The effects of client’s requirements on construction innovation
A case study of the new Ångström Laboratory construction project

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Abstract

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Abstract

It has often been noted that the construction sector is quite inefficient in producing innovation especially when compared with other industries (Winch, 2003). Moreover, innovation is becoming more and more a key competence in competitive environment of construction. Clients were found to play a pivotal role of clients in promoting construction innovation. However, how clients contribute to innovation is less investigated. Also, the construction project consists of a network of actors who interact with each other on different levels. These interactions affect and shape the requirements of the clients which then influence the innovation process of the construction project. It is important to take into account the several aspects of these interactions into consideration (Havenvid et al., 2016).

The aim of this study is to investigate the role of clients in driving construction innovation by studying how their requirements may generate change within the project network. The second question aims to capture the different project actors’ views and perspective on construction innovation. This is done by conducting a case study on the construction project of the New Ångström Laboratory; an academic building of Uppsala University in Sweden. The data where collected following a qualitative approach. The results were analysed using ARA model (Actors, Activities and resources) framework.

The study concludes that partnering can lead to an increase in productivity and efficiency of carrying out construction project work. The study also found that clients requirements can trigger innovation in a construction project. Another finding is that process innovation may generate greater effects on the actor’s network than product innovations and suggest focusing on process innovation to accelerate the overall innovation process.

Key words: Client, innovation, partnering, project, construction
DEDICATION

In the memory of my beloved late grandparents, Rana Muhammad Khan Manj and Iqbal Begum, who always has been an inspiration to me.

-Yasir Ali Khan
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-Muhammad Al fateh
Popular Science Summary

The construction sector is very important for a country's overall economy. But compared to other industries like transportation and finance, the construction industry has been quite inept and conventionally observed to be sluggish in adopting technological progression. This troubling reality suggests that the construction industry sector should become much better in taking advantage of the opportunities that emerge along the way. Otherwise, construction is under the serious danger of falling behind in the race for innovation. Hence, there is a great need for disrupting thinking and a fresh approach which could change the way we build in construction. At this point, the biggest challenge lies in being able to identify the opportunities that are already present in the market and implement them in construction.

This paper looks mainly into the role of clients in relation to construction innovation in a particular context as to how their relationship reinforces the innovation process. To answer this, we reviewed a single case study where we followed the empirical models as well as academic resources mannerism in addition to conducting interviews with the main actors involved in the project. In this case study, the new building of Ångström was studied. The outcomes give rationales that it is doable to come up with project solutions in collaboration while making the construction safer and more efficient with the use of technology.

Our results were analysed using the techniques and relevant models including the ARA model derived from the Business Network Approach theory. By doing the analysis using the ARA model it is found that clients can act as generators of renewal through their requirements, the renewal may involve several actors in the project network. Changes can be captured in three dimensions of Actors of the project, Resources utilized and Activities carried out in the project. Thus, findings suggest several conclusions. Firstly, a statement that clients can act as drivers for innovation and trigger renewal within project actors. Also, the study concludes that relationships between individuals and firms are very influential in relation to construction innovation. Also, concluded that changes in processes of doing the project work and how different actors interact with each other can bring benefits to the project.
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Abbreviations
UU: Uppsala University
AH: Akademiska Hus
BIM: Building information modelling
ARA: Actor, Activity, Resource
1. Introduction

This chapter presents the purpose of this research paper. It starts with a short discussion about the construction industry which is being studied and some of the circumstances in which the research was conducted. Following the presentation of the industry, comes problematization and purpose section then finally the aim of the study and the research questions are presented.

