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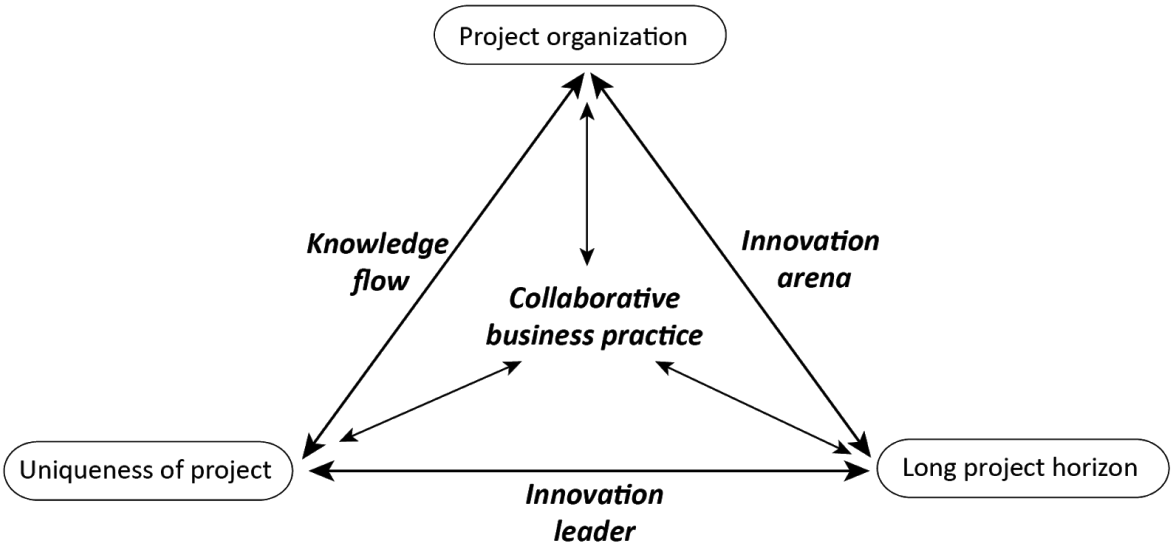

Collaborative Learning and Innovation

A Way to Overcome Inertia in Construction Sector

Master's Thesis in Design and Construction Project Management
Master's Thesis in Management and Economics of Innovation

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CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

The purpose of this research is to explore the reasons for low rate of innovation and their corresponding resolutions in the Swedish construction industry from clients and consultants perspectives. Various practices of collaborative innovation, i.e. product/service innovation, process innovation, organization innovation, have been observed. Qualitative interviews with academic experts, consultants and clients in the industry were held and were compared to literature. By applying Absorptive Capacity framework (ACAP), a comprehensive understanding of innovation development and collaborative learning in case study organizations was obtained. Essential role of factors in ACAP, such as social integration mechanism as well as transformation and exploitation, are recognized. The findings focus on the issues attributed to production dynamics, as opposed to market dynamics, where characteristics of the construction process, namely project organization, unique project and long project horizon contribute to inertia. Furthermore, collaborative practices that may resolve the inertia are found to be knowledge flow, innovation leaders, innovation arena and collaborative business relationships. In addition, digitalization and long-term financial and environmental sustainability are identified as main drivers of collaborative innovation.

Keywords: Collaborative learning, Collaborative innovation, Inertia, Partnering, ACAP framework, Swedish construction industry

SAMMANFATTNING

Byggbranschen sägs ofta vara konservativ och har låg grad av innovation. Syftet med denna studie är att reda ut varför byggbranschen är så trögrörlig och hur man genom bättre samverkan mellan svenska byggherrar och konsulter kan främja innovation. I rapporten har olika typer av mellan-organisatoriska innovationer undersökts såsom produkter och tjänster samt process och organisatoriska innovationer. Kvalitativa intervjuer med akademiska experter, konsulter och byggherrar inom industrin har genomförts och jämförts med litteratur på ämnet. Deras respektive förmågor i innovationsutveckling och samverkan med andra organisationer har utvärderats med hjälp av ett ramverk som kartlägger organisationers förmåga att absorbera kapacitet (ACAP). Resultaten i studien visar på att trögrörligheten beror dels på marknadsrelaterade egenskaper av fastighetsförvaltning. Med ett fokus på byggprocessen har en komplex projektstruktur med många företag inblandade bidragit till låg grad av innovation samt att projekten är unika och långa. Lösningar som har identifierats till att främja innovation är att ingå i bättre kunskapsutbyte, både internt och tillsammans med andra organisationer, innovationsledare, innovationsarenor samt att etablera mer kooperativa affärsrelationer.

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PREFACE

The journey of thesis work was amazing. Since our supervisor *Pernilla Gluch* gave a nautical map- a list of interview interests from CMB Innovation Group and the key- ACAP framework, we departed to the ocean of unknown in search of the hidden treasure, which is the secret of innovation. Yet the sailing was not always smooth-going, internal friction on where to go was common. Especially, both of us come from different programs as well as from distinctive cultural backgrounds. But in the end it turned out to be an interesting collaboration experience. We learned from each other's strength through continuous communication and negotiation. On the other hand, our working is quite inspiring with various participation in industrial conference, lunch lecture, on-site visit and the idea exchange after that. The learning process was accumulating and interactive, gradually we mapped out innovation capacity from practical perspectives.

We would like to acknowledge the contribution from all of our interviewees. Thanks so much for providing inputs from practitioner's viewpoint. When we reflected over the interviews, the learning drawn from there lead us to get closer to the hidden treasure. Also, the empirical data became a solid foundation for our analysis and discussion to innovation resolution. Gradually, we created an overview on the basic factors for inertia and approach to address it. In particular, a need to build up multiple and essential collaborating relationship within the industry was highlighted. Exploration eventually come to an end. However, the results of the research become evidence of the journey and guild new explorers to a further chapter.

Peiyu Wu & Hampus Sörensson
June 2019, Gothenburg

ABBREVIATION

ACAP	Absorptive Capacity
ABK	Allmänna bestämmelser för konsultuppdrag inom arkitekt och ingenjörsverksamhet (General Regulations for Consultancy work within Architect and Engineering)
AB	Aktiebolag (Limited company/ Corporation)
BIM	Building Information Model
CMB	Centre for Management of The Build Environment
CIFE	Center for Integrated Facility Engineering
CSR	Corporate Social Responsibility
DBT	Design-bid-Build
DB	Design-Build
ECI	Early contractor involvement
FOG	Friends of Gothenburg
GRESB	Global Real Estate Sustainability Benchmark
HVAC	Heating, Ventilation, Air conditioning
IoT	Internet of Things
PACAP	Potential Absorptive Capacity
RACAP	Realised Absorptive Capacity
R&D	Research and development
SCI	Supply Chain Integration
SBUF	Svenska Byggbranschens Utvecklingsfond (Swedish construction development fund)

1 INTRODUCTION

1.1 Background

Innovation is the backbone in every market economy and is the driver for change (Widén, 2006). By contributing to better quality, more resource efficient processes or improved social and environmental standards, it is subject to end-user benefits and thus commercial value. This commercial value is what drives businesses to develop strong innovative capabilities, both in order to offer better products and services and to strengthen their competitive advantage to rivals. Since construction accounts for 5-10% of gross domestic products in Sweden, it is to certain extent influential to economic growth (Trading Economics, 2019). Construction is regarded as traditional industry sector owing to a variety of performance problems, including low-tech, low productivity, high cost, less concern for customers (Harty, 2008). Even though of the issue, various innovation still take place and result in changes (Kadefors and Femenías, 2014). The main trends for innovation in construction are that more digitalisation is being applied, more environmental consideration is enforced by legislation and more consideration towards working environment is being regarded (Kadefors and Femenías, 2014; Kytömäki, O. and Kadefors, A., 2018).

1.2 Innovation inertia

Despite the apparent need to innovate, the construction sector is underdeveloped and experiences low rate of innovation (Mannesson and Roos, 2011). It can be partly attributed to the interorganizational structure where a lot of companies are involved in the development and implementation of innovation, which implies several stakeholder interests, interdependent coordination and a complex waterfall process (Dubois and Gadde, 2002b; Kadefors and Femenías, 2014). Another inhibitor is the character of the products being developed in long and unique projects which refers to high uncertainties and risk and reduced frequency to test and modify compared to the mass produced commodities (Mannesson and Roos, 2011). An unwillingness to take risks by construction firms, consultants, clients and customers is further resisting the innovative processes (Mannesson and Roos, 2011). It can also be attributed to a lack of capacity of construction firms that evokes cost-orientation before a need to innovate (Business Region Göteborg, 2017; Loosemore and Richard, 2015). Furthermore, the complex market structure of the construction sector with high prices, negotiability in pricing and regulatory restrictions lead to complex transactions (Mannesson and Roos, 2011). These slow the rate of innovation in the sector and contribute to, what this study refers to as, innovation *inertia*.

Urbanisation and increased attractiveness of commerce, residence and tourism is contributing to a high demand of construction and domestic capacity is not able to meet the demand (Business Region Göteborg, 2017). Therefore Business Region Gothenburg, as well as other governmental trade organisations, address and invite foreign construction firms (Business Region Göteborg, 2017). With an increased capacity, the competitive situation in the sector increases and puts pressure on the current construction firms. The competition is further increased from amongst other, Danish, German and Polish construction firms with the European Union's deregulations and liberalisations on business exchange in the European region (Jagrén et al., 2005). More competition means more rivalry in procurements, which in turn stimulates innovation in order to reach higher performance.

It is in this way through larger industry-wide organisations that the lack of capacity is being overcome. Similarly, changing the nature of the complex transactions that characterise the macroeconomics of the market is on an industrial-wide level and thus to some extent beyond the control of individual firms (Harty, 2005). However, collaborative actions and enhanced cooperation at inter-firm level may be solution to innovation inertia. Good relationships between partners, customers and colleagues enhances the mutual trust, reduces risk and improves the capacity to develop and commercialise innovation (Anderson, 2019). A study including over 500 clients and constructors with the intention to evaluate risk, the results showed that 91% agreed that partnerships and collaboration reduces risk (Jones, 2017). The study concluded that the best ways to mitigate risk are to include partners early in the project cycle, understand each other's perspectives and to share the same vision and goals of the project. With the statements, the thesis will have a focus on how collaborative practices can enhance the innovative capacities.

Other collaborative ways to overcome innovation inertia is through testbeds or innovation arenas where pilot projects are test with new techniques and concepts in an environment isolated from the regular business practices (Kadefors and Femenías, 2014). The pilot projects are developed across organisational boundaries in the innovation arenas, such as in Akademiska Hus' A Working Lab or HSB Living Lab. A conclusion drawn from the experience with pilot projects is that it allows innovation to be explored in depth, often resulting in successful projects and reports. However, there is a gap between the success of results and spreading the results across an organisation or commercialising innovation. A study from Engström and Lidelöw (2015) on pilot project perceived a lack of resources in the implementation stage as a reason to why the results of the pilot project is poorly replicated in subsequent projects.

With the intention to generate and spread knowledge and innovation across the sector, industrial organisations and research institutes, such as Vinnova[1], CMB[2] and SBUF[3] are amongst others financing

[1] Vinnova: Swedish innovation agency which supports development of innovation systems, as well as improve long-term innovation environment and condition. Smart and sustainable city is their focused innovation area.

research projects, arranging knowledge seminars and in other ways supporting the development of innovation. Considering the interorganizational character of the sector, this thesis investigates how more collaboration and coordination between actors could be an approach to address and ease the innovation inertia.

1.3 Purpose

The research aims at giving a comprehensive picture of the contributing reasons to the innovation inertia that stifles the Swedish construction industry as well as identifying and evaluating collaborative practices that can potentially resolve this inertia and increase the rate of innovation. Investigating low rate of innovation in the construction sector is frequent in research, therefore to more specifically evaluate how organizations can collaborate would be a contribution to the literature and of value for managers to know.

1.4 Research question

Stressing the necessity of innovation, there is obvious reasons for improving the processes around innovation. As such, the research question is formulated to investigate how the interorganizational practices and collaborations between clients, consultants, research institutions and other stakeholders can together enhance the rate of innovation as a whole for the industry.

"How can collaborative praxis be a means of resolving innovation inertia?"

By applying the theoretical lenses of absorptive capacity (ACAP), first developed by Cohen and Levinthal (1990), the results are expected to give some inspiration for practitioners to orient innovative construction project and generate some advice on challenges encountered during innovation development. In academic aspect, the insights yielded from the study could contribute to an in-depth application of ACAP framework in construction.

[2] CMB (Centre for Management of The Build Environment): Sweden's premiere forum for leadership management issues related to the built environment. CMB was established in 1998 as a long-term partnership between Chalmers University of Technology and Sweden's built environment sector.

[3] Svenska Byggbranschens Utvecklingsfond (SBUF) (Swedish construction industry development fund): An industry-wide organization for R&D ranging construction-, infrastructure- and installation areas. It acts as an open platform for its members, especially small to medium company, to conduct research projects whose result can be transferred into daily practice. Besides financing research projects, SBUF also facilitates knowledge exchange and information puliction across industry.

1.5 Delimitation

The study investigates mainly the perspectives from clients and consultants because they are two principle enablers in innovation development in construction (Kytömäki and Kadefors, 2018; Loosemore and Richard, 2015). Clients determine project scope by means of procurement strategy, while consultants possess knowledge and expertise to promote R&D. As such, their collaboration becomes the foundation of innovation process in project settings. Viewpoints from academic experts are taken as prelude to expand the understanding about the topic. Aside from that, since the sample selection does not cover all of the actors in the whole construction industry, therefore, the results should rather be viewed as indications and suggestions.

2 METHODOLOGY

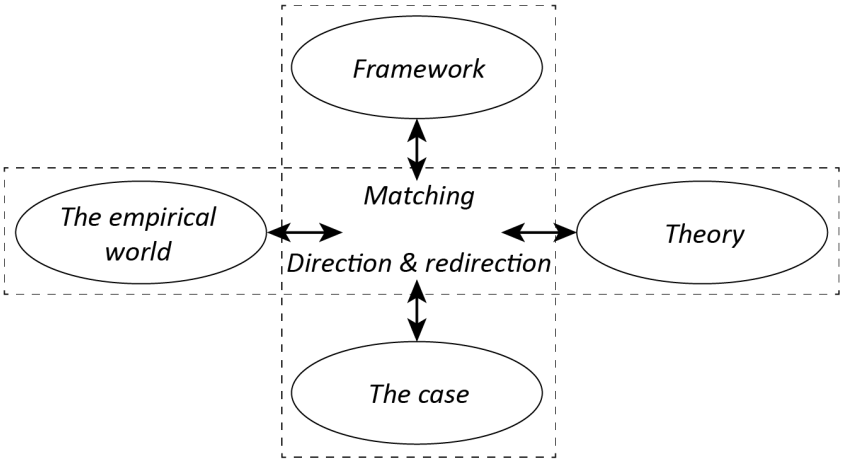
First an overview of the research is presented which outlines the general method for collecting and developing data. This is followed by describing how data was collected in literature and in the empirical study. Lastly, how data has been analysed is presented as well as an assessment on the trustworthiness of the data collection method and the analysis.

2.1 Research approach

The research with focus on interorganizational collaboration was designed on the basis of systematic combining, see Figure 1. It is a research method that refers to a process where theoretical framework, empirical fieldwork, and case analysis evolve simultaneously, and it is particularly useful for development of new theories (Dubois and Gadde, 2002a). Grounded in an abductive logic, two processes are performed. Firstly, matching theory and reality, then taking framework as direction and redirected it with the insights retrieved from case study. Systematic combining could help to overcome the boundaries of four factors by cross-comparing different information. The inductive approach would result in successive modification of original framework since unanticipated findings appeared from the empirical results. Our purpose of applying systematic combining was to create plentiful apprehension about the reasons for innovation inertia and solutions in construction through a mixture of theoretical models and new concepts derived from reality.

