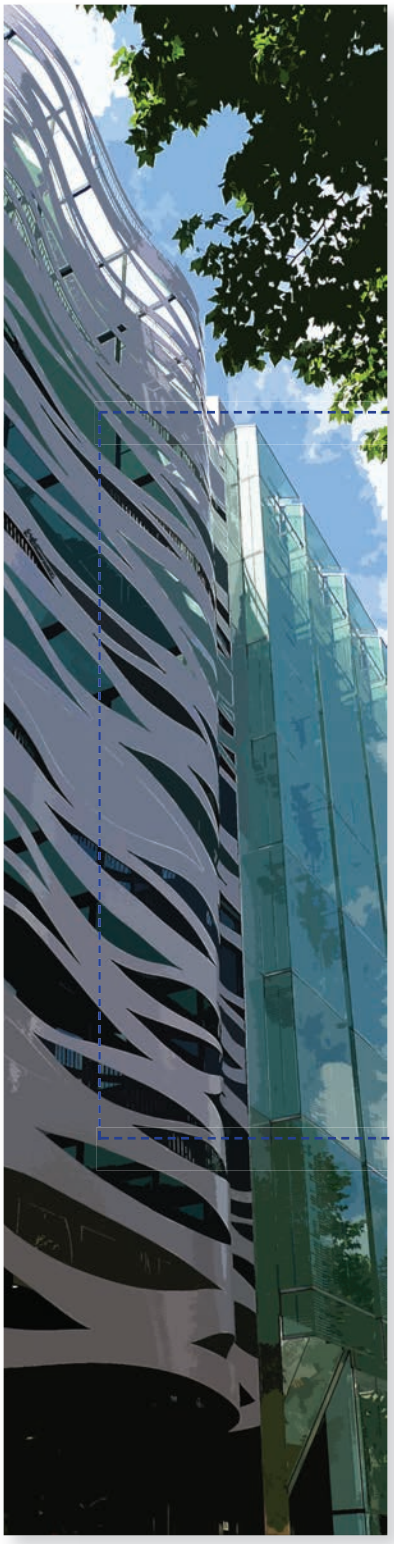

Ole Jonny Klakegg, Kari Hovin Kjølle,
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Asmamaw T. Shiferaw, Ruth Woods
(editors)

PROCEEDINGS FROM
7TH NORDIC CONFERENCE ON

# CONSTRUCTION ECONOMICS AND ORGANISATION 2013

## *GREEN URBANISATION – IMPLICATIONS FOR VALUE CREATION*

TRONDHEIM
12–14 JUNE 2013

SINTEF
NTNU Norwegian University of Science and Technology
CREON
STATSBYGG
SKANSKA

# 7th Nordic Conference on Construction Economics and Organisation

## Trondheim

## June 12-14, 2013

*ISBN 978-82-321-0273-0* (online publishing)



*Layout:*
*Cover: Ole Tolstad*
*Foreword, introduction and paper template: The editors*

*Akademika Publishing*
*NO–7005 Trondheim,*
*Norway*
*Tel.: + 47 73 59 32 10*
*www.akademikaforlag.no*

*Publishing Editor: Lasse Postmyr (lasse.postmyr@akademika.no)*

We wish to thank the following for their contributions to the conference.

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# 7th Nordic Conference on Construction Economics and Organisation, Trondheim 12.-14. June 2013

## FOREWORD

The first Nordic Conference on Construction Economics and Organisation was held in Gothenburg at Chalmers University of Technology back in 1999. Since then, the conference has been held biannually (with the exception of 2005) in Sweden (4 times), on Iceland and in Denmark. Now it is Norway's turn to host the conference, and Finland is scheduled to take over the baton next time. We are very pleased to be carrying on the tradition, and we hope to live up to the expectations created by previous conferences.

In 2011 in Copenhagen an initiative was taken that marked a shift in the organization of this series of Nordic conferences: CREON was founded. The first general assembly was held during the 6th Nordic conference. The CREON network is a voluntary, non-profit association for people who study, work, teach and do research about all aspects of management and construction. The CREON network aims to promote collaboration across Nordic knowledge institutions and this series of conferences is an important activity for CREON. NTNU and SINTEF, as local organizers, are proud to present the 7th Nordic conference on behalf of CREON.