1.1. Background

Construction industry along with its related building activities form a major aspect in the prosperity and the economic development of any nation (Marceau et al., 1999; Seaden and Manseau, 2001). In Sweden, the construction industry is considered booming and together, the built environment by adding the value of different infrastructure such as roads, bridges, railways, ports, airports, adds up and makes up about half of the national wealth (Sverigesbyggindustrier, 2019). Due to the importance of construction it is quite important for the construction sector to increase efficiency and productivity where innovation can play a role. However, it has often been noted that the construction sector is quite inefficient in producing innovation. It is argued that it is not as innovative enough comparison with other industries (Winch, 2003). It is also stated that the economic well-being in the construction industry is related to innovation, by implementing the innovation in construction industry means more affluence in the construction business which ultimately drive more economic offshoot for better economic evolution (Blayse and Manley, 2004). According to early government-commissioned reports, some factors were identified as barriers to innovation, such as lack of funding in research and development, supply chain issues, as well as poor collaboration between academic entities and the construction industry (Dulaimi et al.,2002). Furthermore, it is more emphasized by Tatum (1991: 447): “At the bottom line, engineering and construction firms need to innovate to win projects and to improve the financial results of these projects. They must innovate to compete. Development and effective use of new technology can provide important competitive advantages for engineering and construction firms. These advantages stem from distinctive technical capability, improvements in operations, and image as a technically progressive company.” Within the construction industry, the companies seek to implement new technologies and designs for their materials, systems, equipment, methods and management processes.

Innovation is becoming more and more a key competence in competitive environment of construction. There are many factors that can foster or hinder construction innovation. The study by Blayse and Manley (2004) shows there are primary influences on construction innovation. Clients and manufacturers were among six key influences to the construction innovation the other five key influences were the structure of production, relationships between individuals and firms within the industry and between the industry and external parties, procurement systems, regulations and standards, and the nature and quality of organizational resources. To that end, relationships within the construction industry are considered a key factor which can enhance or
hinder the innovation. The special characteristics of the construction industry also found to play a role in shaping innovation Winch (1987). The reason why relationships are important is that they have the capability to facilitate knowledge flow through interactions between individuals and different actors within the industry. For instance, manufacturing firms and suppliers have an influence on innovation, being inventors and supplier of material, they provide creative solutions and products. This influence is then affected by the type of relationships that exist between these firms both internally and externally within the industry. This includes the relationships with the so-called “innovation brokers” such as universities and construction research institutes (Bygballe and Ingemansson, 2014). One of the main drivers for innovation within engineering projects is to increase the financial gains of these projects, which help these firms to become more competitive and win more projects (Tatum, 1991). Another key thing to remember is the special case of working in a project environment where each project stands as a unique venture. This act as a main challenge in the industry. The short-term focus on individual projects can give rise to discontinuity and loose couplings in the relationships between the actors. This affects the relationships between project participants and could also make it difficult to disseminate the knowledge gained to other projects. This could have either a positive or negative effect on the innovation process (Dubois and Gadde, 2002).

1.2. Problem and purpose

Construction industry is a network shared and formed by the contribution of different organisations. It is noted that these actors interact on multiple levels with different economic logic toward innovation (Bygballe and Jahre, 2009). Moreover, there are many factors that can influence innovation in construction projects. One of the key influences in this regard are the clients. Clients and end-users are considered key participants who can drive innovation in a construction project as they have an essential role in managing the project since the early stages. Studies show that companies are becoming more interested in building closer connections with their customers and users, which have traditionally been weak (Blayse and Manley, 2004).