Absorptive capacity (ACAP) illustrates the ability to link and integrate external knowledge with organizational previous knowledge base, which associated positively with R&D competence (Cohen and Levinthal, 1990). In ACAP theory, absorptive capacity is regarded as a mediator, transforming external knowledge source to business advantages in form of performance or innovation. Exploring the relation between ACAP and innovation in Swedish construction industry could yield insights on innovation generation mechanism. Therefore, as part of the systematic combining approach, the ACAP framework was used to gain insights on what internal and collaborative innovation praxis that the organizations have. It set the structure and formulation of the interview guidelines.

Figure 1 Systematic combining (Dubois and Gadde, 2002a)



2.2 Data Collection

The qualitative research used systematic combining approach by cross-comparing literature study and empirical results. Interviews with experts and industrial representatives were conducted for empirical data collection. Besides, observation was also made when participating in a leadership conference hosted by CMB, a lunch lecture about innovation culture as well as a guided visit of the HSB Living Lab.

2.2.1 Literature review

Literature study is a method to investigate the domain of previous research and potential area for further research (Dubois and Gadde, 2002a). In this research, a literature study was used as a means for knowledge acquisition and laid the foundation for extensive knowledge to be developed. The source of data included academic articles, conference papers, lecture slides, industrial reports, online material and books. Google Scholar and the Chalmers Library have been key sources of articles from academic journals and the main search words were: *construction, conservative, inertia, innovation, collaboration, partnering, collaborative learning* and *ACAP*. Consideration was taken to the author's background and to the number of citations on the articles, as well as to the date of the sources, to gain as relevant knowledge as possible.

2.2.2 Empirical study

In order to interpret innovation practices in the industry, the ACAP model was applied as a theoretical framework to analyze collaborative learning and innovation. The ACAP framework was followed to outline the interview guideline by categorizing questions to different ACAP elements. Mapping companies' R&D process and innovative capacity through the framework was a way of identifying

bottlenecks in the process as well as collaborative solutions. Thus the ACAP framework would constitute lenses of interpreting the empirical study.

Collaborative innovation across organisational boundaries is of such complex nature, thus, the study were qualitative and oriented toward narrative interviews. This means that interviewees were encouraged to go into contextual depth and gave more practical examples (Bryman and Bell, 2008). The interview guidelines (see Appendix 1, 2 and 3) consisted of 15-20 questions, leaving room for follow-up questions as in semi-structured interviews. The interviews lasted between one to two hours and were held individually either at the interviewees' office or construction site or on Skype if the interviewees were not proximately located.

Regarding the clients that were included in the study, their business regions cover research and educational properties, commercial shops and offices as well as residential properties. They are large property owners with a certain impact on the Swedish construction market. Referring to consultancy firms, they represent a variety of business landscape. From global to local scale, both public and private consultancy firms are enclosed to gain access from a wide industrial view. Table 1 shows interviewee background including roles, company and major field for reference.

Table 1 Interviewee background

Company	Role	Major field
Expert		
Chalmers/ KTH	Professor	Innovation within construction
Chalmers	Senior researcher	Collaborative innovation
Client		
Akademiska Hus	Innovation leader	Energy and technique and automation
	Project Manager	Regional business development
	Strategic real estate developer/ Architect	Learning environment (Learning Lab)
	Project leader	Project management Business administration
HSB	Project Manager	Sustainability and climate change
Vasakronan	Senior Manager	Real Estate Development Strategic Planning & Asset Management IT Strategy
Consultancy firm		
Friends of Gothenburg (FOG)	Senior consultant	Urban innovation and development Strategic innovation
Allegro	Senior manager	Project management
WSP	Sales manager	Construction project design
	Senior manager	Infrastructure and urban system Business development
	Business area manager	Effective process in energy and industry
Business Region Gothenburg	Senior consultant	Establishment and investments in construction

Expert interviews

The intention of the interviews with academic experts was to gain a broad understanding of innovation in construction before holding interviews with industry representatives. These interviews laid the foundation for the interview guideline, which was only minorly modified after this stage. The academic experts were a professor and a senior researcher at Chalmers, who have been researching the topic of innovation within the construction sector. The professor is researching learning and communication across organisational boundaries and is specialised in *procurement and innovation in project-based organisations*. The senior researcher is involved in a research group called "Managing In-Between", where they investigate inter-organisational innovation and collaboration between established and emerging actors.

Interviews with industry representatives

Interviews with industry representatives were arranged to give a practical point of view and to provide examples from innovation practice. The industry representatives were firstly assembled from a network for potential interest within the CMB Innovation Group, Centre for Management of The Build Environment. This initiative led to eleven different interviews at seven different companies; private and public. A majority of the industry representatives are of innovation-facilitating positions; either internally within their company as for example innovation leader or externally as innovation consultants that promote innovation across organizational boundaries.

The three construction clients involved are Akademiska Hus, Vasakronan and HSB. Akademiska Hus is a state-owned developer and manager of property with the purpose to host educational or research activities. Their mission assigned from the government is to strengthen Sweden as a knowledge nation. As a way to promote innovation within the sector, they established A Working Lab (see Table 2). The interviewees represent a broad view on the company since they come from Akademiska Hus' various areas of innovation; construction & energy, future learning environments and campus & urban development.

HSB and Vasakronan are included to represent residential property and commercial property and to compare the governmental interests of Akademiska Hus. HSB is one of the largest cooperative organizations in the Swedish real estate sector that through the innovation arena HSB Living Lab (see Table 2) pursues innovation projects. Their main service contains property and facility management, supporting cooperative housing. As for Vasakronan, it is a state-owned real estate company specializing in offices and commercial properties. Vasakronan is owned by the public AP-funds which, just like private organizations, pursue profit and business sustainability and are thus evaluated on a free market basis. The respective ownerships, Akademiska Hus' governmental mission and HSB cooperative identity, the scope of clients pose interesting conditions for comparing the respective innovative interests and processes.

Four consultancy firms were included. The global consultancy firm WSP have established an accelerator program, Growspark, involving startups into their process (see Table 2). Various interviews were held with responsible employees in this program. Besides, innovation and urban development consultancy firm Friend of Gothenburg (FOG) was included since they have collaboration with Akademiska Hus and Vasakronan. As representative of medium-size consultancy firm in Sweden, Allegro was chosen for interview. Lastly, a senior consultant from Business Region Gothenburg added perspectives on establishment and investments in construction.

Table 2 Characteristics of three initiatives for innovation

Company	Initiative	Description
Client		
Akademiska Hus	A Working Lab	An innovation testbed and office for Akademiska Hus and their partners. It has its own innovation program for both the construction process and the finished innovation arena. More than twenty innovation projects have been started within the A Working Lab, including A Living Lab, which is established to realize company's strategy on future learning environment. Pilot projects are oriented toward energy-efficient solutions, green multifunctional hall, outdoor office, IoT smart building.
HSB	HSB Living Lab	An innovation arena that explores HSB's mission on "good and living together". It serves as research test bed and demonstration arena for future sustainable living, testing in a real scale. Five research domains of HSB Living Lab, including energy, resource efficiency, laundry, indoor environment and water, embodies their vision and ambition.
Consultancy firm		
WSP	Growspark	A venture collaboration program, to work with relevant startups as part of WSP Sweden's strategic business development agenda. The objective of the program is to accelerate the companies' transformation within digitalization and innovation. Innovation areas within project projection, urban development, drinking water and wastewater systems are prioritized.

Semi-structured interview

The interview guidelines were from the same template in order to facilitate similar and comparable answers that can be used in the discussion section. The questions were designed to cover the interviewed companies' R&D process with objectives to attain relevant background information and

valuable insights in order to answer the research question. For consultancy firms that are facilitating innovation inter-organizationally, such as FOG and WSP, the interview guideline was somewhat modified to better suit their role. The interview guideline for the experts was somewhat different due to their holistic, impartial and academic perspective as opposed to the practical industry interview guideline which held more examples and was more objective.

2.3 Analysis

The most relevant insights were discussed after the interview, to further comprehend how they related to the research question. Also how it applied to the ACAP framework and the organizations' respective absorptive capacity as well as other literature was discussed. Within the next day, the recordings were transcribed into manuscript. Then an interview matrix was compiled with answers from the three different groups of interviewees. Even though the interview guidelines were somewhat different for clients and consultants, the answers could be compared by combining related questions. However, since the purpose of the expert interviews was to gain a broader understanding, the matrix is not designed to compare the data to that of consultants and clients. Continuously during the empirical study, the research question was discussed in order to update the understanding on what contributes to the inertia and how to overcome it. As such, emphasis was laid on common and opposite viewpoints from different group of interviewees as well as literature when comparing the answers.

2.4 Trustworthiness and ethical consideration

With the intention to obtain unbiased answers, the interview guideline was designed to influence the interviewees as little as possible by the preconception that the sector experiences inertia. Thus the interviewees were firstly asked to openly share their interpretation of the innovative culture in construction. The trustworthiness of the results were strengthened by triangulation, where multiple data sources are compared and cross-validated (Bryman and Bell, 2008). Also, the interviews were recorded to clarify possible uncertainties and to correctly quote statements. In order for the interviewees to be more open in sharing ideas that may be conflicting to their professional status, the interviewees have been kept anonymous. The interviews were also encouraged to be situated in closed meeting rooms in order to have more privacy and for the interviewees not to be influenced by surrounding colleagues. However, somewhat contradicting is the choice to let the company names be revealed. This could be a source for tracking employees to statements. However, it is considered by the authors of this report more beneficial than harmful for the organizations to publicize and advertise the organizations. It is also more engaging for the reader when one can relate to the case.

3 THEORETICAL FRAMEWORK

This section will present the literature that is relevant for the study. It starts with outlining how innovation is being developed within construction, then it presents the framework of absorptive ACAP and finishes with literature on interorganizational collaboration in innovation.

3.1 Innovation in construction

3.1.1 Innovation scope

The value of innovation is long appreciated in construction due to its effect on enhancement of business performance and competitive advantage. Innovation is defined as "the implementation of a new or significantly improved product/service, or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005). Domain of innovation goes far beyond confined R&D department, rather, it occurs across borders, sectors and institutions. In the Oslo Manual, four main types of innovations are recognized: product and service innovation; process innovation; market innovation and organizational innovation (ibid.). Product innovation specifies improvement in material and goods used in innovation as well as services used in for example real estate management. Products are for natural reasons often times developed by subcontractors or suppliers. Process innovations include changes made in the procedures of construction, for example due to technological adoptions and digitalization, e.g. BIM and artificial intelligence. Market innovation relates to accessibility, promotion and pricing. Finally, organizational innovation refers to change in business models and external relations (ibid.).

In the project-based industry context, incremental innovations occur more often than systemic (architectural) innovations in construction projects. In the category of innovation scope developed by Taylor and Levitt (2004) in Table 3, incremental innovations imply that improvement of existing product/service or process is made by reinforcing the core concept, while the relation between core concepts or components does not change. This kind of innovation elevates performance of individual component, however, overall productivity may have positive or negative results. Contrast to that, systemic innovations reinforce same concepts or components but introduce a new process that demands multi organizations to change their practice. Essentially, systemic innovations allow significant promotion of overall productivity on a long-term basis. Despite of the benefits, previous research showed that systemic innovations diffuse slowly in construction due to industrial characteristics such as project-based, engineer-to-order, fragmented and institutionalized (Larsson et al., 2017). Incremental innovations happen during problem solving in construction projects, however, its influence prevails only on project level rather on established practice. To overcome the restriction from incremental

innovations, coordination of a number of actors in the supply chain could enable systemic innovations (Colvin et al., 2014).

Table 3 Innovation framework detailing categories of innovation scope (Taylor and Levitt, 2004)

		Core concept	
		Reinforced	Overturn
Linkage between core concept & components	Unchanged	*Incremental innovation*	*Modular innovation*
	Changed	*Systemic innovation (Architectural innovation)*	*Radical innovation*

Innovations could be driven internally or externally where various levels in construction practice are involved. In a dutch empirical research, innovation is observed to be stimulated in intra-firm, inter-firm and trans-firm levels (Bossink, 2004). Distinguishment between varying levels was based on organizational boundary, for example, intra-firm level concerned internal operation at individual organization; while inter-firm level symbolized cooperative relationship built on partnering. The trans-firm level surpassed intra- and inter-firm levels and referred to important issue for the industry as a whole. As construction industry is characterized by inter-organization and cross-border collaboration, the terminology *unbounded innovation (collaborative innovation)*, where the innovation is developed between a range of actors, could better describe the sector (Harty, 2005). Successful implementation of collaborative innovation required interaction between project organizations to ensure effective knowledge sharing, thus, negotiation and alignment are approaches to facilitate the process. A case study conducted in UK by Harty (2005) indicated that unbounded innovation concerned about system building through establishing mechanism for common roles, disciplines and culture. He also stated that the outcome yielded by unbounded innovation are not only transformation of practice and system, but also potential revolution of technologies.

The paragraph covers from general innovation types that is recognized across industries to focus on innovation scope. By introducing feature of the project-based industry, a comparison between incremental innovations and systemic innovation is made and reasoned. Incremental innovations is more prevailing in construction due to feasibility in operation of the project organization, while involvement of multiple stakeholders in the complex supply chain leads to difficulty when developing systemic innovations. Following the thread, *unbounded innovation (collaborative innovation)* is introduced that stressing the feature of interorganizational collaboration on innovation development. Afterward, necessary elements and output containing in collaboration at operational level are raised.

3.1.2 Innovation process

Various components shapes the innovation process in construction, including the drivers, inputs, enablers, barriers and outcome. In regard to explore the innovation process at project level, a research in UK by Ozorhon (2013) developed a framework to analyze four case studies. Results showed that innovation in the cases was primarily driven by *environmental consideration* with enablers from *collaboration* and *commitment*; while *reluctance due to low return*, *inexperience in new methods* and *relative high cost* hampered innovation development. As a complement, a statistic research in USA regarding technical innovations in constructions listed factors that influence development and diffusion. Gambatese and Hallowell (2011) argued that *support from upper management*, *client support*, *organization culture*, *presence of innovation champion* and *communication* should also be included as innovation enablers. Apart from the aforementioned barriers, *fear of change* was noted.

Extending from project-level innovation, firm-level innovation has been highlighted to an increasing extent in construction. A study conducted with multiple method approach by Meng and Brown (2018) investigated innovation drivers and strategies of construction firms of different sizes, which constitutes of contractors, subcontractors and suppliers. Their findings mark innovation strategies into four categories: technology, resource, marketing and management. For instance, managerial support to enable innovation performance improvement as well as encourageous culture account for management aspect. Resource perspective could be explained by effective resource utilization to realize innovation strategy; Enhancement of technical capability is critical for innovation capacity building; whereas vision and mission lead marketing strategy. Meng and Brown (2018) claimed that the selection of innovation strategy has both commonality and differences among construction companies of different sizes. Comparing to focus on long-term development for large companies, small companies tend to innovate in response to changing market dynamics. In addition, the paper concluded that construction innovation is resulted by combined effect of technology-push and market-pull as well as a shift from cost-driven innovation to value-driven innovation.