We, the organizers, had two specific ambitions when we started preparing for this conference: Firstly, we wanted this conference to be acknowledged as a high quality academic conference. We have therefore put a lot of effort in the review process. Three rounds of blind reviews is a lot of work, but now when we see the result – it was worth it. The close collaboration with Akademika Publishing makes sure publication points can be awarded to the authors. The papers are presented in two parallel sessions over three days here at the NTNU Gløshaugen campus.

Secondly, we wanted to establish a closer connection with the construction industry. We therefore put together a very strong Program Committee, comprising of prominent representatives from the Norwegian Construction Industry, who identified the main topic: Green Urbanization – Implications for Value Creation. We realized that it was not realistic to turn an academic conference into a popular construction industry event, so we have chosen to collaborate with NTNU in marking their new initiative for improving knowledge about the building process. Thus the idea for the Building Process Day was born – we will spend half a conference day together with distinguished guests from the Norwegian construction industry. The building process day will also be the scene for another conference innovation: Statsbygg awards for best paper and best young researcher. Enjoy!

Ole Jonny Klakegg, Kari Hovin Kjølle, Cecilie G. Mehaug , Nils O.E. Olsson, Asmamaw T. Shiferaw, Ruth Woods (Editors).

# INTRODUCTION, CONTEXT AND SUMMARY

The construction industry plays an important role in society. Construction forms our physical surroundings and creates the infrastructure we need to develop society. Physical infrastructure and buildings represent approximately 70 per cent of Norway's Real Capital. Public investments in infrastructure constitute half of all infrastructure investments in Norway. It is also a major factor in the society's economy, representing a substantial share of the GNP, and, for example, it represents approximately 30% of the employment in Norway. According to Statistics Norway the construction sector is the third largest industry in Norway, employing 350,000 workers in more than 75,000 enterprises, and has a high turnover; over NOK 308 billion in 2011, approximately the same level as 2008 which was a top year. The Confederation of Norwegian Enterprise (NHO) states that the construction industry in Norway provides 10% of the total value creation. The construction industry is truly a cornerstone of our society.

On the other hand the dwellings and construction industry is also mentioned as "the 40% industry" by the Ministry of Local Government and Regional Development. This is a reminder that the construction industry uses approximately 40% of the total energy in our society, 40% of the materials, and produces about 40% of the waste that goes into landfills. This indicates the industry's importance in relation to climate and other environmental challenges. If there is one industry that really can make a difference, it is probably construction.

Furthermore, the construction industry has a reputation of being conservative, having a low degree of innovation, and low productivity. It is not known to be the first industry to implement sustainable solutions. The construction industry does use low-tech solutions and employ low skilled workers, but it does also include highly advanced New Tech solutions to technical problems and engage some of the most qualified engineers in our society. The truth about this industry is as complex as the problems it is trying to solve on behalf of society.

In the next ten years, growing globalization will promote an already increasing trend of competition among international construction companies according to The Federation of Norwegian Construction Industries (BNL). Additionally, Norway has the following challenges ahead:

- Growing population, expected to surpass 7 million by 2060, up from today's 5 million
- Increasing trend towards centralisation
- Growing elderly population with needs for health care and housing
- More pressure on transport infrastructure
- An ever increasing immigrant workforce

- Long cold winters and harsh climate, worsened by climate change which may lead to more floods, landslides and frequent winter storms

All these challenges will lead to:

- High demand for new dwellings
- Need for higher investment in low energy buildings
- Need for more robust buildings and infrastructure
- Need for more investment in transport infrastructure
- Need for a larger workforce and recruitment in all sectors
- Need for good integration programmes, development of expertise and training in relevant areas for new migrants and unskilled labour.

These are the sort of challenges that the Program Committee saw when they discussed the profile for this event back at the beginning of 2011. They called it Green Urbanization. The situation calls for new solutions, new knowledge, new thinking. Both small steps and huge leaps help as long as they lead in the right direction. Is the construction industry ready for it?

The sector is fragmented and contains many small enterprises. Thus, large companies account for a smaller share of the construction output in Norway than in most other countries. Small companies with highly specialized competence indicate a fragmented industry. The typical construction project is also said to be one-of-a-kind at a hectic pace. It is obviously hard to optimize process and solutions in such an environment.