The pivotal role of clients in promoting construction innovation is one of the most highlighted themes running through the literature. However, how clients contribute to innovation is less investigated. Clients claim for effectiveness in their construction projects in means of time and quality which rise the service pricing for the payers and ultimately cause more financial stress to the clients. To overcome the demand in limited constraints of time and price, clients may drag the construction industry to bring innovation into their systems. Besides this, customers are also focusing to cut down the future expenses for operational costs. Among that, environmental impacts also push the construction project teams for the development and implementation of innovation (Slaughter and Cate, 2008). However, stakeholder and project management expectations are more often conflicting with each other, stakeholder expectations are not meant always to be fulfilled (McManus, 2002). This situation is challenging for project managers to prioritize the demands of the stakeholders which are to be fulfilled in comparison to the real content of the project. It needs attention and skills to set preferences as per the demand of stakeholders, as the success of the
project is very much linked to this preference criteria, in spite the other factors of cost, time, budgeting and scope (Bourne and Walker, 2005). The construction project consists of a network of actors who interact with each other on different levels. These interactions affect and shape the requirements of the clients which then influence the innovation process of the construction project. It is important to take into account the several aspects of these interactions into consideration (Havenvid et al., 2016). In relation to construction innovation, clients and end-users are widely considered to have a great capacity to influence the firms and individuals working within construction projects positively (Barlow, 2000; Gann and Salter, 2000; Kumaraswamy and Dulaimi, 2001; Nam and Tatum, 1997; Seaden and Manseau, 2001). A modern trend of construction companies toward becoming customer-oriented leads towards exploitation through the external network, at least on the customer side. A balance in the innovation logic of the construction company is needed, in terms of the innovation orientation in exploitation or exploration, also whether to lean towards the internal or external network (Bygballe, and Ingemansson, 2014).

Therefore, it is important to look into the different factors that can affect the client’s capacity to promote innovation as well as their role in driving innovation in construction projects. Certain requirements set by clients can drive innovation in the project network in a direct or indirect way. In this paper, the authors will focus on the role of clients and end users in triggering the innovation process within construction projects as a result of their set requirements. Also, the authors will try to understand the perspective of different actors in the project network when it comes to implementing innovation. This will be done by doing a case study on a construction project of an academic building of Uppsala University in Uppsala, Sweden. Some similar studies were conducted to explore the role of clients in connection to construction innovation. For example, a study by Havenvid et al. (2016) on health care construction projects, investigated how client requirements create renewal, such as innovation and learning, in the project network. In the current case study, the authors followed the same logic but with some adjustments and different focal area i.e. educational sector to investigate the role of client’s requirements in relation to innovation. The study looked into the client’s requirements effects on bringing about innovation on an inter-project level. Among the findings in the study was that these effects relate to several dimensions of interaction and how actors relate in new ways, how resources and activities are combined and organized. The study also argues that by adopting an interactive perspective, it is possible to reveal how construction clients can contribute to the innovation process, directly and indirectly, within and across projects. Another study on the Turkish real estate industry concluded that it is the client that establishes and communicates the goals that tie up the project team members to develop and implement innovative approaches in a successful way. It is important to understand the characteristics of the construction clients that promote innovation. It is found that being a team player, promoting respect for people, and disseminating knowledge and information are considered as constituents of the championing characteristics of a client that promotes innovation in a construction project (Kulatunga et al., 2011). In another similar study, it was found that if the clients are more challenging and already experienced there will be a chance that they impact more on the innovation (Barlow, 2000).
1.3. Aim

Based on the above introduction, we believe that the project-based nature of construction work requires more case studies to be conducted to help understand the role of clients in relation to construction innovation in specific project contexts. In this thesis, the study is built upon the article of Havenvid et al. (2016) with some adjustments and modifications to investigate the clients influence on innovation in a project within the Swedish construction industry. The project is for higher education sector buildings. This research and case study are confined to the Swedish construction industry and its environment as well as the focus will be on clients including the end user’s roles in relation to construction innovation. Therefore, this leads to the following research questions, which will be subject to further empirical analysis.

RQ2) How can client’s requirements affect construction innovation in a project network?

RQ2) What views do project actors have on construction innovation in a project network?