Innovation drivers are triggering innovation to be developed or implemented and is caused by external trends. According to Bossink (2004), innovation drivers could be categorized into four aspects: environmental pressure, technological capability, knowledge exchange, boundary spanning. Environmental pressure is typically related to market-pull, such as environmental regulation or demand from public procurement. This activation trigger resulted in green innovation that featuring energy-efficiency. Technological capability referred to technology-push resulted in implementation of new solutions in construction. Prior study showed that market-push is more influential on innovation development than technology-push due to low-tech connotation compared to other industries (Harty, 2008; Meng and Brown, 2018). Knowledge exchange underpinned information flow as essential process, which is viewed as antecedent and social integration mechanism for innovation development in absorptive capacity (illustrated in section 3.2). Lastly, boundary spanning stressed the importance of

interorganizational coordination and integration of design and construction. In particularly, clients play a key role in creating project conditions and transmitting users need (Ozorhon, 2013).

The section explores the interplay of various factors that are influential in the innovation process, see Table 4. Firstly, innovation drivers, enablers and barriers are underlined to understand the circumstance of the industry. The former could be concluded by managerial measure and innovation climate within organizations, whereas lack of recognized innovation value and unfamiliar manner in operation are cited as the main barriers. Further on, innovation at project- and firm-level are deliberated. Example is raised concerning strategy and drivers in various size of firms. Then continuing with innovation drivers that are recognized by in-depth case study and classified into distinctive dimensions. In the next section, attention will be put on exploring different aspects that are associated with innovation development in construction.

Table 4 Synthesis of innovation development factors

Driver	*Enabler*	*Barrier*
- Environmental pressure - Technological capability - Knowledge exchange - Boundary spanning - Market dynamics	- Collaboration - Commitment - Support from management - Client support - Organization culture - Innovation champion - Communication	- Reluctance due to low return - Inexperience in new method - High cost - Fear of change

3.1.3 Innovation development

In project-based industry, innovation is collaboratively contributed from various actors in the project organization. Previous research explored their roles in innovation development (Liu and Chan, 2016), among all, clients are identified to be particularly important in innovation value chain stages, i.e. idea generation; conversion of ideas; diffusion of solutions (Kilinc et al. 2015). A qualitative research in Australia regarding potential and actual role of clients in driving innovation supports the argument. Loosemore and Richard (2015) recognized the importance of client leadership in procurement, however, competitive bidding (lowest price) remained favorable compared to other procurement methods. In fact, clients are able to affect innovation by means of project strategy that allow emergence of alternative solutions without predetermined scope and time. However, the actual situation is not that case due to clients' internal governance constraints, reluctance, lack of competence and evaluation tools in procurement as well as poor understanding of how properties can contribute to their core business. The findings from a qualitative research on turkish real estate sector by Kilinc et al. (2015) confirms

this description. Their study on design-build project revealed that clients play a mediator role in conversion of inputs to outputs in innovation value chain. On the other hand, clients could also hinder innovation owing to norms, regulation and procurement strategies (Larsson et al., 2014). Different payment principle in procurement is illustrated in Table 5.

Table 5 Payment principle in procurement

Price-based		
Lump sum/ Fixed price	The client pays a fixed price to the contractor irrespective of the actual cost.	- Cost risk with contractor
Unit prices remeasurement	Contractors tender fixed prices per unit of work or activity. Facilitates valuation of limited variations.	
Cost-based		
Cost reimbursable/ Prime cost	Contractors are reimbursed for actual costs. Requires auditing and value engineering. Includes fixed fee covering site facilities, overhead, profit or a percentage fee.	- Cost risk with client - Client have more control - Used in Partnering - Used when uncertainty is high
Guaranteed maximum price (GMP)	Contractor is reimbursed for actual costs (plus fees) up to an agreed maximum price.	
Fee-based contracts	Fees per hour or percentage, fees for consultants and contractors in early stage of involvement (ECI).	- Used when uncertainty is high, cost is less important

Since procurement is recognized closely related to project innovation from clients perspectives, impacts of various procurement strategies on innovation development are explored (Haugbølle et al. 2015). Among all, multiple selection criteria is introduced in procurement from the public sector is introduced to eradicate low price mentality. A multiple case- study of six infrastructure projects from Swedish Transport Administration revealed that clients and contractors hold different viewpoints and experienced different challenges on clients' procurement strategies and project management practices (Larsson et al., 2016). Based on the contract types in the case studies, comparison between competitive procurement strategies for design-build contracts and collaborative procurement strategies for early contractor involvement (ECI) or long-term contracts was made in the qualitative research. Their

findings suggested that the choice of delivery system is dependent on contract types, i.e. Design-bid-Build (DBT) or Design-Build (DB) contract, instead, the entry timing of contractors and the length as well as specification in the contract have greater effect on their performance and motivation to develop innovation. Also, comparing to efficiency-focus project management, flexibility-focus way could create more innovation opportunities for clients. In respect to promote collaboration within project organization, collaborative procurement strategies is found to impact the dimensions of collaboration, i.e. scope, depth, duration and intensity. Empirical study on infrastructure in Sweden and Netherland showed that implementation of collaborative procurement strategies required change in organizational structure for actors in project organization in order to create long-term setting, including process, routines and capabilities for innovation management (Eriksson et al., 2018).

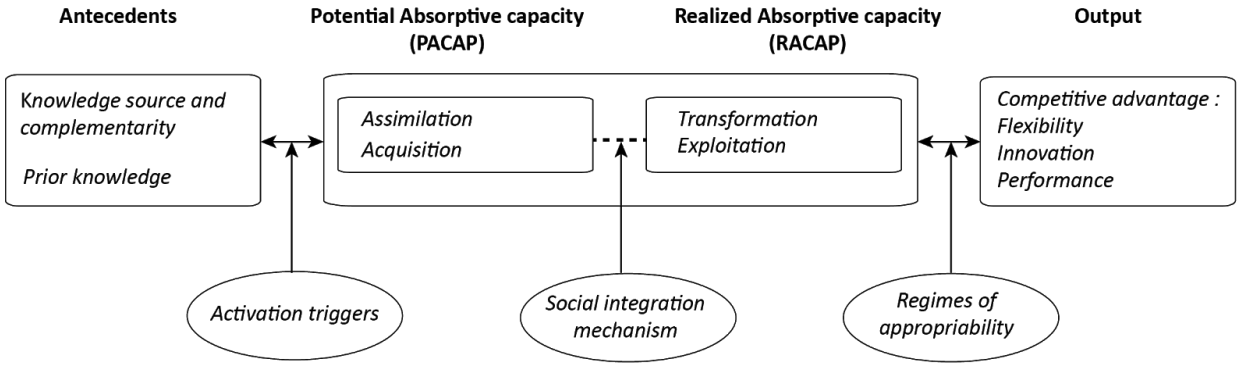
Another focus is laid on utilization of innovation potential of suppliers in construction projects. A qualitative exploratory research in Finland reveals that contractors regard the relationship with their suppliers is the source of construction innovation (Sariola, 2018). By operating relationship-oriented practice at business and project level, they identified a higher innovation opportunity. Sariola (2018) found that framework agreement, partnering arrangement are only the outbreak of collaboration at business level, more importantly is informal rewarding and social networks at operational personnel between contractors and suppliers. For example, low-stake incentives that are not tied to specific performance are suggested to be introduce in early project phase (Eriksson and Kadefors, 2015). In order to boost up suppliers innovation potential, contractors can enhance their relationship with suppliers by ensuring reasonable tendering and constructing feedback loop for suppliers. With gradual acceptance of early involvement, they become influential for construction innovation in project execution. As conclusion in their study, Halttula et al. (2017) suggested that a majority of material and process waste can be avoided with good planning and integration of actors in the early stages of projects. Contractors' role as facilitator to release suppliers innovation energy should be recognized and the tendency to favor old solutions should be changed. To lower innovation barrier, some practical measures, including R&D with suppliers, tendering with incomplete design, assessment of alternative solutions, could be introduced.

The chapter review innovation in construction from scope, process and development aspects. During innovation development, it is noted that clients play a central role for initiating innovation through their leadership in procurement. Although competitive bidding is prevailing in procurement, multiple selection criteria that includes organizational capability is introduced in public sector. Besides, impacts of various contract types and mentality of project management on innovation are discussed. Conclusion has been drawn that collaborative procurement strategies could enhance interorganizational innovation development with prerequisite on organizational change to create long-term learning environment. In the end, innovation potential on supply chain could be stimulated when contractors invest in relationship-oriented practice with their suppliers. The next chapter, absorptive capacity (ACAP) will be presented as a framework to understand the mechanism behind organizational learning capability.

3.2 Absorptive Capacity (ACAP)

3.2.1 ACAP framework

Figure 2 Absorptive capacity (ACAP) framework (Zahra and George, 2002)



The framework of Absorptive Capacity (ACAP) was firstly introduced by Cohen and Levinthal (1990) as a concept for firm to recognize and assimilate information, then apply it to commercial end is critical for its innovation capability. It argued that firm's investment on R&D has positive relation to technical change within the industry. Based on the concept, Zahra and George (2002) further developed the concept and reconceptualized key aspects and constructed a systematic framework (Figure 2). They argued that the extent of absorptive capacity is determined by potential and realized capacity under different condition. The framework contributes to mapping out relation between key dimensions of ACAP. According to Zahra and George (2002), organization's learning ability is built on the basis of *experience*, which influences the locus of search and the development of path-dependent capabilities of acquiring and assimilating *external knowledge*. Thus experience and external knowledge become antecedents of ACAP. Then the development of ACAP in sourcing innovation splits into four stages: acquisition; assimilation; transformation and exploitation. In the *acquisition* stage, organization evaluates which competence is necessary and relevant to support for the intended innovation or for improvements of the organization's operation and performance. In case there is no determined goal, organization would gather new knowledge with the intention to realise in a later stage and potentially reap innovation. *Assimilation* is the stage of interpreting external knowledge and internalising it in the context of the organization.

Assimilation and transformation thus comprise the firm's potential absorptive capacity, PACAP, which is complemented by the realised absorptive capacity, RACAP, where the new knowledge is implemented in current business practices. A study by Leal-Rodríguez et al. (2014) validated that RACAP mediated the influence of the PACAP on innovation, while the indirect effect is positively determined by relational learning, which refers to learning through collaboration and relationship with others. In the *transformation* stage, the newly gained knowledge is combined with the existing knowledge, which can yield new insights in the current positioning of the firm and opportunities as to future competitive advantage. Innovation that are resulted from knowledge transformation would later be *exploited* or utilised. In the process of innovation development, three variables influence the transition of different stages. Between antecedents and PACAP is *activation triggers*, which stimulates the innovative process and navigate the search of new knowledge based on organizational experience. It may come from higher management's interests to stay competitive and meet new market demand or to streamline internal processes, or it may be a response to new legislation or other external requirements. In order to facilitate knowledge sharing and increase the transformation from PACAP to RACAP, *social integration mechanism* is necessary to assist the efficiency of knowledge assimilation and transformation capabilities. If the organization wants to sustain its competitive advantage, *regime of appropriability* of the industry is relative important. Under strong regime of appropriability, organization has higher possibility to protect innovation from competitors in the market. Therefore, it will likely to have more willing to invest in ACAP in attempt to gain competitive advantage. Otherwise, positive absorptive incentives should higher than negative ones to offset their effect and create benefits for companies to engage in innovation development.

3.2.2 Application of ACAP in construction

Since the establishment of the ACAP concept, researchers have started to adopt it to different context, especially in manufacture industry. In regard to its wide application, Gluch et al. (2009) applied ACAP framework to understand the mechanism behind green innovation and environmental performance in the Swedish construction industry. Findings from the quantitative research contributed to revised green ACAP framework and showed that construction companies could enhance business advantage by concentrating on knowledge acquisition, assimilation and transformation. It also indicated that pressure from stakeholders acted as main activation trigger for green innovation. A inductive research in UK indicated even clearly that construction companies turned to focus on business-based innovation and performance management due to procurement criteria included company's capacity, such as knowledge, skills and intellectual capability (McAdam et al., 2010). As such, ACAP framework was used as a tool to understand how medium-size construction companies respond to the challenges. Their findings show that the companies they studied formed a 'Knowledge Transfer Partnership' with local universities to strengthen their capacity in a changing market environment. This referred to collaboration with educational institute is a means for medium-size construction companies, who may not have enough resource for internal R&D, a way to acquire knowledge.

Apart from trying to identify impact of operational predictors in the ACAP framework on organizational absorptive capacity, some researches rather focused on studying how absorptive capacity could be applied to overcome existing challenges in construction. In regard of the fact that the industry is characterized with project organization, Bjorvatn and Wald (2018) applied the ACAP framework on project team level to understand to what extent absorptive capacity help to resolve project complexity. Their structural equation modelling based on large sample size indicated that despite team-level capacity is essential to successful project management, yet delay and overspending caused by project complexity cannot be totally offset. This implies that contribution from other factors to risk control need to be further explored in order to enhance the result of project management. Since the team-level capacity cannot overcome project complexity, attention of ACAP framework application had been paid to interorganizational-level. A study by Unsal and Taylor (2011) aimed at exploring the absorptive capacity of project network in relation to various types of innovation. Simulation experiments are conducted and results represented that relational instability has a negative effect on project network's absorptive capacity in terms of innovation development. In accordance to this argument, an empirical research studied five distinctive industries in the US showed a more clear interactions between organizational coupling and type of innovation. Hofman et al. (2016) found that the degree of organizational coupling among project network influences the performance of collaborative innovations and the type of innovation has a moderating effect. More specifically, modular innovation were found to yield a higher innovation performance, while architectural (systemic) innovation has opposite result, in particular under the situation of high organizational coupling. This is because new linkages in architectural innovation is hard to be identified by members of project organization, thus, using established routine to operate.

Besides project organization characteristics, supply chain in the construction industry is known for waste and inefficiency (Lönngren, Rosenkranz and Kolbe, 2010). To overcome the problems, an in-depth case study of a German network of contractors and subcontractors regarding strategic alliance is carried out. The result showed that the prerequisite for absorptive capacity for project network requires not only a *relationship*, but also high *task-interdependent projects*. The former could be achieved by having a legal-binding coupling for a long term, which is termed strategic partnership. This kind of partnership is often adopted in the alliance between public and private sector and can lead to successful project management as well as the integration of service and production. Crucial factors to a successful strategic partnership alliance depend on central coordination among the partners employing decentralised task management; application of an appropriate IT-solution; and mutual trust among the cooperating partners (Lönngren, Rosenkranz and Kolbe, 2010).

Previous studies concerning ACAP application in construction involve various aspects ranging from identifying influential predictors in the ACAP framework and the reasons in industrial contexts to the way ACAP resolve predicament in project performance. Also, the level of ACAP application is extended to project organization or project networks, rather than conventional individual organizational

level. Strategic partnership is proposed to enhance project networks' absorptive capacity in terms of complex supply chain. Next chapter in literature study will follow the thread on interorganizational collaboration in construction to discuss how collaborative innovation is developed.

3.3 Interorganizational collaboration in construction

3.3.1 Partnering and networks

According to the definition from the Construction Industry Institute, partnering is "a long term commitment between two or more organisations for the purposes of achieving specific business objectives by maximizing the effectiveness of each participant's resources. This requires changing traditional relationships to a shared culture without regard to organisational boundaries. The relationship is based on trust, dedication to common goals, and an understanding of each other's individual expectations and values." (Construction Industry Institute, 1991). As aforementioned definition, partnering could be interpreted as established on the existing practice and align the activity systems in a collaborative relationship. In the recent decades, partnering is often been established within managerial agenda in Swedish construction industry due to multiple benefits it provides, such as potential benefits from increased performance and reduced costs, reduced project time due to early supplier involvement and team integration, improved quality through learning and continuous improvement, improved client satisfaction and enhanced responsiveness to changing conditions, greater stability for effective resource deployment (Bresnen and Marshall, 2002).