Although to a lesser degree than other countries, the Norwegian construction industry is currently facing the challenges that have followed the 2009 financial crisis; small enterprises lost competence due to temporary redundancy and the investments were at a minimum level. Therefore, the diffusion of new knowledge and investments was also at a minimum. To what degree is the construction industry equipped to meet challenges ahead? And to what degree is the academic community able to help this industry overcome its challenges? These are questions that deserve to be asked, and perhaps some answers or indications may be found among the contributions to this conference? Are the academic resources ready for it?

This introduction, its examples and identified challenges are chosen from the Norwegian context, in full awareness of the current peculiarities of the Norwegian situation. We do have a special and advantageous position, but Norway is still clearly a distinct part of the Nordic context. We are also deeply embedded in the bigger international economy and global community. Therefore, the conference profile and the Nordic conference setting feel highly relevant in 2013.

The contributions span a wide range of issues, organized in three tracks with three major themes in each:

| **Sustainable Development of the Urban Environment** | **Organizing for Execution** | **Efficiency in Construction** |
|---|---|---|
| The Sustainability Perspective | Governance and Strategy Implementation | The Human Aspect in Construction |
| Sustainable Design | Decision Making and Relations | Productivity and Quality |
| Sustainability and People | Learning from Construction Projects | Supply Chains and Planning |

The first track; **Sustainable Development of the Urban Environment** is the signature track of this conference. It relates directly to the challenges addressed by the program committee back in 2011. The invitation to authors included contributions on sustainability in a wide sense – the concept of sustainability, the framework conditions defined by government and international agreements, the built environment, both the upgrading of existing buildings and finding solutions for future built environments. As the papers of this track shows, the authors cover these issues from several perspectives and cover a wide range of issues as intended. The track provides a varied and thought provoking approach to the term "sustainable"; one of the most oft-used terms in the construction industry today, but which also continues to be one of the most important issues.

Key issues addressed by the papers are; different challenges in combining urbanization and environment respect, the role and use of green certification systems, the role of sustainability in project management, passive house building, renovation and retrofitting from a sustainable perspective and the development of new technology to the deal with climate and age related problems in building materials. Green has become an important issue and two papers look at the role of green certification and policy in stimulating company activity. It can on the one hand, as one paper suggests, become a catalyst, stimulating more green certified buildings. On the other hand, green may mean, as the second example shows, following the market rather than focusing on policies which benefit clients and society. Encouraging a sustainable build is a theme which may be understood as central in this track; it is present in the aforementioned papers and also plays a role in the papers which focus on retrofitting, project management and the building of passive houses. Further issues are exploring the difference between project management success and project success; analyzing collaborative working and experienced effects on the energy performance of a building project; an analysis of existing Norwegian retail development and their impact on local energy consumption; and the effects of user involvement in the briefing and design of a workplace. Scandinavian and particularly Norwegian examples

dominate the papers, but there are also case stories from USA and China and contributions from the Netherlands and the UK.

The second track; **Organizing for Execution** represents a combination of new and classic issues around governance, decision making and learning. It covers issues with a wide perspective and long-ranging consequences for the organisations involved. Key issues are governance mechanisms, strategy implementation, decision making, relations and learning. Several papers discuss aspects of governance and how organisations may implement processes and structures in order to improve their value creation and value for money in investments. Examples presented here are the governments in the Netherlands and Norway, as well as several anonymous companies associated with the construction industry. This has a lot to do with designing purposeful decision making processes and using the right criteria for prioritizing and choice of projects. Other perspectives are how to implement necessary transformations of the organization in a changing environment. This is an important issue in a world of increasing globalization, competition and new technologies.

One major topic in several papers is the clarity and better understanding of roles and responsibilities in project organisations and between the project and its mother organization, as well as other stakeholders. These relational issues include communication, motivation, emotions and trust, just to mention some important aspects. The most fundamental topic in these papers is perhaps learning. Learning from cases and accumulating experiences in organisations in construction has been argued a particularly challenging thing to do. Several papers look into these challenges.

The types of organisations represented in these papers range from large public agencies, via industrial companies down to facilities management companies. The projects range accordingly from large infrastructure investments via large building design and development processes down to small and medium sized renovation and upgrading projects in existing buildings. All in all, this track comprises discussions on some of the major issues engaging the research community on construction projects in recent years. The picture is clearly Nordic in the sense that most of the cases reported are documented in the Nordic region, but extended to include Poland, France and the UK.