The aim of this study is to investigate the role of clients, how they contribute in driving innovation by defining their requirements and how their requirements generate effects within the project network. The second question aims to capture the different project actors’ views on construction innovation from different perspectives. This means conducting a field investigation on both sides of the client and the end users and the main actors in the project network. The collection of data is done through semi-structured interviews, and discussions with individuals who work for key actors in the construction project as well as the project end users. Then the collected data is analysed under the light of existing literature and the theoretical framework which will be presented in this paper. Based on the findings from the analysis of the case study, the results and findings will be discussed and opportunities for future research and related study implications shall be presented at the end.
2. Literature review

This chapter covers relevant theory and debate that is connected to the purpose of this thesis and the research questions. The literature has been gathered from key sources to create a better understanding of the area under investigation. The knowledge presented in this chapter will be used to support the analysis part of the case study. In this chapter collected information is clustered in four main sections. First, the applicable definition of innovation and a typology model is presented. The second part highlights some important characteristics of the construction industry that of high relevance to construction innovation. The third part discusses key influences on construction innovation and then the final fourth part discusses the role of clients in regard to construction innovation.

2.1. Defining Innovation

It is essential to first define the subject matter being investigated in this thesis to get clarity to proceed. There is no one universal definition for innovation; it is rather diverse with respect to the concepts of studies. Going through the articles it is observed that some of them do not define the word innovation, even when the title of the article mentions this word. One possible explanation can be that few innovation studies are so complicated that it is hard for innovation scholars to agree on one definition. Among those who define innovation, there are few similarities and some differences between them. Within several definitions there is a common notion of innovation being associated with the implementation of something new and novel in relation to the unit where it is adopted. For the sake of this study we chose to use a vastly used definition of innovation extracted from Freeman (1989), also used by Koskela and Vrijhoef (2001) and Slaughter and Shimizu (2000):

“Innovation is the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change”

There are also some indirect references to the same definition by Blayse and Manley (2004) and Kumaraswamy et al. (2004). Sexton and Barrett (2003b; 2004) used a different approach where the emphasis is instead on the outcome or result of innovation, i.e., overall organizational performance must be improved. Ling (2003) further adds to this idea, that there will always be some possible risk and uncertainty attached when something new is implemented. Toole (1998:232) defines it with reference to the construction of housing:

“application of technology that is new to an organization and that significantly improves the design and construction of living space by decreasing installed cost,”
increased installed performance, and/or improving the business process, e.g., reduces lead time or increases flexibility.”

It is to be noted that innovation is distinguished from an invention as an invention could be defined as “a detailed design or model of a process or product that can clearly be distinguished as novel compared to existing arts” (Slaughter, 1998; 2000). Unlike an invention, innovation does not need to be novel with respect to existing arts but only with respect to the creating institution. Therefore, as long as something is new in relation to the implementing institution it can be considered an innovation. While innovation could be an invention, the invention can be regarded as innovation only when used. The below-mentioned figure (1) illustrates that an innovation is a result of development and implementation process of an invention by a respective organization.

![Innovation process](image)

*Figure 1 The relation between invention and innovation in the innovation process (Widén, 2002).*

2.1.1. Innovation typology

Although it is widely perceived that innovation is of rare occurrence in construction companies, in reality, it occurs in a regular manner throughout the industry sectors (Dibner and Lemer 1992; Johnson and Tatum 1993; Slaughter 1993). Construction innovation could come in various shapes. One way to classify it is either to be incremental or radical innovation. It could also be described as modular or architectural or system innovation (Slaughter, 1998). On a broader level, The Oslo Manual label the innovation within several industries as either technical or organizational where technical innovation revolves around product innovation or process innovation and organizational innovation refers to new implementation within organizational structures, management techniques and corporate strategies (Anderson and Manseau, 1999). Additionally, companies within the industry are interested in innovative technologies and designs, weather relating to materials, components, systems methods, equipment, the management or other related areas. As a result, innovation may be in a process, product or routine. “Process innovation is the introduction of advanced management techniques” (Abernathy and Utterback, 1978; Anderson and Manseau, 1999) and its counterpart product innovation is defined as “Product innovation as one which results in a qualitatively superior product from a given amount of resources” Rosenberg (1982: 4). Many theoretical models exist to describe innovation. Some of them are found to be more suitable to the nature of the construction industry. Slaughter (1998) provided the following models which are differentiated by their degree of change from current practice, and their link to other components and systems. Below are five types of innovation according to the models presented by Slaughter (1998).
Incremental and radical innovation