Although partnering in individual projects has improved project performance, difficulties still exist in realizing potential benefits on strategic level (Gadde and Dubois, 2010). Several issues hindered implementation of strategic partnering within and across organizational contexts are identified, including poor uptakes of new processes and management strategies, lack of strong institutional partnering norms in the industry, diffusing the concept through organization and translating the managerial agreement into operational level (Anvuur and Kumaraswamy, 2007; Phua, 2006; Bresnen and Marshall, 2000). By comparing the features of business relationships in construction and close cooperation, Gadde and Dubois (2010) concluded that prevailing supply chain in construction is designed to fit project-based condition, thus makes hard for partnering to reach beyond project level. Their previous research supported the reasoning that the loose couplings exist in the permanent network, whereas the tight couplings in temporary project as appropriate response to complexity of construction (Dubois and Gadde, 2002b).

The extension from project partnering to strategic partnering requires to fulfill several requisites, among all are enhancement of knowledge transfer between projects on the basis of hierarchical structure, substitute of short-term efficiency with consideration on long-term opportunities (Eriksson et

al., 2008; Tsai, 2002). However, if strategic partnering is found to be more beneficial than project partnering for the company, the transition should be conducted gradually with increased collaboration. Gadde and Dubois (2010) suggested that three levels of partnering should be differentiated in construction. Firstly, local partnering which is an intense interaction on construction site during the execution of project. Secondly, central partnering which is a corporate agreement through exploiting economies of scale in operations and thirdly intermediate partnering which is long-term network through regular interaction and contacts. To achieve a successful collaboration in various levels requires engagement from different hierarchical levels and functions of project partners, especially involvement from operational people, preventing blaming on partnering approach (Jones and Kaluarachchi, 2007). Furthermore, strong leadership and strong organizational structures are necessary within interorganizational teams to be successful in order to best direct the individuals (Gluch et al., 2019).

Related to the domain of partnering, supply chain integration (SCI) is getting more attention in construction projects and it stresses collaboration in terms of collective actions and goals. Integration in project-based supply chain consists of four dimensions: strength, scope, duration and depth integration. Each dimension is interdependent thus should be operated simultaneously suggested by Eriksson (2015). Above all, strength of integration implies intensity of linkage concerning the extent of information-, operational- and relational integration between partners (Leuschner et al., 2013). Scope of integration refers to the breadth of project team with consideration of competition dynamics and task alignment. Duration of integration is decisive for engineering projects since the timing of partner involvement and cooperation frequency in the course of project are influential for project results. Lastly, depth of integration refers to what hierarchical level should be included in supply chain integration. Despite top management commitment is critical, engagement from executing personnel and end-user should not be overlooked. High integration of the dimensions could contribute to coordination, adaptability, joint problem solving and knowledge exchange between partners, however, the level of the dimensions should be determined to specific project condition and scope, such as complexity, uncertainty and time pressure (Eriksson, 2015).

Multiple criteria, i.e. reference projects, technical competence, collaborative capability, used in partner selection entail process and social control (Eriksson and Laan, 2007). Process (behavior) control specifies partner's resource allocation and capability in order to achieve project targets; while social (clan) control refers to the construct of common belief and values between partners. Tiwana (2010) argued that the combination of both process and social control could strengthen exploration and exploitation process in interorganizational projects, which is beneficial for innovation development in construction projects. Accordingly, apart from competitive tendering for the lowest price, criteria related to organizational competence become gradually appreciated by clients.

3.3.2 Collaborative innovation development

Interorganizational team, which builds on organizational coupling from the relational perspective, is critical for collaborative innovation (Rindfleisch and Moorman, 2001). Large number of network members and bottom up formation process can generate a greater innovation performance (Thorgren, Wincent and Örtqvist, 2009). Based on prior studies, Hofman, Halman and Song (2016) defined the multidimension of organizational coupling as the relationship between innovation network partners in terms of working closeness and reciprocity. Tight organizational coupling among project network brings benefit to companies in terms of effective integration and exchange of resource across organizational boundaries. However, it sacrifices opportunities for acquiring heterogeneous resources and competences, which are fundamental for innovation. On the other hand, loss organizational coupling characterizes decentralization in terms of collective adaptations and decision making when facing problems. The fact of construction sector is outlined with project-focused tight coupling and loosely coupled interorganizational network. Therefore, Dubois and Gadde (2002b) argued that the pattern of coupling system in construction favoured efficiency and productivity at the expense of sacrificing innovation.

In order to overcome the issue, organizational ambidexterity is drawn into discussion. It refers to how companies take advantage of their existing knowledge and technology to earn short-term profits, meanwhile exploring innovation and new practice to ensure long-term business advantage (Benner and Tushman, 2003). Exploration phase is important in idea generation of innovations, but it must be balanced with exploitation, both to efficiently generate value from the exploration, but also because it is the source of sales (Raisch et al., 2009). Various examples in construction signifies different ambidextrous practice, for instance, incremental developments could be viewed as more exploitative; whereas inventive pilot projects are rather explorative. The paradox of exploration and exploitation in project organizations at different levels in construction was investigated by Eriksson (2013). He concluded that structural and sequential separation of exploitation and exploration in construction projects hinder project organizations to switch from decentralized exploration to centralized exploitation, accordingly, the successful innovation at project-level is hard to transferred to subsequent projects. Consequently, project organizations in construction may be trapped in the dilemma of deficient amount of exploration, yet the result of exploitation is not effectively diffused across organizations (Eriksson, 2013).

Also, the knowledge transfer and innovation diffusion are hard to realized across both project and organization boundary (Smyth, 2010). Individuals spread knowledge within their peers, but systematic transfer of knowledge and innovation is less common due to the heterogeneity of project members in innovation process (Kadefors and Femenias, 2014; Liu and Chan, 2016). A quantitative study by Liu and Chan (2016) indicated that actors in project organization were mutual influenced and affected by different learning transfer factors. For instance, clients bear upon openness to change and performance

self-efficacy; contractors is openness to change; consultancy firms is performance-outcome expectations. In addition, leadership interweaves with innovation climate and knowledge transfer. It was found that both transformational leadership that stimulates intellectual of individual, and transactional leadership that gives contingent rewards are necessary to support innovation development and diffusion. From practical perspective, these call for establishing good routines and standards within organizations and between partnering organizations. Routines will not only determine the spread of knowledge, but there should also be routines in how to change and establish new working processes (Kadefors and Femenias, 2014). In addition, cooperative procurement could be favourable to help interorganizational knowledge development and diffusion. Practical instance suggested by Eriksson (2013) includes joint specification to reinforce integration of design and construction; multiple partner selection criteria to balance price and expertise; incentive-based payment to promote overall group performance instead of sub-optimization; collaborative tools (i.e. joint IT-system and team building) to foster both interdisciplinary work and mutual understanding.

Developing innovation within an interorganizational context implies high uncertainty and equivocality, which are prime challenges for project performance. To diminish the effects, knowledge strategies oriented to exploitive searching and explorative searching are compared. A qualitative research in Sweden reported that the joint explorative knowledge search strategy has positive impact on equivocality owing to diverse viewpoints and competences are involved. After mutual understanding of project team is built and joint goals are set, they can enter the next stage focusing on exploitation of innovation development (Eriksson et al., 2016). Another research conducted by mixed-methods approach in European joint development projects also investigated the interplay of these two variables. Their result indicated that project teams could reduce project uncertainty by means of early end-user involvement, while equivocality could be controlled by joint problem-solving activities between clients and project team (Rönnberg Sjödin, Frishammar and Eriksson, 2016). The former emphasizes the importance of cross-functional integration and communication since clients determine project scope; the latter focuses on mitigating misunderstanding in inter-organizational collaboration.

4 EMPIRICAL RESULTS

To identify and understand the firms' respective innovative practices, the ACAP framework is applied to map out innovation development. In the lenses of the ACAP framework, responses to innovation inertia is illustrated in seven parts. The stages in the learning process are *antecedents, potential absorptive capacity (PACAP)*, *realized absorptive capacity (RACAP)* and *competitive advantage*. These stages are complemented by three elements that influence the learning capability; *activation trigger, social integration mechanism and regimes of appropriability*.

4.1 Antecedents

4.1.1 Outsourced competence

An ongoing trend for clients to outsource competence, especially within *innovation* and *digitalization*, is observed, reported by the professor at Chalmers. This makes the innovation-related knowledge more present in consultancy firms and not so much inhouse for clients. As a result, the innovative competence must be attained through external consultancy firms, which in turn means that the procedures for acquiring, transforming and exploiting innovation can be less controlled by the client and the process of developing and implementing innovation must be more coordinated between companies.

Friends of Gothenburg (FOG) have been developed partly for the purpose of promoting innovation and knowledge sharing both inter-organisationally and between researchers and industry. Their senior consultant viewed their role as innovation facilitator, for instance, a commission that FOG were appointed was assisting Akademiska Hus to develop a clear innovation strategy in accordance to their mission. Being Sweden's largest real estate company with expertise on educational institution *property development*, the areas of innovation strategy were formulated as: Building and energy technology; Future learning environments; Sustainable campus. In order to execute them effectively, sustainability and innovation department is established. The structural change is necessary to enhance organizational effectiveness for innovation development.

4.1.2 Specialized expertise

In comparison to Akademiska Hus, another large state-owned property owner Vasakronan engage in creating *sustainable urban environment*. They are one of the largest clients in Sweden within commercial properties. They own experience on developing hybrid urban districts by implementing user-centered strategy. Vasakronan are innovative in a way that they evolve with trend and apply new

technology to understand their customers need. They tested new concepts at their own offices, for instance, soft innovation could be seen in their working space to stimulate ideas exchange between colleagues. As the leading company in real estate sector, Vasakronan wants to take a step ahead in digital service. Therefore, apart from employing more IT skill, they collaborated with other property owners in different market positions to co-develop open source and digital key platform with suppliers. This addition of competence in IT is aimed to improve performance and innovative capacity. On the other hand, consultancy firms provide consultancy service within architecture and civil engineering, they gather a variety of specialization, including *project design and management.*

As a fact that the nature of the sector being rather practical and conservative on applying new innovation in their practice. Low inflow of external knowledge makes innovation becomes less stimulated. Also, the business area manager at WSP indicates that the academic level in the sector is low. This implies low awareness of external research and R&D practice and hence little focus on developing innovation. It even leads to more resistance to change in routine and process in established practice.

4.1.3 Summary

Antecedents consists of external knowledge and experience. External knowledge and interviewed organizations' specialized expertise are summarized in figure 3.

Figure 3 Summary of antecedents

4.2 Activation triggers

4.2.1 Economic benefits

Economic benefits foremost innovation driver that are mentioned several times during interviews. The senior manager at Allegro expressed that main objectives of innovation development for Allegro are to strengthen project management triangle: time, cost and quality. From their point of view, project quality is prioritized and are hence more customer-oriented and revenue-focused than cost cut. The quality aspect concerns elevating the standard of living and is regarded as a major source of competitive advantage, in order to be more attractive to customers and gain higher revenues. They also expected time benefits by introducing innovation, including less capital being trapped in projects, lower risk for obsolescence and shorter delivery time. Hence, both the quality and time aspects have an underlying economical benefit and motive. Similar to Allegro, also the clients HSB and Vasakronan confirmed that long-term profitability is the main activation trigger behind innovation. As for Akademiska Hus, who are entirely governmentally owned, have large financial capacity and carry public mission to invest in innovation, the economic interests are balanced with other triggers. Even though they face competition in free market, but they are not equally forced to deliver economic results as privately owned companies. Comparing to that, Vasakronan are supported by public pension funds and have to strive for long-term profitability, therefore, they have to create a financial sustainable business model. *"Working smart and economical profitability go hand in hand, there is more potential to be explored in the industry."* Their manager concluded.

Cost reduction is another primary criteria when it comes to innovation investment. Sales manager at WSP thought that construction is still very costly. By introducing innovation, the cost of building production could be lowered down. Digitalization brings revolution in the industry, such as counting technology and simulation is advanced during the course of time, which makes operations more efficient and better control of uncertainty.

4.2.2 Environment consideration

During the interviews, environmental consideration is constantly mentioned as a critical driver for innovation development. According to the senior consultant at FOG, there are many reasons behind it, among them are legislation and regulation on sustainable development. Fund for climate from banks and private investors has expedited the market shift to provide sustainable property. For example, housing association could get a better term and condition from banks if their buildings fulfill sustainable criteria. Besides, private institutional tenants pose environmental requirements on properties. For example, they asked for brown discount of the price if the properties do not get green certification. Hence, Vasakronan took initiative by launching green rental contract and invested in solar

cell in their properties. They reached agreements with investors providing zero interest rate for sustainable project development.

Motivation to work on sustainability at real estate market could be understood as strategic consideration. Manager at Vasakronan stressed the benefit of sustainability: *"Green innovation leads us to sustainable business. Cost efficiency and less vulnerable to climate change."* The effort put on green innovation became competitive advantage for Vasakronan. Global Real Estate Sustainability Benchmark (GRESB) rated Vasakronan as one of the world's most sustainable property companies and the European leader of the sector. It is observed that environmental consideration has been concern for the clients when it comes to the evaluation between investing costs and operational costs. Since the clients in our interviews develop and operate the buildings themselves, they tend to view the investment as a long-term issue, which means that operational costs are as much important as investing costs. Applying green innovation in properties may increase construction cost, but in return lowers operational costs by consuming less energy.

4.2.3 Brand recognition

Brand recognition is regarded as an activation trigger based on our interview findings. Professor at Chalmers claimed that working on innovation could be beneficial for marketing. Reasons for laying a lot of resource in innovation development is to attract competent employees and partners as well as gain a positive brand image towards customers. She implied that innovation provides some additional value beyond monetary reward. The argument corresponds to the opinions of the project manager at Akademiska Hus. She emphasized: *"The incentives for innovation may lie in attracting skillful employees and partners because we keep developing ourselves. Customers would like to rent from us since they see advantages. They feel that we take our mission seriously and on the way to accomplish our goal."* The sales manager at WSP expressed the same standpoint: *"We want to create a working environment that employees are aspired for because knowledge exchange is extremely important for consultancy company. If WSP show to the world that we are advanced and keep up with the trend, the society will view us leader in the sector."*

4.2.4 Market threat

Digitalization brings both opportunities and threats in the business development, which could be in turn trigger for innovation. Facing threat from WeWork, a startup featuring coworking and office space, Akademiska Hus started to reflect on how to become more attractive to their tenants and keep their market position. As response to it, digital platform connecting suppliers and customers was created. Another example of competition in the market could be found in WSP. Resource allocation is seemed to be the bottleneck to develop innovation in consultancy firm because innovation does not result in short-term profit. The project manager at WSP said: "*Central budget on innovation investment is viewed as no return, therefore, a change of business model is necessary."* In order to maintain R&D

energy for long-term competitiveness, WSP launched Growspark to collaborate with cross-disciplinary startups.

4.2.5 Public missions

Akademiska Hus carries a mission to reinforce Sweden as a nation of knowledge and is imposed with a special responsibility for being a leader of sustainability. *"It is of great importance for innovation to align with company's goals."* mentioned by the project manager at Akademiska Hus. She referred to enhancement of business advantage is a critical criteria when evaluating innovation. Taking innovation arena A Working Lab for example, it performs as a test bed for research and approximately 30 projects are selected to be implemented during the construction of A Working Lab. A common point for them is that they are parallel with Akademiska Hus's innovation strategies. By means of collaborating with Swedish centres of education, i.e. universities and colleges, Akademiska Hus develop a dialogue process with their customers and gain a deeper insight regarding campus development.

