confident and experienced project manager may more easily remain true to his preferred approach, which can be a good or bad thing depending on the overall systemic conditions of a given project.

This study is limited in that it is based on a multiple case study of four large construction projects that are all situated in Sweden. Although globalization is gradually homogenizing societies around the world, more research is required to assess the generalizability of the presented conclusions to different cultures and empirical contexts. Moreover, researchers would benefit from interviewing both project managers and members of governance forums to compare their views. Additionally, it might prove useful to apply other methods (e.g., observations or ethnography) to fully grasp the emergence and development of reinforcing cycles involving tensions at several organizational interfaces. Additional research is needed to investigate the extent to which project managers and those occupying governing positions are aware of paradoxical tensions related to control, flexibility, direction and empowerment and to improve knowledge of appropriate managerial actions. Moreover, additional studies should investigate the applicability of conclusions presented in this paper to other interorganizational projects.

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