They represent the two ends of the innovation spectrum models. Incremental innovation is small changes based on current expertise and knowledge where radical innovation is a breakthrough in science or technology that changes the nature of the industry (Marquis, 1969). When the innovation is incremental, impacts are expected and negligible wherein radical innovation a big disruption normally takes place in the characteristics of the industry. Old linkages and interactions become irrelevant to existing systems and organizational ties (Nelson and Winter, 1977; Dosi, 1982).

Modular and architectural innovation

This is a way to distinguish innovation based on the area of change especially in the interactions with other components or systems. Modular innovation entails a big change in a component but makes no significant change in the links with other components. Architectural innovation conversely involves a small change within a component but leave a noticeable change in the links of the system (Henderson and Clark, 1990). This distinction is of importance to understand the implementation process of the innovation. Especially in dealing with affected parties within and outside an organization (Afuah and Bahram, 1995).

System innovation

System innovation is recognized by the integration of various independent innovations that must act together to perform new functions or enhance the performance of the facility as a whole (Cainarca et al., 1989). System innovation is prevalent within the construction industry (Hutcheson et al., 1996; Kangari and Miyatake, 1997). The five types of models could be represented according to the degree of change in the below figure (2).

Figure 2 Innovation models for construction (Slaughter, 2000).

An example of incremental innovation is a full body safety harness to prevent workers from falling. Which is an incremental improvement over the waist level safety belts (Korman, 1997). One radical innovation in the construction industry was the introduction of structural steel a hundred
years ago. It changed the type of buildings that could be designed and constructed (Elliot, 1994). As an example of a modular innovation we can look at the machines that tie the reinforcing bar’s wires for cast-in-place operation automatically (Talon, 1996). One recent architectural innovation is the self-compacting concrete (Okamura et al., 1995) which eliminate the vibrational stage of placing the concrete. As for system innovation, a recent innovation is the zone module construction method for large power plans that run with coal (Zone, 1996) which eliminate on site activities for the placement of building components.

2.2. Characterizing the construction industry

Walker (2016) argues that effective innovation requires a deep understanding of the context surrounding the innovation taking place and what type of implications could happen as a result of its adaptation. There is a perpetual need to minimize undesired consequences after introducing changes. Also, how to replicate innovation to create sustainable value for the firms and enterprises depend on understanding these contexts. Furthermore, it is noted that the advancement of technologies and the means by which data is shared and analysed add to the complexities of these contexts where innovations come about. This is why in order to understand how the construction industry behaves in relation to innovation, we find it important to look into the way construction activities and actors are organized.

2.2.1. Complexity factors

Many previous studies suggest that the construction industry is characterized by some complexity factors related to industry-specific uncertainties and interdependencies as well as the inefficiency of operations. These underlying characteristics, shape and affect how the industry operate and perform. For example, Winch (1987) argues that construction projects are among the most complex jobs ever. A study form Gidado (1996) argue that complexity within the industry stems from a number of sources: Resources employed; the environment of construction work; the level of scientific knowledge required and the number of interactions of different parts of the workflow. Two categories were distinguished, the first one is connected with uncertainties related to the tasks originate from the resources employed. The second category comes from the interdependence among tasks represent sources of complexity that stem from bringing different parts together to form a workflow. Moreover, there are four causes of uncertainties in the undertaking of individual tasks. The causes are (1) unfamiliarity of management with local environment and resources; (2) lack of complete activities specification at the construction site; (3) lack of uniformity of work, materials and teams with regard to location and time; (4) unpredictability of the environment. Additionally, three factors of complexity associated with operational interdependencies were appointed: (1) the number of technologies and their interdependencies; (2) the rigidity of sequence of different operations; (3) overlapping of stages and elements of construction. These conditions
arise from two characteristics of the industry. The first is “the organization of production force into a variety of trades” and the second is “the practice of subcontracting portions of the project to special trade contractors by primary contractors”. These characteristics were distinguished by Eccles (1981).