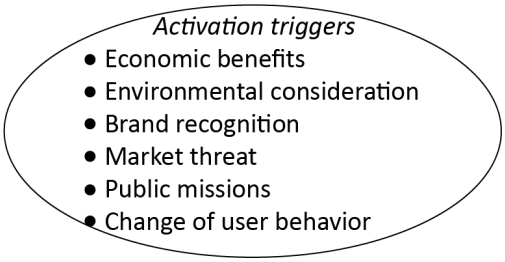
4.2.6 Change in user behaviour

User behavior changes in associated with technology advancement and modern lifestyle over time, thus, posing new demand on property market. Yet, sometimes the mentality of users does not catch up, then it requires property developers to lead innovation and strive for gaining acceptance among customers. For instance, since flip classroom concept is introduced, interactive education has gradually substituted traditional one-direction-communication. Akademiska Hus recognized the trend and engaged in creating new learning environment and experience, however, their customers kept asking standardized gradient classrooms, said by the strategic real estate developer at Akademiska Hus. In order to reverse the situation, Akademiska Hus together with collaborators from various pedagogic disciplines co-developed a pilot project Learning Lab, a digital learning theater with high-tech multimedia. By this way, they could better understand customer's need and facilitated innovative learning style. Similar example is given by the senior manager at Vasakronan. According to his experience in the sector, customers do not know what they want, instead the real estate developers should apply sensors and follow the latest trends to identify customers' latent needs.

4.2.7 Summary

Figure 4 shows that activation triggers identified during the interviews range from economic, environmental, marketing and social perspectives.

Figure 4 Summary of activation triggers



4.3 Potential Absorptive capacity (PACAP) ; acquire and assimilate

4.3.1 Knowledge channel

Market dynamics trigger companies to search channel to acquire external knowledge that could reinforce their business. Both clients and consultants indicated that digitalization and sustainability are less developed in companies during interviews. Many attempts have been made for knowledge acquisition, including outsourcing to *consultants* and *employ skills or competence*. Competence, which is related to core business, tends to be obtained in-house, whereas assisting function such as IT skills is outsourced to consultancy firms. However, with the growing influence of digital technology, Vasakronan nowadays hire more IT competence to reinforce their ability in development of technology; implementation of technology; operation of technology. Also, since Akademiska Hus developed innovation process and innovation leaders, they further wanted to internalize innovation coordination competence that are outsourced to FOG before.

Apart from that, cooperating with universities are regarded as an effective way to obtain knowledge. Since Akademiska Hus has a special relationship with educational institutes in Sweden, this give them access to cutting-edge knowledge to implement in their projects. While HSB collaborated with Chalmers University of Technology in HSB Living Lab and invited scholars and students to move. Latest low energy consumption technology was tested and user data collection was conducted on site, which became an essential source for them to develop new projects. Not only clients, consultancy firms also benefit knowledge from *research initiatives*. Another senior consultant from FOG worked as half-time researchers at Gothenburg School of Business, involving in City Business Partnership and Mistra Urban Future[4]. The experience allowed her to deliver knowledge and build capacity of the company. Also, Allegro gained virtual design knowledge from Center for Integrated Facility Engineering (CIFE) at Stanford University. In addition, our interviewees also participated in *industrial*

[4] Mistra Urban Futures: An international research and knowledge center for sustainable urban development. Their mission is co-producing knowledge for achieving a sustainable urban future and creating accessible, green and fair cities.

organizations activities like breakfast seminars, conferences and lectures, award selection hosted by industrial organizations CMB and SBUF.

4.3.2 Knowledge alignment

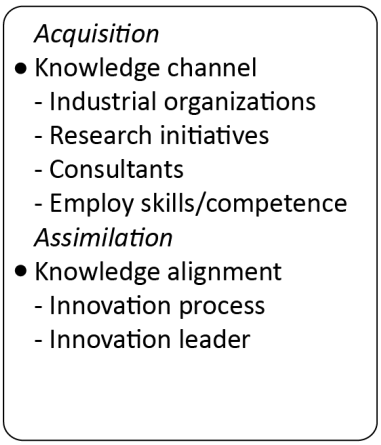
Assimilation is an essential step for companies to understand and internalize acquired knowledge. From the interviews, clear boundary between assimilation and transformation stage has not been noticed, the procedure happened rather naturally. An example of the assimilation and transformation process was discovered in the interview with the manager from Vasakronan. He talked about the office revolution in Vasakronan: *"We did office case studies from other countries, then we tried to apply the features in our own offices. It became a great success. After improving our experience, we launched new offices on the market. Smart & Klart is our new concept of offices."* From his word, case studies could be regarded as acquisition and assimilation, while tests in their offices signify transformation. Then launching new products/service is a way of exploitation by merging innovation to their established practice.

In Akademiska Hus, relevance of external knowledge to innovation strategies is assessed by *innovation leaders*. As part of *innovation process*, innovation strategies helped Akademiska Hus to determine which innovation areas they should put resource on and what partners they should work with. According to the project manager at Akademiska Hus, after formulating the strategies, innovation in projects was easier to navigate because of the clear set guidelines. She said: *"Now we know what is important to us, so we can drive innovation more actively."* They held a lot of workshops for developing innovation with employees and strategic partners, which resulted in that R&D department was scattered into operational teams in the likes of innovation leaders. These innovation leaders have specific expertise and in charge of national projects. In their respective teams, the innovation leaders stimulate innovation through being aware of external trends and cutting edge research, as well as integrating innovation into routine. The key function of innovation leader in relation to company's vision and strategy and research. Knowledge development cycles bring new learning and routine from previous project to the next, whereas innovation leaders assist the innovation development by bringing in trend and research. During the process of innovation implementation and evaluation, innovation leaders align innovation development in projects with company's goals.

4.3.3 Summary

Potential absorptive capacity (PACAP) comprises of acquisition and assimilation phases. Various channels to acquire external knowledge are discussed, following process and key role to align internalized knowledge to company's vision and goals. Figure 5 summarizes examples presented from the interviews.

Figure 5 Summary of potential absorptive capacity (PACAP)



4.4 Social integration mechanism

4.4.1 Knowledge sharing

Social integration facilitates the transition of potential absorptive capacity (PACAP) to realized absorptive capacity (RACAP). It implies not only formal way of knowledge sharing, but also formation of informal social network for ideas exchange. Internal seminars and presentation are common solutions to promote internal knowledge flow for clients and consultancy firms. Since Akademiska Hus bears a mission to promote knowledge level in the society, an *open database* for public accessibility is created with research and innovation reports. However, rare utilization of reports and lack of interest become a bottleneck of internal knowledge sharing, according their project manager. Instead, she thought that key person is rather an effective way to spread knowledge, who are experts in particular areas and support the course of projects. They are essential in bridging lesson learned from previous projects to next projects as well bringing in external resources. As a complement, positions like *project support* and *project advice* are established in project to underpin project network. Another crucial issue about social mechanism is the transformation of individual knowledge to organizational competence. At Vasakronan, formal social integration channels, such as regular regional technology meetings, *project progress update meetings*, *group exercise*, are applied in the large company.

Since competence comprises of the value of consultancy firms, capacity building becomes an extremely important, knowledge sharing is a way to realize it. At WSP, both formal and informal knowledge exchange channels are observed. Formal internal knowledge sharing includes *breakfast seminars, internal marketing, global workshops*. Yet, sales manager from WSP considered corridor talk is more

effective in terms of experience sharing. She said: *"Sometimes we spread experiences in the corridor regarding utilization of new technology in our business areas, discussion is initiated when a question is thrown to a department and receieves an answer from the other department. I think it is super interesting because it is just a foot way to share information but at the same time keep a bit private."*

4.4.2 Partnering

Partnering reinforces inter-organizational integration by allowing partners to learn from each other strategically, developing systematic processes and facilitating knowledge sharing. According to the senior consultant at FOG, strategic partnering is beneficial for innovation since in a longstanding relationship, knowledge transfer is lift up from individual to organizational level, which means the collaborated experience of project is accumulated. Also, the higher level of partnering leads to better control of change and enable a continuing innovation development. The argument is in line with the opinion from the manager of business area at WSP, he stated: *"More established strategic partnerings result in the incremental development of knowledge. No one really owes the ideas, innovation and approaches."* The knowledge aggregation requires new governance framework and agreement. Nowadays, agreement with consultancy companies in Sweden applies General Regulations for Consultancy work within Architect and Engineering (ABK), an agreement that pays per hour, rarely leaves a fixed price.

The prerequisite for a partnering are to find *common goals* and *mutual benefits*, according to the opinion from the clients during interviews. Accessy[5] and RealEstateCore[6] are examples of collaborative innovation, which is a leap for real estate sector to scale up the development of new services as well as connect different actors in the city. These property owners faced the same concern for security control, thus became a chance for cooperation. The senior manager at Vasakronan viewed innovation development as an open collaborative process of different competences by stating that *"it does not work to sit behind computer alone to devise standard for the whole industry."* Instead, companies should reach out to other actors and build industrial constellation to create win-win situation. By forming a project network, they not only created more value for their customers, but also reduced operational costs by reaching a certain economical level.

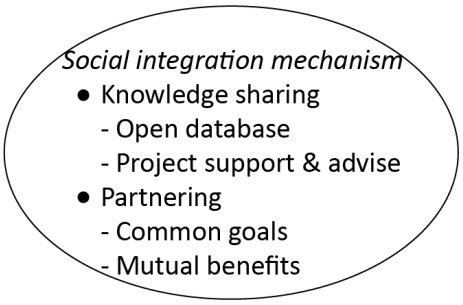
4.4.3 Summary

Internal as well as interorganizational knowledge sharing are summarized in figure 6 as means of social integration mechanism.

[5] Accessy: Digital key for property owners to allocate access, rights and permissions to the property, was launched in the form of tenants App. It increased the safety control and service level for logistics- and waste management.

[6] RealEstateCore: An open source language with the incentive to develop the knowledge capacity of real estate management firms, especially in terms of Smart City. The main objective is to manage, store and share data that come from sensors in the buildings and BIM and to create new services for suppliers and tenants.

Figure 6 Summary of social integration mechanism



4.5 Realised absorptive capacity (RACAP) ; transform and exploit

4.5.1 Tolerant culture

Open corporate climate and tolerant culture that tolerates mistakes play an important role on cultivating innovation at pilot stage, argued by both clients and consultants in interviews. The project leader at Akademiska Hus emphasized open climate could foster new ideas, meanwhile, they are working on internal incentive system to promote innovative working manner. Their project manager also added that innovation development process should be simple and encouraging for employees to test new proposals. The manager at Vasakronan expressed the same opinion during interview, he brought up the importance of learning lessons from projects and improve it in subsequent projects. As such, risk of repeating mistake decreases. He resonated that "*it is better that one person makes a mistake and shares it with ten people than that they all make the same mistake."*

4.5.2 Support from management

Managerial support is necessary in innovation development because ideas are to a large extent initiated and driven by individuals. Senior consultant at FOG as well as project manager at Akademiska Hus both stressed the importance of driving spirits "eldsjälar" (enthusiasm) as a key for some of the innovation processes to come into action. With few internal incentives from higher management to drive innovation, such as monetary rewards or personal recognition, it must mainly be driven by hobby or interest outside of ordinary job description. Therefore, the project manager at HSB complemented with flexibility and adaptability in terms of working routine. Innovation does not happen within rigid, planned schedule, instead, it requires time to be explored and developed. According to the interviewees, employees in the client organisations; Vasakronan, Akademiska Hus and HSB, have the possibility to leave proposals about ideas that they want to test. The respective R&D departments evaluate the proposed idea and assign necessary resources for the project to be undertaken in case it has potential to

be developed to a good business case. As for Vasakronan, the individual initiators themselves can be appointed as innovation project leader, but in Akademiska Hus and HSB, this opportunity for individuals is not a formal procedure.

Both clients and consultancy firms agreed the importance of leadership in innovation development, including a effective decision making process, resource allocation and sound incentive system. From the senior consultant from FOG's standpoint, support from high management is the prerequisite for vision and strategy formulation, which become the basis of innovative initiative selection criteria. Also, the sales manager from WSP stressed the gradual process of innovation implementation: *"The innovation should start with small things in order to make our colleagues feel safe before scaling it up. The purpose of step by step implementation is to make our colleagues familiar with it and further use it."* She implied that when innovation is introduced, internal acceptance and understanding should be taken into account by managerial level.

4.5.3 Innovation exploration

When it comes to transformation phase, the selection of assimilated knowledge in relation to business area becomes crucial. For Akademiska Hus, they intended to create open innovation, therefore, focus is laid on the capability of partner organizations. In the project of A Working Lab, consultancy firm ÅF was procured for acoustics and HVAC system (Heating, Ventilation, Air conditioning) because they are willing to drive innovation together. They got half paid as they are investing on capacity building themselves. On the other hand, the agreement with the project contractor Byggdialog is open book. Prime cost is selected as payment in order to gives them incentives to be more innovative. Selection of collaboration partners comprises of dimensions such as previous experience with projects, organization and the way of collaboration, according to the project leader at Akademiska Hus.

Comparing to that, the consultancy firm WSP has distinctive consideration regarding idea selections. According to the manager of business area at WSP, the transformation of knowledge to pilot project is assessed by: the relation to the business on a long-term horizon; of value to customer; strategic spread of risk. Innovation development is suggested to begin from small scale so that new ideas could be developed practically, thus, innovation arena is introduced to test pilot projects. Later, results are compiled and assessed for further development potential. However, it is noticed that gap between documentation and implementation existed, which often occurred between transformation phase and exploitation phase. Various pilot projects are carried out in innovation arenas A Working Lab and HSB Living Lab, however, difficulty was encountered when the innovation is planned to be implemented extensively across the company.

4.5.4 Organizational ambidexterity

How to enhance the organizational ambidexterity regarding the separation of exploration and exploitation was mentioned in interviews. The project manager at HSB considered that the best practice is to separate pilot projects from the core business practice. She claimed that it was due to the risk that core business practices will be interrupted. She was nevertheless, well aware of the conflicting opinion from literature and that distinguishing innovation from ordinary processes like this may imply a more complex implementation with higher risk of resistance from employees. The business area manager at WSP had the counter-opinion and thought that it was important to continuously implement innovation in operations by stating: "*Often times internally developed innovation yields good reports, but they are poorly spread within the organization. Growspark is intended to set new standards of implementation*." He proposed good routines and standards to successfully exploit and spread innovation.

In addition, long project horizon is another challenge posing on innovation development. The senior manager from FOG pointed out: *"Ensuring capital stability in a long term is a challenge specific for urban development, since it takes much longer than conventional building projects."* Same principle was applied to infrastructure project, agreed by the senior manager at WSP. To overcome the challenge, clients tend to form collaborative business relationship with their contractors to share the risk of fluctuation of costs, conversely, the contractors could better understand the financial situation of clients.

In addition, risk accounts for a primary reason for inertia, thus, risk distribution among partners play an essential role for innovation development. According to the senior manager at WSP: *"Part of the solution to risk control is to look at the procurement process and contract formulation, how can we share risk to create more new technology, processes and innovation. Fixed price is to a certain extent good because the actors would become more efficient and effective."* However, the project manager at Akademiska Hus had a counter opinion as he referred to the procurement contract that Akademiska Hus have agreed on with the constructor of A Working Lab. In this contract, Akademiska Hus covered all the costs of the construction and reward the construction firm a predetermined commision after the project is finished. This agreement leaves more room for the construction firm to investigate ways to streamline their processes, he said. One of the reasons to this open ended contract is to lower the risk of the constructor's innovation practice, thus encouraging them to invest innovation aligned to Akademiska Hus goals.

Predetermined procurement documents are another barrier for innovation development. The senior manager at Allegro had experienced in the firms consultation as a contractor the influence that a client have on the amount of innovation that can be undertaken in projects. The more *flexibility of project scope* is by the client, the more room contractors have in implementing and driving innovation. The senior manager at WSP who works within infrastructure emphasises the high level of influence and

control that Trafikverket and other political organs have, both as regulator, but also commonly as client. This makes it difficult for private contractors and consultants to navigate and drive innovation.