The third track; **Efficiency in construction** is the original core area of construction economics and organisation, internationally perhaps better known as construction management. It covers both qualitative and quantitative aspects of efficiency in construction. The majority of the papers address the human aspect in construction, but in different ways. Innovation, learning, daily life, scheduling, BIM, productivity, quality, procurement, contracts and supply chains are addressed, among other issues. Roles and interfaces between different stakeholders in a construction project are addressed in several papers.

Innovation is a key topic. It is addressed both explicitly in some papers, and implicitly in many more papers. Innovation in the construction sector is an important topic. It is mainly

illustrated through cases. The construction sector is characterised by cooperation between many stakeholders. Design, planning and execution are typically carried out by project-oriented organizations. Deliveries of building components and materials are carried out by manufacturing companies. Interestingly, we also have comparisons between the construction sector and other sectors, as well as the use of analytical models used in other industries but here applied in a construction context.

Contracts and supply chain are addressed in several papers. The contractual relationships in the construction industry are illustrated, with special focus on incentives and stakeholder relations. Planning is addressed in a quantitative way, but from different perspectives. We also have a terminology overview related to planning.

The track includes examples of technology advancement in the construction industry, including Building Information Modelling (BIM).The track includes BIM approaches in a life cycle perspective.

Cases and data come from a wide array of countries, and are not limited to the Nordic region.

The research approaches represent an interesting mix of theoretical work in the form of literature reviews and conceptual papers, development of decision models and understanding of observed performance in real situations, as well as documenting learning from cases and demonstration projects. The empirical side is not surprisingly dominated by document studies and interviews. Several papers are based on case studies. Some papers have a more theoretical approach, while others are very empirical and data driven. In total these proceedings represent a good cross section of contemporary research in the field of construction economics and organization in 2013.

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# MANAGING EXPLORATION AND EXPLOITATION IN CONSTRUCTION PROJECTS

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**Abstract.** *Prior 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 and prepare for tomorrow's demands. The capacity to achieve both exploration and exploitation is especially problematic in project based organizations due to projects' discontinuous nature. In spite of its theoretical and practical importance, research on exploration and exploitation in projects and project-based organizations is scarce. The purpose of this study is to investigate how exploration and exploitation is managed in construction projects. Empirical data was collected through a multiple case study involving interviews with the client's project manager, the contractor's project manager, and the design manager in seven construction projects. Tentative findings show that the project actors often focus more on exploitation than on exploration although they acknowledge the importance of exploration too. However, exploitation often involves adopting conventional methods and solutions based on existing knowledge without any development efforts. Time constraints in tight schedules are hindering both radical innovations and continuous developments. The findings also reveal that explorative solutions must be possible to exploit in the same project. Sufficient project size and/or long-term contracts over a series of projects therefore enhance both investments in explorative activities and exploitation through continuous developments from project to project. Exploration activities are mostly performed in early stages while the focus on exploitation strengthens as the project proceeds. Exploration is often conducted by the contractor or by the client, consultant and contractor together. Hence, in design-bid-build contracts the client and consultant often miss opportunities to explore new technical solutions. Early contractor involvement, (e.g. in Design-build contracts) thereby enable the achievement of both exploration and exploitation.*

KEYWORDS: Exploration, exploitation, ambidexterity, efficiency, innovation

## 1 INTRODUCTION

Prior 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 and profit on tomorrow's demands (March, 1991; Benner & Tushman, 2003). Tiwana (2008) argues that project-level research, in which the tension between exploration and exploitation is investigated within projects, is scarce. This gap may be due to that research on this topic has mainly focused on various high-tech manufacturing industries (Katila & Ahuja, 2002; He & Wong, 2004) rather than project-based contexts, such as the construction industry (Eriksson & Westerberg, 2011). Due to decentralization, short-term project focus, and interdependencies between actors and their activities it is especially difficult to achieve both exploration and exploitation in project-based organizations (Söderlund, 2008; Eriksson, 2013).

Prior studies in the construction industry have found that time and cost overruns are common and that there is a need for improved efficiency and productivity in construction

projects (Chan & Kumaraswamy, 1997; Chua et al., 1997; Odeh & Battaineh, 2002). Although sometimes challenged, the habitual view is also that the construction industry lacks ability to pursue innovation (Barlow, 2000; Reichstein et al., 2005). Hence, many studies pinpoint the need for improved innovation capabilities in the construction industry (Tawiah & Russell, 2008; Ozorhon, 2012). However, suggested improvement agendas often fail to account for the specificities of innovating within the project-based construction industry (Dubois & Gadde, 2002; Harty, 2008). 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). Previous research has thereby focused on what should be done, while managers are in more need of understanding of how it can be done. Furthermore, although previous studies have highlighted the urgency of addressing either short-term efficiency or long-term innovation they fail to acknowledge the mutual importance of, and the tension between these improvement agendas. Hence, it is vital to develop an improved understanding of how exploration and exploitation can be simultaneously achieved in construction projects.