Additionally, compared to other industries, a number of authors have held arguments that the construction industry has failed to adopt acknowledged techniques that have helped other industries to improve their performances. Example of these techniques is just-in-time (Low and Mok, 1999), partnering with suppliers (Cox, 1996), total quality management (Shammas-Thoma et al., 1998), supply chain management (Vrijhoef and Koskela, 2000) and industrialization of manufacturing processes (Gann, 1996). Correspondingly, it appears that there is a common view among many authors that the construction industry would benefit from altering its behaviour in accordance with the norms of other industries. But at the same time, by taking under consideration the particularities of complexities that exist within the construction industry was pointed in earlier studies (Winch, 1987; Gidado, 1996), it might not be a good idea to immediately apply management techniques from other industries to the construction industry which work with different logic of operation and context (Dubois and Gadde, 2002).

2.2.2. Project-based work environment

It has been noted that construction is about practising project-based activities on-site to manage specialized tasks and activities (Cox and Thompson, 1997; Shirazi, Langford and Rowlinson, 1996). In supplement to this, the overlapping of stages and rigidity of workflow make coordination difficult.

Another prevailing feature is that strong focus on individual projects advocates for narrow perspective in both time and scope. Besides this, competitive tendering lead actors to the perception that subcontracting will be carried out at the lowest possible cost (Cox and Thompson, 1997). This factor here further strengthens the need for standardization on construction works. Another important peculiarity within the construction industry is that the role of firms can vary between projects as the scope of activities can get very broad with various combinations. As a result, the division of labour among other parties and the role of the individual firm can differ considerably (Dubois and Gadde, 2002). Competitive tendering plays a role in setting the conditions for business relationships between parties. These relationships are found to be characterized depending on market-based and short-term interactions and cooperation between independent businesses (Gann, 1996). Thompson et al. (1998) confirm that market-based interaction is the norm and further concluded that firms traditionally gave very little regard to relational elements of business transactions.
2.2.3. Organizational relationships and fragmentation of networks

According to observations made by Dubois and Gadde (2002), they suggest that the whole industry be regarded as a “loosely coupled system” in terms of activities, resources, and actors that constitute it. Any location in an organization contains interdependent elements that differ in the number and strength of their interdependencies (Orton and Weick, 1990). For instance, industrial activities are usually interdependent with other activities. Depending on the variables these activities, elements or systems share, they could be defined as ‘tight’ or ‘loose’ couplings (Houten and Aldrich, 1980). Loose coupled may occur among various dimensions: individuals, organizations, subunits, hierarchical levels, actions, etc. Loose coupling can provide adjustability to localized adaptation for the system. It provides a sensing mechanism that helps to understand the environment and let actors deals with obstacles in a number of ways that encourage variety and innovation (Weick, 1976). A pattern for couplings was observed as it evolves into two interdependent layers, the first is tight couplings in the individual projects and the second one is loose one on the permanent adaptation of collective work within the network. It has been argued that working on a short-term perspective does not favor innovation and technical developments (Dubois and Gadde, 2002).

Looking at how the organization of activities and actors is fragmented across both time and space, the industry is treated as a special case (Bresnen and Marshall, 2001; Harty, 2008). How the firms are keen towards innovation depends upon the adoption of the techniques they use to grasp the benefits. Different organizations benefit themselves with the spurring knowledge of innovation by hooking up with each other for more vivid and refined knowledge (Millar et al., 1997). Moreover, researchers are also showing the positive attributes towards the relationships and their bondage strengths have a conclusive impact on the development and prosperity of innovation. Hence, sharing of knowledge by means of informal networks have also a significant role by making the adoption more effective (Bossink, 2004; Frambach and Schillewaert, 2002).