4.5.5 Summary

Realized absorptive capacity (RACAP) contains transformation and exploitation phases. It deals with organizational ambidexterity concerning the extent of exploration (innovation arena) and exploitation (current practice). Critical elements for each phase are summarized in Figure 7.

Figure 7 Summary of realized absorptive capacity (RACAP)

4.6 Regimes of appropriability

4.6.1 Competitive hinders

Another discussion topic which is relevant in evaluating the implications that collaboration can have on innovation is to identify the hinders involved in industry-wide knowledge sharing, especially between competitors. Since one activation trigger for innovation is to become more competitive through improved quality and reduced costs, it is natural for companies to be restrictive in sharing knowledge that influences their competitive advantage. This is especially true for consultancy firms whose main asset and proposed value is knowledge. Contrary to this common protectionistic practice where companies attempt to hinder the spread of internal knowledge and innovations, Akademiska Hus testified to an ecosystem that is very open with sharing. This open sharing is mainly due to Akademiska Hus' governmental mission; to strengthen Sweden as a knowledge nation and thus distinguishes the regimes of appropriability to other actors that are competing purely on a free market.

Despite their governmental ownership through the pension funds, Vasakronan are evaluated on the basis of the free market and thus have no reason to share more knowledge and innovation than their competitors. They are often restrictive in engaging in seminars and workshops that can cause them to share sensitive internal knowledge that can give rise to competitive advantages. However, Vasakronan are willing to cooperate and contribute to better awareness in environmental issues that have trans-firm benefits and implications.

4.6.2 Typology of innovation

Innovation is developed across organizational boundaries and supply chain. Innovation observed from the interviews could be categorized as following: *Product/Service, Process, Organization*, see Figure 8. Product innovation occurs often associated to technology advancement, such as building components and system. Integration of DC electricity supply in buildings and ventilation & lighting system improvement are innovation instances given by Akademiska Hus. Aside from that, the construction of massive wood structure without tent is product and process innovation in A Working Lab. Examples of service innovation could be found in real estate sector. For example, Vasakronan along with other leading real estates company and Accessy AB developed digital key, enhancing safety and flexibility for both property owners and tenants. Besides, big data and monitor system is developed to help property owner to achieve environmental requirement, including lighting and ventilation. An example given by manager from Vasakronan was: "Every year, the offices are only used for 50 weeks, the 2 weeks energy waste accounts for 10% of energy consumption. We have potential to use energy in a smarter way." Vasakronan collected the data and developed an online platform to reduce unnecessary energy consumption, meanwhile, they can better understand user behavior in their properties.

The second type of innovation is process innovation. In attempt to enhance production efficiency and streamline workflow in a project organization, Building Information Model (BIM) is developed and applied extensively in construction. Lastly, organization innovation found both in clients and consultancy firms. In the interviews, some changes could be viewed as organization innovation: Innovation arenas, WSP Growspark, Vasakronan Green certificate and open source RealEstateCore. By means of building innovation arena, pilot projects could be tested in collaboration with tenants, suppliers and researchers. Innovation areas A Working Lab focuses on realizing Akademiska Hus's strategy, including energy smart solutions, green multifunctional areas, shared space between houses, Learning Lab and so on. Similar to this are HSB Living Lab and Riksbyggen Positive Footprint Housing. On the other hand, WSP launched a strategic innovation accelerator program Growspark, which draws WSP closer to startups with the intention to become cutting edge in their business. Various benefits for both sides are identified according to the manager of business area in WSP: *"The program make the venture capital less difficult to obtain for startups, on the other hand, industry knowledge and customers are much stronger and important for us, we have the industry's glasses and co-selling our business. Yet the condition and term of the collaboration of course exists, the startups cannot deliver the innovation exclusively to other competitors."*

Figure 8 Innovation typology

Product/Service innovation	Process innovation	Organization innovation
• DC electricity supply system • Outdoor massive wood construction • Learning Lab changable setting • Accessy digital key	• Building Information model (BIM) • FOG Innovation process and leader	• Innovation Arena, i.e. A Working Lab/ HSB Living Lab • WSP Growspark • Vasakronan Green Certificate • RealestateCore

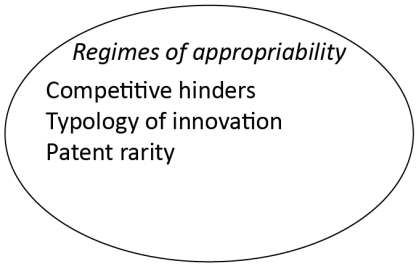
4.6.3 Patent rarity

A trend is observed from close atmosphere toward open attitude regarding knowledge sharing in Swedish construction industry in interviews. In refer to the risk of spill out ideas, the senior manager at FOG complemented: "*We have to differentiate concept development and production development, the later can be used to apply patents, while the former is developed within collaboration, so it is hard to know who exact proposes the idea. Within sustainable innovation, there is more reason to protect knowledge because the interests are global. For processes innovation it is of course difficult to prove violation of patent*." Also, knowledge is neutral, more important is further development of ideas to be commercialized product/service. Process innovation concerning improving internal feedback regeneration, and organization innovation on promote business advantage, have difficulty to obtain patents due to they are tangible. By exception, product/service innovation that could be defined with technical scope, are more possible to have patents. For consultancy firms, who's value comprises of the knowledge and competence, such as WSP and Allegro are more careful on choosing partner to develop innovation with. However, due to the production dynamics, where several different consultancy firms are contracted for different functions, they sometimes have to cooperate with competitors.

4.6.4 Summary

Innovation mentioned in the interviews is categorized into different typology, including product/service, process, organization. Based on that, the fact of rare patent in construction is reasoning. Figure 9 summarizes topics deal with regimes of appropriability in empirical results.

Figure 9 Summary of regimes of appropriability



4.7 Competitive advantages

4.7.1 Cost efficiency

As reported by the project manager at Akademiska Hus, construction is cost-oriented. Thus, innovation that could result in cost reduction could easily get support from company and collaborative partners. Both clients and consultancy firms actively engage in developing product/service and process innovation in order to become pioneer and gain competitive advantage in early stage. The senior manager at FOG thought that innovation could aid the company better adapt to the change of external circumstance. One of the prominent example is introduce of higher environmental standard and regulation in property market. From client perspective, green innovation is prevailing in terms of low energy consumption technology and sensors measurement, which help them to lower operation costs It is developed in response to reduce the rate of resource consumption. Cost efficiency creates economical and environmental value for clients and customers and thus innovation toward sustainability is highly appreciated.

4.7.2 Long-term sustainability

Ensuring long-term sustainability is of great importance for clients and consultancy firms. Construction industry corresponds to high risk because large amount of capital could be trapped for a long time. In particular, comparing to building project, urban development project could take up to eight years. Not to mention infrastructure project often exceeds twenty years. With many ongoing projects in an unpredictable market, financial leverage accompanies risk premium. Therefore, market-oriented innovation would give company advantages as early adopter in innovation adoption cycle. Taking Vasakronan for example, launching green certificate made them acquire market leading position in terms of energy-efficient property. On one hand, the company reduced the risk of climate change and energy price fluctuation, ensuring the long-term corporate financial sustainability. On the other hand, they were able to acquire green fund from banks and private investments. Financial support from third party's facilitates the execution of green innovation. Changing of business model is reported by the project manager at HSB : "*We have to revise our offerings and revenue models; going from a focus on price-per-square-meter into offering more services and maintenance to support and leverage the customers living space*."

4.7.3 Positive image of firm

As corporate social responsibility (CSR) getting more and more attention, innovation is driven by brand recognition and public missions and result in positive firm image. As reported by the sales manager at WSP, the company aims at becoming innovators or early adopters in the industry. Therefore, Growspark is not only a means for integrating innovation in their established business, but also a good way of marketing. Also, Akademiska Hus put effort on developing innovation and sustainability to gain

trust from customers, employee and partners. As large consultancy firms and clients, they have higher possibility to lead the industry and encourage other actors to take part in innovation initiatives. As reported by the professor at Chalmers, a company's higher R&D expenditures and innovation focus are perceived by potential customers, employees and partners as an indication that the company embraces change; technical, social and environmental. The inclination about brand promotion could even sometimes become more important than the actual results of the innovation.

4.7.4 Improved project performance

Improved project performance in terms of time, cost and quality could be related to activation trigger market threat. Competition from market leads to business upgrade in order to stay competitive in the market, which could be achieved by innovation. For example, by applying drone, WSP gained more accurate result in facade inspection. BIM application improves project performance in construction, which is recognized by the senior manager from Allegro. It contributes to project management triangle-time, cost and quality by synchronization of documentation, reducing change of design during construction. In addition, with introduce of sensors and technological measurement, evidence-based design brings production closer to users. Thus, apart from elevating production efficiency, innovation implementation also contributes to promote customers' satisfaction.

4.7.5 Organizational effectiveness

Organizational effectiveness implies that resource sharing and knowledge exchange in a project organization are more effective. It could be achieved by designating key role and responsible departement to help realized company strategy and innovation development. For instance, coordination of project schedule and innovation process is challenging. It poses a high demand on projection and project management. Innovation leader and project leader could enhance innovation implementation by coordinate resource among project partners and decide what innovative solutions are feasible for the project.

4.7.6 Summary

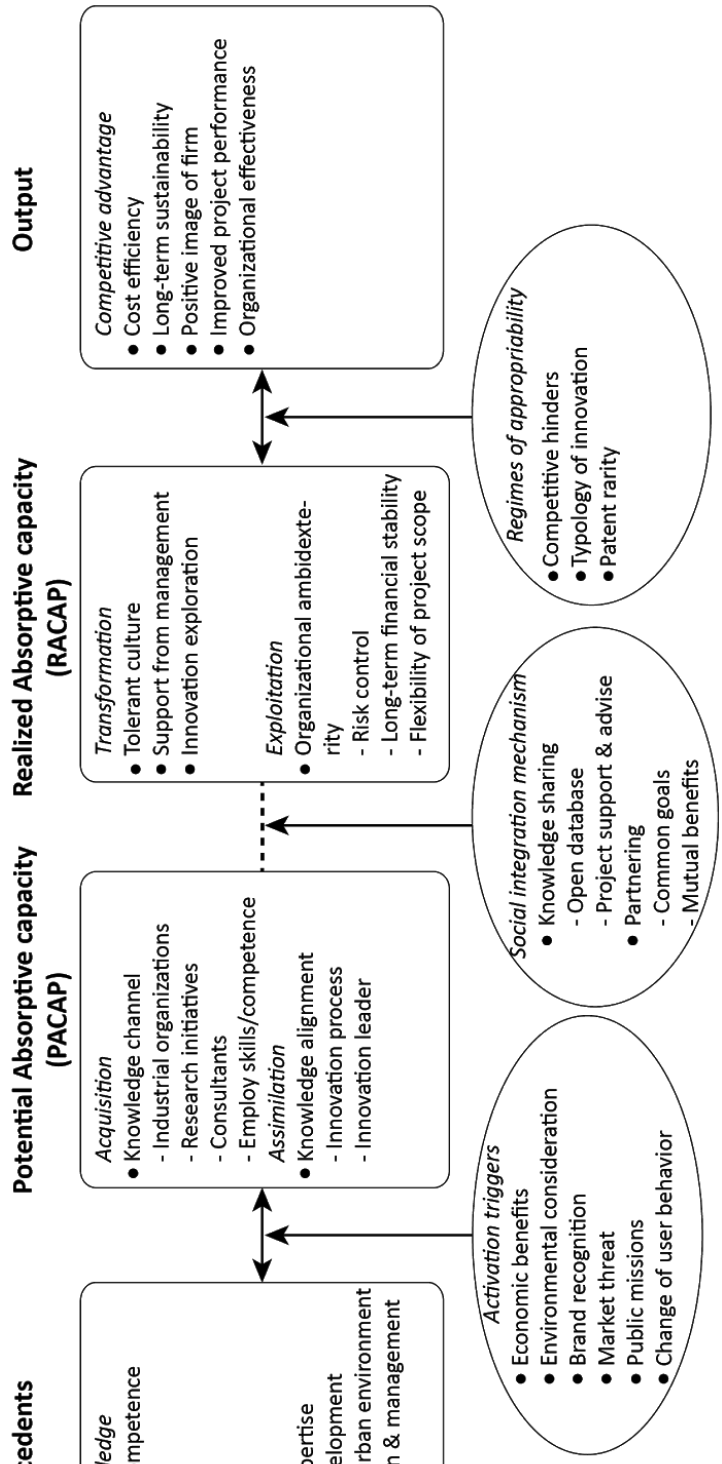
Competitive advantages interviewed organizations gained from developing innovation were to some extent related to their activation triggers and summarized in Figure 10.

Figure 10 Summary of competitive advantages

4.8 Summary of ACAP

Compiling different elements in the ACAP framework, Figure 11 presents insights of innovation development in the interview findings.

Figure 11 Innovation development within the ACAP framework



5 DISCUSSION

The interviewees testified to different opinions about the status quo of the industry; most deemed it to be afflicted by a low level of innovation. Statistics support this claim, for example the R&D expenditure in construction is lower than other industries (Reichstein et al., 2005). However, the senior researcher at Chalmers and the business area manager at WSP challenged this common preconception by referring to various less apparent process, service and organizational innovation that have been developed. Similarly, Winch (2003) questioned the statistics on industrial rates of innovation by implying that even if the internal R&D may be low for construction firms, innovation happens to a higher degree in architectural and engineering firms and are being implemented into construction projects. However, no matter their view on the status quo of the industry, most interviewees were of the opinion that it is becoming less conservative, partly due to the improved technological drivers and establishment of interorganizational collaboration.

5.1 Reasons to low rate of innovation

By interpreting the interviews and combining it to the literature, the reasons for Swedish construction industry to experience inertia and low rate of innovation could be categorized into two attributes: *market dynamics* and *production dynamics*. As for the market dynamics, it refers to the characteristics of the market and how they impede innovation. Long time frame of projects imply a lower transactional rate as explained by the project manager at HSB, which gives rise to a lower frequency to test and implement innovation. Furthermore, high prices, negotiability in pricing and regulatory restrictions, cause complex transactions which slows the rate of innovation (Mannesson and Roos, 2011). Regulatory restrictions and political intervention is the case for Swedish Transport Administration (Trafikverket) that exert much influence and control in their role as both client and a regulator.

Another reason for the slow moving sector is the lack of capacity of construction firms that causes governmental organisations to introduce foreign construction firms (Business Region Göteborg, 2017). With a higher demand on residential, commercial and institutional construction than what the capacity can meet, there is less of a need for clients and construction firms to innovate since they will regardless of innovative capacity be requested on more projects than they are able to meet. This is confirmed by the innovation leader at Akademiska Hus when he said that "*there is no need to innovate because we are after all profitable"*. Since buildings are long lasting products, both clients and producers want to have a predictable result of the project, therefore, proven solutions are preferred than innovative proposal (Loosemore and Richard, 2015).

As mentioned in the introduction, it is beyond the influence of individual firms to change the nature of the market because that is rather on an industrial level. Therefore, the collaborative practices mentioned have been identified to be more of the inter-firm and intra-firm level and affects the issues concerning production dynamics. The rest of this discussion is divided into two parts; firstly, presenting the production dynamics reasons for why there is low rate of innovation in the sector, after which collaborative practices will be presented and how they may alleviate the inertia that afflicts the sector. The reasons are divided into *project organisation, unique projects* and *long project horizon,* whilst the collaborative solutions are presented in section 5.2.