The research described in this paper addresses the abovementioned literature gaps and managerial challenges by investigating how exploration and exploitation are managed in large construction projects. More specifically, the research sheds light on how various governance and management approaches interact and affect exploration and exploitation activities. Empirical data was collected through interviews and site visits in a multiple case study involving seven ongoing construction projects.

## 2 THEORETICAL FRAMEWORK

### 2.1 Organizational ambidexterity by achieving both exploration and exploitation

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 & Birkinshaw, 2004; Andriopoulos & Lewis, 2010). The organizational capability to simultaneously achieve both exploration and exploitation is often associated with the term organizational ambidexterity, which was coined by (Duncan, 1976). Accordingly, ambidexterity involves the capability to both exploit existing knowledge and technologies for short-term profits and also explore new knowledge and technologies to enhance long-term development (O´Reilly & Tushman, 2008).

There are three main types of ambidexterity solutions: 1) Structural ambidexterity separates exploration and exploitation activities in different business units (Benner and Tushman, 2003; Duncan, 1976; Tushman and O´Reilly, 1996). 2) Sequential solutions separate the exploration and exploitation through focusing on first one type of activity and then the other one (Adler et al., 1999; Duncan, 1976; Gupta et al., 2006). Recent research suggests that there is a third way of dealing with the tension between exploration and exploitation: 3) 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). Eriksson (2013) argue that structural and sequential ambidexterity solutions are not sufficient in the project-based construction industry. Due to interdependences between different actors and their explorative and exploitative activities distinct separation of exploration and exploitation in time and space may be unsuitable. Instead contextual ambidexterity within projects is required in order to obtain sufficient focus on both exploration and exploitation (Eriksson, 2013).

### 2.2 Exploitative efficiency in construction

Prior research has investigated many different causes of cost and time overruns in construction projects as well as factors that enhance efficiency. Two quantitative studies performed by Chua and colleagues (the first investigating 75 construction projects and the second involving the perceptions of 20 industry professionals) obtained similar results related to critical success factors that enhance budget performance: 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 cost and 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 (Chan & Kumaraswamy, 1997; Josephson & Hammarlund, 1999; Odeh & Battaineh, 2002; Assaf & Al-Hejji, 2006; Faridi & El-Sayegh, 2006; Sambasivan & Soon, 2007). Taken together these studies indicate that short-term efficiency is enhanced by exploitation of existing knowledge and by planning and control.

### 2.3 Exploratory innovation in construction

Prior research has found many different drivers and barriers for innovation in construction. 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 trialing, inflexible product specifications, and product liability concerns are major barriers to product innovation. 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 & Russell, 2008; Ozorhon, 2012) whereas collaboration and early involvement of key actors, end-user involvement, and internal R&D-efforts, are enablers for innovation (Caldwell et al., 2009; Bröchner, 2010; Ozorhon, 2012). Prior studies have however found that exploratory development projects in project-based organizations were managed in the same control focused way as the regular exploitative business projects, which stifled innovation (Keegan & Turner, 2002; Blindenbach-Driessen & van den Ende, 2006).

## 3 RESEARCH METHOD

This paper is based on a multiple case study of seven large construction projects in Sweden, in which interviews were used as the primary data source. Two rounds of interviews will be conducted in each project. The first round was conducted while the projects were ongoing, investigating how exploration and exploitation were addressed in the projects. The second round will be performed after each project has finished, enabling comparisons with actual project results from an exploration/exploitation perspective. At the time of the final submission of this paper, the first round of interviews has been finalized in all case studies, while the second round of interviews has been conducted and tentatively analyzed in only two of the seven case studies. However, at the conference in June 2013 tentative results from the second round of interviews in more case studies will be presented.