2.3. Drivers, barriers and key influences on construction innovation

There are many factors that can foster or hinder construction innovation. A study by Blayse and Manley shows there are primary influences on construction innovation. Clients and manufacturers were among six key influences to the construction innovation the other five key influences were the structure of production, relationships between individuals and firms within the industry and between the industry and external parties, procurement systems, regulations and standards, and the nature and quality of organizational resources (Blayse and Manley, 2004). To that end, relationships within the construction industry are considered a key factor which can enhance or hinder the innovation. The reason why they are important is that they have the capability to facilitate knowledge flow through interactions between individuals and different actors within the industry. Demands of the clients changes to cope with new pressing trends and needs and will not remain stagnant. Construction parameters will also be changed in terms of materials and methods.
The construction industry needs to be dynamic in order to keep pace with the changes that the world is constantly facing (Aouad, Ozorhon, and Abbott, 2010). Environmental impacts also push the construction project teams for the development and implementation of the innovation (Slaughter and Cate, 2008). As the competition is increasing, the firms within the construction sector try their best to introduce innovation by pursuing the most adequate approaches so that it can help them to succeed in getting a good market share. The benefits of construction innovation are also well emphasized by quantitative type of studies regarding the increased productivity stimulated by innovation as well as how the environment is being facilitated to customer satisfaction (Ozorhon et al., 2016). It was also acknowledged in the above-referred research that another thing is still lacking in the industry which is the advancement in the technology techniques, and that there is still a need for more innovation to escalate the productivity (Gann, 2000) and to enhance the profit ratio (Tatum, 1991). Researchers however also figured out some barriers to innovation in construction (Blayse and Manley, 2004; Davidson, 2013; Suprun and Stewart, 2015). These barriers have been in specific relation to the typical sort of complex of having unique models for construction projects in multi-firm production (Jones et al., 2016).

There are other barriers which seem to hinder innovation. Innovation is a process which demands financial investments as well as dedication so the changes in the organizations and processes can bring benefits. These changes can then be innovative. In product and process innovation scenario some of the relevant issues noticed repeatedly is that some employees were being hesitant to adopt the change while some are worried because of increased costs (Brandon and Lu, 2008).

2.4. The influence of clients on construction innovation

According to Hartmann et al. (2008), clients could be described as the actors who ‘initiate, commission, and pay for a construction project’ and the actors who ‘formulate and communicate the requirements of a construction project to be accomplished for the intended usage of the facility’. Thus, a client can be the owner of the facility and/or the end-user who will be a tenant in the facility. When it comes to laying conditions for construction innovation, some actors play more integral roles than others, particularly clients have been identified as more prominent in provoking change (Blayse and Manley, 2004; Hartmann et al., 2008). The reasons for this could be traced to certain factors. Chens and Bryant (1984: 177) argue that construction industry researchers tend to oversimplify the role of the client in the construction management process. Since then, a number of studies have addressed the clients’ role in driving innovation (Nam and Tatum, 1997; Gann, 2000; Briscoe et al., 2004; Ivory, 2005; Manley, 2006; Brandon and Lu, 2008; Hartmann et al., 2008; Harty, 2008; Håkansson and Ingemansson, 2013). In relation to construction innovation, clients and end users are widely considered to have a great capacity to influence the firms and individuals working within construction projects positively (Barlow, 2000; Gann and Salter, 2000; Kamaraswamy and Dulaimi, 2001; Nam and Tatum, 1997; Seaden and Manseau, 2001). Moreover, clients have also been identified as likely to trigger innovative behaviour among other project actors within the inter-organizational network (e.g. Winch, 1998; Håkansson and Ingemansson, 2013). To overcome the demand in limited constraints of time and price, clients are pushing the various actors in the construction network to bring innovation into their systems. Besides this, customers are also focusing to cut down the future expenses for operational costs.
Clients set the requirements and specifications for the projects which steer their outcomes (Kometa et al., 1994; Gann and Salter, 2000; Newcombe, 2003). More to that, studies show that companies are becoming more interested in building closer connections with their customers and users, which have traditionally been weak (Blayse and Manley, 2004).