5.1.1 Project organization and large amount of companies

With a variety of companies involved in projects and numerous interrelated parts that affect the development, implementation and management of innovation, driving innovation becomes difficult (Kadefors, 1995). Confirming the statement, the business area manager at WSP highlighted this issue as he explained team building in the sector is of great importance. Members of the project team, who come from different disciplines and distinctive firms, are required to cooperate intensively within a short time. This implies complex and sometimes conflicting stakeholder interests and inefficient coordination. Also, a continuous shift of partners leads to new relationships and trust building that demand shared agendas and alignment to goals as well as coordination of processes between organizations (Hobday, 1998). As such, this interorganizational structure of the projects refers to a complex co-creation and implementation of innovation, compared to other industries with a more vertical supply chain, in which the R&D is often times more internal. Such complex relationships between project collaborators, different disciplines and between individuals suggest a need for leadership support and strong organizational structures and processes (Gluch et al., 2019).

5.1.2 Uniqueness of projects

With varying geographical location, clients' demands and project prerequisites, construction projects compose a unique profile. In other words, construction projects are engineer-to-order since they are highly dependent on external circumstance and thus cannot be produced before getting approval from clients. New and ad-hoc teams are built to execute these unique projects and these constellations often have no prior cooperative experience nor routines. Contextual factors pose challenges in organizational learning and inter-firm knowledge sharing (Widén, 2013). It causes issues in transferring knowledge learnt in one project to the next, referred in the empirical findings to an implementation gap. Implementation gap implies how innovative results from pilot projects are poorly exploited, yet the incremental improvement achieved from prior projects failed to transfer to the subsequent projects. Incremental innovation is more frequent in construction than systemic innovation due to the fact that a change affects the whole supply chain, affecting several organizations (Colvin et al., 2014; Larsson et al., 2017). This is supported by interviewees who claim that systemic innovations happen less often than incremental ones due to the complex interorganizational structure that requires more coordination.

5.1.3 Long project horizon and big scale

As the project manager at HSB said; due to the long lead time from land acquisition until tenants are ready to move in, many factors and processed need to be coordinated according to waterfall schedule. This requires much planning and high uncertainty in interrelated activities may jeopardize the budget in case of delay or variance (Gulati et al., 2000). Big scale projects with a lot of functions mean high uncertainty and are very costly, said the project manager at HSB, and hence include large aversive risks for tenants, both organisations and privates. Low risk tolerance, contributes to a conservative industry (Mannesson and Roos, 2011). Large scale and long time horizon of projects lead to large amounts of trapped capital and high risk for obsoletion, especially for urban development and infrastructure projects, which are of longer lead-time and include more political authorities and public interests. Making changes in processes where several actors are affected implies high risk and hence a resistance to innovation. In the empirical part, both clients and consultants indicted the fact that consultants tend to propose safe solutions with little uncertainty because they bear responsibility and also the clients prefer conventional methods. Consequently, at the most cases, consultant firms have insurance to ensure accountability distribution and risk compensation. But in some cases, clients are willing to bear uncertainty in order to stimulate innovation in projects, then consultants will have more room to work with unproven and alternative solutions.

5.2 Resolutions to inertia

The collaborative solutions that are identified to alleviate the inertia are *knowledge flow, innovation leader, innovation arena and collaborative business relationship.* The intention of this section is to map how they contribute to resolving the reasons presented in section 5.1 as observed from literature and empirical study.

5.2.1 Knowledge flow

An efficient knowledge flow can be a competitive advantage because it deals how well a company is absorbing knowledge, both innovation and required competence, from external sources, transferred internally or within organizational collaborations and exploiting innovations or using knowledge (Zahra and George, 2002). In ACAP framework, it is related to *PACAP* and *social integration mechanism* with separate emphasis on how knowledge is acquired, assimilated and shared both within company and inter-organizations. There is a trend for construction firms to outsource R&D, which poses a threat to maintaining and transferring the innovative capacity internally, but also implies a good source of external knowledge (Kadefors and Femenias, 2014). The knowledge outsourcing phenomenon is confirmed in the empirical findings, where clients search assistance from innovation consultancy firms to build their innovation strategy and innovation process. However, recognizing the importance of innovation during the restructure procedure, the clients tend to internalize the outsourced competence

by building new department. Within the sector, there are various organizations with the intention to enhance the level of knowledge in the market and improve the innovative capacity, such as CMB, SBUF, CIFE, Mistra Urban Futures. Both clients and consultants revealed that they actively engage in this industrial organizations or research institutes to obtain interdisciplinary knowledge and become more attractive to their customers. The fact from empirical study confirmed the research that construction companies could enhance business competitiveness by concentrating on knowledge acquisition and assimilation (Gluch et al., 2009). In contrast to the literature that pursuing green innovation is initiated by pressure from stakeholders, both clients and consultants revealed that they are proactively build their capacity as well as invest in innovation because they want to stay attractive to their customers even encountering market threat. This distinction shows the shift from cost-driven innovation to value-driven innovation happening in construction, which is in conformity with research from Meng and Brown (2018). Their argument on the combined effect of technology-push and market-pull on driving innovation is perceived in interviews. Clients in commercial real estate sector acknowledged that their service innovation is oriented to sustainable trend and customers need, thus, they actively developed digitalization capacity and sensor-based design to ensure long term competitiveness. Principle innovation incentives regarding economic benefits and environmental consideration are admitted in both literature review and empirical findings, thus facilitating for more awareness of innovation and less resistance to it.

In order to facilitate knowledge assimilation process, knowledge sharing activities including internal conferences and group discussions in different disciplines are arranged, reported by clients and consultants. The aim is to spread experience, competence and awareness across the departments, which is beneficial for interdisciplinary team. Sometimes workshops and meetings are even held across organizational boundaries with project partners to find common goals and mutual benefits. Apart from spreading knowledge, these meetings facilitate for the spontaneous talks between specialized subjects and between partners in project organizations as well as networking. The heterogeneous connection is, according to literature, beneficial for innovation development (Liu and Chan, 2016).

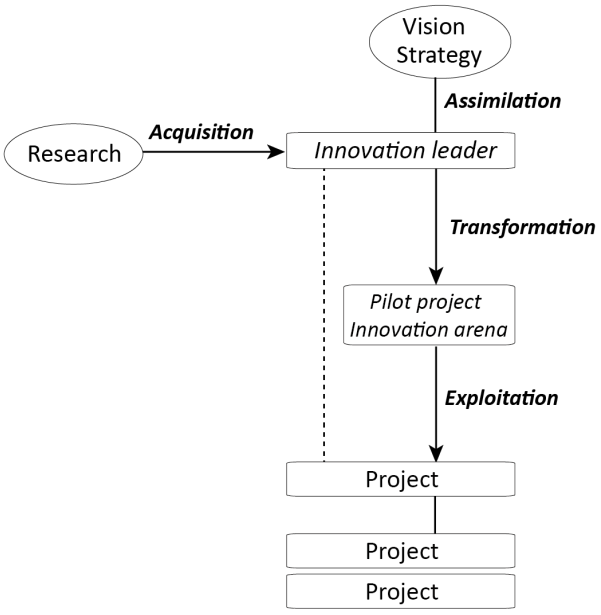
5.2.2 Innovation leader

Considering the transfer of knowledge, both interviewees and literature highlight the issue of implementation gap (Kadefors and Femenias 2014). Smyth (2010) admitted that knowledge transfer and innovation diffusion are hard to realized across both project and organization boundary. This concern was also addressed by both clients and consultants during interviews. In response to it, innovation leaders are a way of increasing the awareness and applicability of innovations. Their function cover *four critical elements of ACAP* with illustration in Figure 12. One of the consultancy firms have through their acceleration program, Growspark, initiated a good innovation facilitating role which entails mutual benefits with start-ups. By this way, companies get access to the latest trends and technology without the need of an internal R&D department, whilst start-ups can reach commercialisation of their innovations. This improves the innovative capacity within the sector since

consultants act as an innovation broker between on one hand new technology, products, services and processes and on the other practical application in industry.

The implementation gap, caused by poor knowledge transfer between unique projects and the nature of project organization, could be solved by appointing a new role of the innovation leader. The role of innovation leader is devised by collaboration of clients and consultants . An innovation leader would lead in the development of an innovation strategy, aligning innovation practice, such as pilot project that are tested in innovation arena, with the company's goals. It serves as an innovation broker with the intention to, at an early stage, assess what innovations or technology are appropriate for established projects. Through an overview on previous projects and ongoing pilot projects results, they act as a bridge to scale the innovations through documentation, but primarily active involvement in ordinary business projects. It would be relevant to let innovation, which is driven by enthusiasm, transform into these innovation leaders since their practices and interests are similar (Kadefors and Femenia, 2014). Figure 12 shows how innovation leaders facilitate systemic innovation development by applying ACAP in their role. Firstly, they acquired knowledge from research and through assessing business relatedness to align to company's vision and strategy. The step is necessary to bridge heiger value and operational level by evaluating feasibility. Afterward, knowledge is transformed into practical pilot project to be tested in innovation arena. Results from pilot project become reference for company to decide whether the innovation is worth to exploit in regular business. According to Meng and Brown (2018), innovation strategies constitutes of four aspects, that are technology, resource, marketing and management. The role of innovation leaders could be regarded as management, but their tasks are comprehensive to evaluate available technology and resource to optimize potential innovation capability. However, the specific role of innovation leaders would not find the scaling and broad application in smaller client firms, even though the activity could be imitated.

Figure 12 Role of innovation leader



5.2.3 Innovation arena

Study from Bjorvatn and Wald (2018) indicated that team level absorptive capacity could only contribute partly to project management triangle due to project complexity. Therefore, structural change on firm and inter-firm levels are required. Innovation arenas such as A Working Lab and HSB Living Lab are examples that represent the effort on developing innovation from clients. They are established in order to increase the feasibility of innovation at *RACAP* phase. In both cases, strategic partners such as tenants and research institutes as well as project partners in supply chain involved in project scope formulation. This implies that not only incremental innovation, but also systemic innovation would happen owning to more than one supplier and contractor involve in collaborative innovation development (Colvin et al., 2014). The purpose of establishing innovation arena is aim at controlling uncertainty in pilot projects to facilitate their implementation in regular business. In other words, with high uncertainty comes high risk in testing new technologies, services, products or processes in ongoing projects, pilot projects can be tested, modified and co-created in innovation arena without causing harm to client. In addition, due to long, high cost, unique and interorganizational nature of construction projects (Larsson et al., 2017), pilot projects could be a solution for obtaining innovation result in a short time frame and without costing too much resource. Implementation of pilot projects signifies the transition of transformation and exploitation phases in ACAP framework. A Working Lab is a construction project itself in which innovations are being tested and will in the future be a testbed for more innovation to be developed and tested, such as pilot project about electrical

system change from AC to DC. As such, innovation arenas reduce risk because innovations can be tested outside of the ordinary business practice.

As been highlighted both among interviewees and in literature, an essential issue is often not to come to profitable results in pilot projects, but rather to implement the successful experience across the organization. Then it is of importance to build systematic implementation of the innovations, through routines and standards that effectively exploit the intellectual capital and continuously adapt and renew (Kadefors and Femenias, 2014). There is contradicting opinions from the interviews in how to best deal with this ambidexterity that is caused by innovation arenas when innovations are developed far from ordinary processes. To resolve the paradox caused by structural and sequential separation of exploitation and exploration in construction projects (Eriksson, 2013), innovation selection criteria are developed on the basis of companies' strategies. For instance, three business areas were identified as priority when choosing startups in Growspark. HSB Living Lab also pinpointed five research domains that are related to future living. Along with result evaluation of pilot projects by innovation leader, a higher possibility of transformation from decentralized exploration to centralized exploitation could be accomplished.

5.2.4 Collaborative business relationship

Collaborative business relationship encourages consensus on mutual goals, interest and project schedule, which implies trust relationship and team building, knowledge sharing and coordination in processes as well as experience in collaborating with each other. Team building is essential element in the beginning of interorganizational team forming. A prominent instance of collaborative business relationship is partnering. It facilitates collaboration and commitment in a project-based organization, which is critical for collaborative innovation development (Ozorhon, 2013). Testing innovations in unique projects and within new team constellations cause uncertainty and risk. This risk can be reduced in case companies engage in closer relationship (Jones, 2017) and involve partners at an early stage (Halttula et al., 2017). According to Larsson et al. (2016), contractors early involvement (CEI) is effective in reducing the amount of big changes later on in the process and thus facilitate systemic innovation, which was agreed by consultants in interviews. Also, it is supported by the claim made by Halttula et al. (2017) that efficient planning and integration in early stages of projects reduce waste in material and in processes. Thus profitability that is one of the most important outputs of innovation is enhanced.

It also incurs more costs and bureaucratic procedure and thus the level of appropriate collaborative business relationship is determined from project context and strategy towards partners. At this point, clients play an important role in creating innovation environment by providing long-term contract (Larsson et al., 2016) and building partnering. By means of long-running relationship, the innovation potential laid between the contractors and suppliers has higher possibility to be stimulated (Sariola, 2018). Besides, due to the fact of interdependent relation in the sector, where many actors are affected

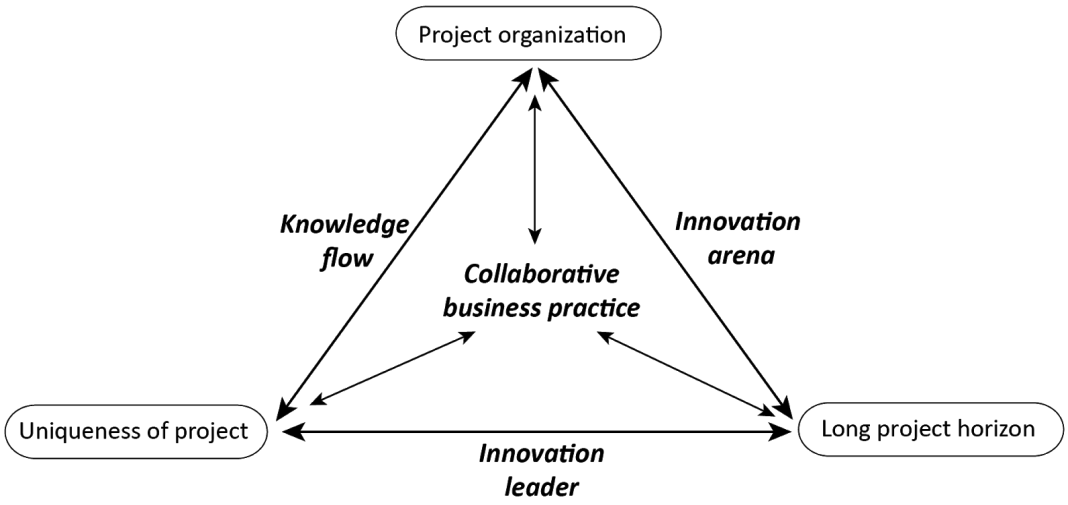
by process changes happening in projects, systemic innovation is difficult to co-develop and therefore uncommon (Larsson et al., 2017). However, through establishing routines, aligning practice and in other ways integrating the supply chain, systemic innovation could be more frequently achieved (Colvin et al., 2014). Thus, collaborative business relationship could to some extent resolve innovation inertia and increase the level of systemic innovation in construction.