### 3.1 Sample

The seven large construction projects were chosen using theoretical sampling, with

multiple cases within each main category to enable replication (Eisenhardt, 1989). The main categories were 'civil engineering or building', 'design responsibility – client or contractor', and 'private or public client'. The seven projects were all located in Sweden, had a contract sum above 50 million Euros each, and together they comprised production of roads, bridges, office buildings, process industry, and refurbishment and production of a hospital, see Table 1. The main reason for studying large projects is that a larger size and longer project duration may increase the possibilities for managing ambidexterity in various ways (structural, sequential, or contextual ambidexterity) within each project.

*Table 1: Information about the seven cases*

| Case | Object | Category | Design responsibility | Client type |
|---|---|---|---|---|
| 1 | Road, Tunnel | Civil Engineering | Client & Contractor (interior - tunnel) | Public |
| 2 | Road, Bridges | Civil Engineering | Client & Contractor (bridges) | Public |
| 3 | 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 |

### 3.2 Data collection

The primary data source is 23 semi-structured interviews during the first round with people who, at the time of the interview, represented the client, the contractor or the main design company involved in each of the seven large construction projects in the sample. Most of the interviews were conducted at each construction site and a secondary data source were project documentation such as project plans. 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 used as they are more commonly and widely accepted in practice, for example innovation and flexibility (exploration) and short-term efficiency and continuous developments (exploitation).

The interviews were recorded digitally, and after weighing pros and cons of transcription (Alvesson, 2011) it was decided not to transcribe the entire interview recordings. Instead comprehensive field-notes were used for initial analysis. Notations of time elapsed when entering new questions made it easy to listen to specific parts of the recordings for further details and clarifications.

### 3.3 Data analysis

The analysis was inspired by Eisenhardt (1989), using 'within case analysis' to establish patterns in the views expressed by interviewees in each case, followed by 'cross case analysis" to seek replication and overarching patterns. Examples of exploration and exploitation were established, together with mapping of the opinions regarding what was regarded as most important in each case. Due to space limitations the within case analysis is not presented in this paper. The empirical results presented below focus on overall findings from the cross-case analysis. Moreover, comparisons among the different categories of cases will not be conducted until the second round of data collection has been conducted.

## 4 RESULTS

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). One client meant that exploitation is most important for projects, whereas exploration is most important for the industry. Others argued that

exploration was most important in their particular project but that exploitation may be more important in other projects. Several respondents supported the notion that ambidextrous behaviors are critical by pinpointing the need of focusing on both innovation and efficient use of existing knowledge. Some respondents argued that it is important 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 distinction between exploration and exploitation is not completely clear. Some respondents argued that it is difficult to distinguish between larger and more radical development work on one hand and more continuous development and fine tuning on the other hand. A consultant 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, some respondents expressed an attitude that all sorts of development is exploration no matter how small the fine tuning is.

### 4.2 Exploitation

Exploitation in terms of fine-tuning and continuous development was not performed to a large extent in the projects, at least not in a formalized manner. However, it was mentioned that certain fine-tuning and adaptation is occasionally conducted on craftsmen level though 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 consultant stated: *"sure we made changes and unconventional solutions to provide a better working environment and so on, and so on. I mean we make a passage beneath the subway, we add sound joints, etc., but it does not justify calling it innovation"*.

Most respondents mentioned that exploitation in terms of utilizing existing knowledge and technologies as they are without any development was dominant. One consultant expressed this as: *"We are bad at fine-tuning and continuous developments, we often do as we always have done"*. Some respondents mentioned that exploitation is 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 is time pressure. In many projects the schedule was so tight that the respondents felt that there was little time to spend on fine-tuning and continuous development. It is faster to adopt a conventional method as it is than to try to improve and develop it before implementation. A contractor 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 an excessive man on a project*". Another barrier closely related to time pressure is that even slight fine-tuning or developments may influence the distribution of risk and liabilities.

### 4.1 Exploration

Some respondents mentioned that incentive-based payment may serve as a driver for innovation since the contractor will benefit from cost and time savings that result from new solutions and methods. Development work is also dependent on commitment and efforts by individuals in the project organization. Some respondents stated 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 dependent on initiatives by contractors, which are largely affected by contract forms.

Respondents representing all three types of actors (client, contractor, and consultant) argue that the commonly used procurement procedures based on Design-bid-build (DBB) contracts and fixed price payment are a main barrier to innovation. In this approach 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 this case is just to focus on short-term project cost rather than a more long-term life cycle perspective. A client representative stated that: *"The contractor often has difficulties to rethink; detailed specification will program a contractor to think that these are the rules"*. A contractor had similar thoughts: *"An approved design in DBB-contracts makes the contractor hesitant to suggest new design solutions for which the contractor has to take responsibility"*.

Another barrier that was mentioned is time pressure, which was a common aspect of many projects. Tight project schedules discourage contractors from thinking outside the box. It is faster to do things the conventional way than to spend time on trying to come up with new and better ways to do it. However, one contractor also argued that time pressure can serve as a driver for innovation. *"If we know that the schedule is too tight to perform a certain activity the conventional way we feel the pressure to develop a new method to do it"*.

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 skeptical 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. A contractor exemplified this by describing a suggestion involving prefabrication of a fan foundation. *"Our solution passed all the requirements in the norm, but they didn't approve it. We had to fill it with concrete, because it <u>should</u> be filled with concrete"*. These norms and regulations thereby prohibit the contractor from adopting new and innovative processes, production methods and products. One consultant stated that it is even harder for consultants to get innovations approved. Relating to the abovementioned example of the fan foundation, the consultant proposed a conventional design on purpose to get the administration's approval, and then the contractor could propose a more innovative solution. *"If we had proposed the innovative design it would never had been approved"*.

Also in the office building project, the client discouraged innovation. The contractor stated: *"The client's sharp opinion is that nothing that is newer than a decade is worth anything. He is very clear that he wants solutions that have been proven to work, and are sustainable from an operational perspective. He does not want any innovations that no one has tested; he does not 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"*.

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. 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.

## 5 DISCUSSION

In many projects there was an apparent awareness that both long-term innovation and short-term efficiency are of crucial importance, both for their particular project and for the industry. The challenge, however, is to implement governance and management approaches that address the tension between exploration and exploitation and that can enhance the achievement of both. 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. The introduction of an 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.

This study indicates that different forms of payments and contracts can heavily impact on exploration and exploitation. Incentive-based payment where clients and contractors share benefits from cost saving innovations can diminish the risk for goal misalignment (Rose & Manley, 2012). Contractors are motivated to invest time in both exploratory and exploitative development activities since they will share cost savings with the client and the client is more motivated to approve new alternative technical solutions or production methods since their cost will be lowered. In line with earlier research findings, competitive tendering based on Design-bid-build contracts can hinder innovation (Tawiah & Russell, 2008). Instead early involvement of key actors will enhance both exploration through joint innovation and exploitation through improved buildability. Furthermore, large-scale projects and/or long-term contracts can 1) motivate contractors to invest in exploratory innovations that can be exploited in subsequent projects and 2) enhance continuous developments across projects or activities within a large project.

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). This study has shown 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 exploratory or exploitative developments. However, time pressure can in some circumstances be a driver for innovation. When actors are facing a situation where conventional solutions or methods are 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 a coming shortage of time is identified in advance, enabling proactive actions.

This study support prior research that has shown that client championing is a main driver for innovation. A client that functions as a champion by encouraging the other project actors to conduct innovation work is important (Gil et al., 2012; Ozorhon, 2012). However, this study highlights the importance of not only encouraging supply-side actors to perform innovation activities, but even more importantly to accept and embrace new and untested solutions. Client championing can be especially important in situations characterized by time pressure. When a client procures a project with an explicitly tight time schedule and simultaneously demands innovative time saving solutions, project actors can be especially motivated to focus on exploration.

## 6 CONCLUSIONS

This paper presents a study of how exploration and exploitation is managed in large construction projects. Prior ambidexterity research, which previously has focused mainly on high-tech industries, suggests that exploitation involves continuous development and incremental innovation. A contribution to the ambidexterity literature is that in mature industries, such as construction, the exploitation concept often seems to involve the utilization of existing knowledge just as it is rather than continuous developments of existing knowledge. A contribution to the literatures on project management and construction management is that the common element of time pressure in projects can serve as both a driver and a barrier to innovation. Hence, it is important to distinguish among different forms of time pressures; both regarding their causes and consequences.

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 adaptations or developments. Another implication is that some mechanisms, such as early involvement of key actors, incentive-based payment, large-scale projects, and/or long-term contracts and framework agreements can enhance both exploration and exploitation. Hence, managers can enhance organizational ambidexterity in construction projects by implementing such mechanisms.

One limitation in this study is that only people working in project 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 therefore is to interview many 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 exploratory innovations and exploitative developments.

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