Another important aspect to collaborative business relationship in the development innovation is procurement strategy. Because the clients choose suppliers, contractors, consultants and determine the project scope and requirements through procurements, the level of flexibility and room for innovation are being influenced and determined to a large extent (Brandon and Lu, 2008). Especially, innovative capability of contractors and consultants is restricted by clients' need to continuously having to adapt to clients' requirement. Consultants supported this claim in interviews and referred to how they as turnkey contractor were often restrained to innovate by the clients. This is partly because there is no need to enhance their innovative capacity after the contractors have won the procurement. It is also partly because in procurement procedure, the clients have insignificant competence or do not recognize their leadership in innovation development (Loosemore and Richard, 2015). According to both clients and consultants, revising procurements could be a way to better share liabilities and risk, which would constitute a resolution to the inertia that afflicts on construction firms. Consultants believed that fixed costs in procurement for contractors creates efficiency; while clients revealed that the way of sharing costs with their contractor in A Working Lab was not fixed costs, instead, prime cost with a certain profit for contractors were used. This has resulted in an open innovate capability for the constructors who feel comfortable in testing new ideas in the project for the mutual performance improvement. Even if this way of sharing risk in procurements inflicts on the client's proportionate risk, it creates a higher overall group performance due to integration, collaborative tools and mutual understanding and interests (Eriksson, 2013). As the procurement strategy for consultants, they rather targeted at the firms who were willing to share cost and co-develop innovation with them. By this way, they could realize innovation with effective resource utilization (Meng and Brown, 2018) as well as involve consultants and contractors at an early project stage (Larsson et al., 2016).

In the discussion, reasons for low rate of innovation in the industry and their corresponding resolutions are illustrated. Innovation inertia could be mainly attributed to production dynamics such as *project organization*, *unique project* and *long project horizon*. To resolve innovation inertia, four resolutions are proposed to deal with various aspects in the contributing factors. Increasing *knowledge flow* are proposed to enhance knowledge transferred in unique project context and collaborative learning in project organization. Whereas *innovation leader*, who is in charge of leading innovation process and bridging implementation gap would be beneficial for collaborative innovation despite the challenges posed by unique project and long project horizon. From operational perspective, *innovation arena* is test bed for interorganizational explorative practice to take place. Pilot projects conducted there would contribute to innovation development that is restrained due to long project horizon. Lastly,

collaborative business relationship is regarded as resolution for the three inertia factors owing to it create long-term, promising condition for collaboration among project partners. This implies that they have common goal and are committed to collaborative innovation development. Thus, cooperation experience will assist project organization to form working routine even every single project has unique context. Risk that is created by long project horizon could also be more evenly shared by partners. Figure 13 shows the resolutions to contributing factors of innovation inertia.

Figure 13 Resolutions to contributing factors of innovation inertia



6 CONCLUSIONS

Comparing literature to findings, collaborative innovation has shown potential to resolve the inertia in construction in several ways and these have been summarized below. The study distinguishes production dynamics from market dynamics due to the industry-wide context of market dynamics that is beyond the influence of the individual organizations and specific collaborations. Relating to production dynamics, contributing factors to inertia and resolution to them are identified and summarized into a conceptual framework in Figure 13.

Knowledge flow, which relates to RACAP and social integration mechanism in ACAP model, is instrumental in resolving issues involved with project organization and unique project. On one hand, it recognizes the importance of creating open climate as well as tolerant culture to reverse conservative mindset and thus encourage innovative initiative; on the other hand, it facilitates knowledge to be well spread throughout organizations and their collaborations through internal and interorganizational seminars, workshops and other knowledge meetings. The role of *innovation leader* is a way of leveraging the knowledge flow and the innovative capability for organizations. As knowledge broker, innovation leader transforms results from pilot projects to fit unique project scope in regular practice, thus, alleviates the implementation gap. Despite high uncertainties and costs caused by long project horizon*,* the role assist the shift of cost-focus to value focus by coordinating project schedule and innovation development. Furthermore, pilot projects tested in *innovation arena* reduce the risk in innovation development, which is owing to no market testing could be done in long project horizon, thus address the issues involved in implementing innovations across organizational boundaries that stifle the sector. Innovation arena also serves as a place where organizations can come together to run mutual projects, which opens for possibilities to co-develop systemic innovation among partners. *Collaborative business relationship* alleviates the issues involved in communication by enhancing trust and team building, knowledge sharing and coordination in processes as well as aligning goals and interests. It also allows for early involvement of partners and sharing liabilities and risks through more collaborative procurements. To sum up, suggestion for resolution implementation to reason for inertia is given in Table 5.

The research also contributes to ACAP literature through elevating ACAP application from firm level to interorganizational level. Social integration mechanism and RACAP are two predictors that are identified particularly critical in collaborative innovation development. Various industrial organizations and research institutes engage in knowledge sharing by hosting conferences, seminar and networking, in order to enhance innovative capacity in construction. Through interorganizational collaboration, heterogeneity in project organization becomes foundation for exploratory practice. In addition, implementation gap is highlighted when it comes to transformation and exploitation phase in RACAP.

To address the issue, the role of innovation leader undertake capacity building mission through embody ACAP process. Lastly, the study contributes to collaboration literature by respectively presenting perceived challenges and opportunities in collaborative innovation development from clients and consultant perspective. As innovation initiator, clients can enhance innovation potential by involve project partners at early phase and co-determine project scope and target goals through inclusive and extensive communication. Establishing a long-term collaborative business relationship is beneficial for promoting commitment in innovation development. Working as innovation facilitator, consultants proactively search for interorganizational collaboration to build their capacity. For both of them, ensuring long-standing sustainability concerning financial and environmental are principle innovation drivers. In respect of industrial-wide inertia, collaborative initiative undergone a resolution to systemic innovation development.

Table 5 Suggestion for resolution implementation

Factor to inertia	Reason for inertia	Resolution		Recommendation
Project organization	Complex co-creation	*Innovation arena*	Enhances systemic innovation through co-development	Innovation development alliance
	Conservative mindset	*Knowledge flow*	Open and tolerant culture	Support from management
	Coordinating interorganizational teams	*Collaborative business relationship*	Alignment of goals and processes	Involving partners at early stage Long-term contract
Unique project	Implementation gap	*Innovation leader*	Facilitate innovation process and knowledge transfer	Incentive systems to promote innovative activities
	Project specific requirement	*Knowledge flow*	Knowledge spread throughout organizations	Internal and interorganizational seminars and workshops Knowledge meetings
	Ad-hoc constellations	*Collaborative business relationship*	Building collaborative experience	Establishing routine and standard
Long project horizon	High uncertainties, risks and costs	*Innovation leader*	Cost focus into value focus	Coordinating project schedule and innovation development
	No market testing	*Innovation arena*	Pilot projects reduce risk	Implementation is eased when customers and partners are involved in the process and can assess the results
	Risk aversion	*Collaborative business relationship*	Collaborative procurements	Co-developing project scope Contracts that stimulate exploration

7 RECOMMENDATION

7.1 Managerial suggestion

In this section, managerial suggestion for practitioners will be put forward to facilitate innovation development. The advice is derived from insights in interviews regarding under what condition could better foster innovation initiative as well as problems that may occur during implementation. The purpose is to share experience and explore necessary elements from good practice, rather than giving a comprehensive solution that fits in every context.

- **Engage and co-create in innovation arenas**
  In the interorganizational context, co-creation and implementation become a prerequisite in order to drive innovation. With more innovation arenas being established, the opportunities to drive projects together with other companies become more tangible. The implementation phase is eased when the companies have mutual competence and interests in the project. The risk due to high uncertainties, which are a main cause for the implementation gap, is lowered. This also enables for market testing and customers to assess the results, which due to the long project horizons are otherwise not possible.

- **Encourage innovative mindsets**
  A way to overcome the conservative mindset that stifles the sector, it is important that manager encourage a tolerant culture which promotes the generation of new ideas and stresses the importance of sharing experience on making mistakes. Making mistakes is a good way for organizations to learn, if they can be effectively revealed and benefitted from. Employees are given flexibility regarding schedule and workload so that they are able to initiate innovation bottom-up. Apart from that, resources should be allocated to nurture necessary competence to drive innovation. This could be achieved through either personal training or organizational adjustment, such as setting innovation leaders.

- **Implement incentive system to promote innovative initiatives**
  Innovation is often driven by enthusiastic individuals that are passionate to innovate and drive change, drawing benefits from their personal connections and network. However, innovation must be developed on an organizational level to ensure sustainability. Similar to the activities taken on by an innovation leader, employees could be rewarded for innovative activities. This is especially apparent for smaller firms with less resources available to employ the exclusive role as an innovation leader. Apart from rewards within the internal working practice, collaborative procurements could be a means of incentivising between organizations. Predetermined procurement strategy and fixed project scope often time give no reason for contractors to be

innovative, rather than fulfill their duty. Yet, in a collaborative business relationship, procurement is co-decided by partners through agreement, thus it allows the presence of mutual benefits. Procurements can be a means of sharing risk through introducing various incentive systems, such as prime cost, 50/50 gain pain share. This allows the contractor to be explorative in searching for better solutions without increasing their risk.

- **Develop interorganizational alliances**
  A collaborative business relationship allows companies better align their goals and resources as well as processes, which is fundamental to collaborative innovation development. It can be done through involving partners at an early stage and through building mutual routines and standards. Ad-hoc constellations and new business relationships that are caused by unique projects and interorganizational structure can gain cooperative working experience if businesses and teams are developed within a longer strategic collaborative business relationship. As part of these interorganizational teams, innovation leaders can spread their broad scope of knowledge, R&D practices and innovations to further enhance the innovative capacity. Such an innovation broker role is similar to the role of Growspark acceleration program which is a bridge between cutting edge technology and construction projects.

7.2 Suggestion for future research

The research preliminarily proposes a conceptual model of resolutions for inertia factors as well as suggestions for resolution implementation across Swedish construction industry. Yet due to the delimitation, some project actors such as architects, contractors, suppliers could not be included. In addition, the advantages and disadvantages of developing innovation regarding organizational ambidexterity could be further clarified and discussed. Lastly, digital trend is surging the sector and has induced change on interorganizational collaboration, which is a subject worthing to investigate more. Therefore, suggestions for future research are made based on the aforementioned aspects.

- **Extension of sample's variety and category**
  In the future research, the choice of interviewees could include more actors from different construction background. It would be valuable to present perspectives from contractors, subcontractors and architects, then compare them with clients' and consultants' viewpoints. Also, it would be interesting to have a broader scale on the clients, which could further elaborate on interests of privately owned clients from the large proportion of governmental clients that were included in the study.

- **Ambidexterity and implementing innovation**
  Some thought that innovation should be developed independently from established business, while the others claimed that innovation would be better to merge in the practice. As such, future research could further investigate best practice in implementing innovation in interorganizational context.

- **Influence of digital trend on interorganizational collaboration**
  During data collection process, it was noticed that digital topics such as Artificial Intelligence (AI) and Machine Learning are widely discussed in the industry. For example, industrial representatives in CMB leadership conference expect a high potential of AI application on projection and facility management. It is however unclear on which part and to what extent of impact it will have on collaborative innovation in construction. Future research can thus be conducted on how digital trends may influence interorganizational collaboration.

This concludes the recommendations to organizations seeking ways to increase the innovative capacity within the sector. The actionable suggestions can help managers in stimulating innovation through establishing better routines and incentive systems, stronger leadership and improved interorganizational collaboration. It also gives suggestions to practitioners and academics in what areas to further investigate as a complement to the study.

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APPENDIX

A. Interview questions for academic experts

- What is your point of view on innovation within the construction sector? (Multi-organisatorisk, projekt baserad)
- They say the construction industry is conservative and slow changing.
    - Do you agree?
    - What are the reasons for the construction sector to experience this inertia?
    - Does this mean low rate of innovation?
- Can it be overcome with better inter-organisational collaboration?
    - How to manage it?
- Can you give examples of collaborative innovation in construction sector?
- How can strategic partnerings inhibit/foster innovation?
- Are patents commonly used? Why/why not?
- Are collaborative innovations always initiated by the client?
    - Why does construction industry need innovation?
- How do corporate culture and structure facilitate collaborative innovation?
- How do you specify innovation in construction industry? Is it collaborative innovation or collaborative innovation or open innovation?
    - How does the collaborative innovation take place between network partners?
- How to evaluate/control risk in collaborative innovation?

B. Intervjufrågor byggherrar och konsulter (Swedish)

Förstadel/

- Hur ser du på innovation inom byggbranschen? (Multi-organisatorisk, projekt baserad)
- (Om trögrörlig, konservativ) Varför upplever byggbranschen denna tröghet?
    - Innebär detta låg grad av innovation?

Andradel/

- Hur kan detta överbryggas genom bättre samverkan mellan organisationer?
- Hur påverkar innovation er konkurrensfördel? Anser du innovation som viktig? Vad är era incitament för att utveckla innovation? *(Activation trigger/Output)*
- Vilka olika typer av innovationer har ni utvecklat i Growspark? Mellan företag, organisatoriska, produkter, tjänster, metoder *(Social integration mechanism)*
    - Hur uppnår ni detta med startups? Hur ser avtalen, ägandeskap, och investeringar ut med startups?
    - Hur implementerar ni innovationer från startups till WPS?
    - Hur delar ni kunskapen inom företaget (till framtida projekt)?
    - Hur kan er strategiska partnerskap hämma/bidra till innovation?
- Vad anser du som förutsättningar för innovativ affärsutveckling? *T.ex. organisationsstruktur, kultur, tillvägagångssätt (Absorptive capacity)*
    - Hur uppmuntras anställda till att driva innovation? Inger förtroende/incitament eller riskminimerande?
- Hur utvecklar ni innovation med byggherrar? *(Absorptive capacity)*
- Vilka kriterier använder ni för att utvärdera innovation? *(Absorptive capacity)*

- Vilka utmaningar har du upplevt när ni utvecklar innovationer gemensamt mellan organisationer/startups? *(Social integration mechanism)*
    - Upplever du motstånd från samarbetspartner att vilja pröva nya innovationer?
- Kan du ge exempel på risker som finns i att implementera ny innovation/teknik/tillvägagångssätt.
    - Finns det fördelar i att vara ledare/ensam ägare av innovation?
    - Hur jobbar ni för att inte sprida kunskap/innovationer till konkurrenter? Tar ni/startups patent på innovationer?
- Vilken intern kompetens (kunskap/tillvägagångssätt) har WSP anställda i att utveckla innovation? *(Antecedent)*
- Vilken extern kunskap/kompetens anser du vara relevant för de innovationer WSP ämnar att bedriva? *(Antecedent/Absorptive capacity)*
    - Hur införskaffar sig de anställda denna kunskap? Vem samverkar ni med?
    - Hur använder och integrerar ni denna kunskap i projekt/verksamheter?

C. Interview questions for clients/consultants (English)

First part/

- How do you see innovation within construction?

- (If conservative, low level of innovation) Why does the sector experience this low level of innovation?

Second part/

- How can this be overcome through better interorganizational collaboration?

- How does it affect your competitive advantage? (Output)
    - Do you see innovation as important?
    - What are your incentives do you have to develop innovation? (Activation trigger)

- What types of innovation have you developed internally and between organizations? (Social integration mechanism)

- (For Growspark) How do you reach these in collaboration with start-ups?
    - Agreements, ownership, investments?

- How do you implement innovations that have been developed?

- How do you spread knowledge within the organization?
    - And to future projects?

- How can strategic partnerships foster or inhibit innovation?

- What do you see as conditions for innovative business development? E.g. organizational structure, culture, methods (Absorptive capacity)

- What criteria do you use to evaluate innovation (Absorptive capacity)

- What challenges have you experienced when developing innovations together with other organizations? (Social integration mechanism)

- Do you experience resistance from partners to test new innovations?

- Can you give examples of risks involved in implementing new technology/methods/other innovation?

- What are the benefits of being leader/first developer of innovation?

- How do you build barriers of your innovations to keep competitors away?
    - Do you take patents?

- What (Internal/external) competence do you find relevant to support the innovation that you are developing? (Antecedents/Absorptive capacity)

- How does your organization acquire this competence?
    - What other organizations do you work with?

- How do you use and integrate this knowledge and competence into projects/throughout the organization?