3. Theoretical Framework

The aim of this chapter is to present a relevant theoretical framework for the study. It is divided into two main parts, first, we provide definitions to the terms of client and renewal. Second, we present the actors, resources, and activities model (ARA model) (Håkansson and Snehota, 1995), which will be used in the analysis of the data.

Using a theoretical framework sets a limit on the scope of the relevant data by focusing on specific variables and define the specific viewpoint [the framework] that we will take in analysing and interpreting the gathered empirical data. It also facilitates the understanding of concepts and variables according to given definitions and in building new knowledge by validating or challenging the theory.

3.1. Defining clients in the construction industry

In the previous chapter, we presented a widely accepted definition of innovation and provided examples of different types of innovation in the construction industry. We find it suitable to present a definition for the client, as our study analysis will revolve around clients in the construction industry. Hartmann et al. (2008: 437) describe clients as:

(1) The actors who ‘initiate, commission, and pay for a construction project’ and

(2) The actors who ‘formulate and communicate the requirements of a construction project to be accomplished for the intended usage of the facility’.

Hence, a client in a construction project can be the owner of the facility and/or the end-user who will live, work or administer the facility.

3.2. Renewal in construction projects

Another important concept that is related to the study is the concept of Renewal in the construction industry. It has been argued that innovation in construction needs to be studied and understood from the standpoint of the organizational complexity that this industry represents (Slaughter, 1998; 2000). When studying innovation in construction projects there thus appears to be a need for studies that take an inter-organizational perspective on the innovative effects of client requirements.
as well as the relations between projects over time. In tracing such effects, a definition of innovation that includes the interactive nature of implementing change and that will allow investigating innovation, as well as the changes that are associated with it, and the influence on the involved parties, such as substantial learning. Such changes are referred to as renewal by (Håkansson and Ingemansson, 2013; Havenvi et al., 2016). As the concept of renewal may be any adjustment that have a similar effect to an innovation, we will use this term interchangeably with the term innovation. The scope of the study in this paper focus on the inter-organizational network of the focal project only.

3.3. The industrial network approach

The Industrial Marketing and Purchasing (IMP) network approach, also known as business network approach has gained recognition and been practised by researchers in business to business for decades. In a business network of actors, an industrial network perspective puts emphasis on inter-organizational interplay and firms are viewed as not only relating to each other occasionally but also through continuous interaction processes in which they adopt with each other (Håkansson, 1982; Håkansson and Snehota, 1995). No firm can manage all the resources and activities necessary to operate its business; instead, firms are dependent on interacting with other organizations (Gadde et al., 2003; Håkansson et al., 2009). Consequently, this makes interaction a central activity for firms and relationships with other organizations’ crucial resources (Håkansson, 1982). Through interaction, firms are able to relate and access activities and resources to those of others. The model also points to the interaction between two firms being able to be interconnected to other actor constellations in various ways (e.g. Håkansson and Snehota, 1995). This approach and insight to business networks have been conceptualized into the ARA model (Håkansson, 1987) which specifies three dimensions (or network layers) through which organizations can interact: activities, resources, and actors (see Figure 3).

![Figure 3 Network model Håkansson (1987:17)]
**Actors** are essentially humans and can be individuals or a collective of groups, departments, organisations, or networks of organisations. **Resources** can be tangible or intangible, stable or unstable, valuable or worthless depending on their configuration. **Activities** can be of any kind and can take place at any level from the individual to the organisational network. Actors have control over some resources, access to others and work with other actors to create combine, develop, exchange or destroy resources (Gebert Persson et al., 2014). Actors can be referred to as, for example, companies or organizations that control technical or organizational resources, such as competence and expertise, products and production facilities, by which activities, such as planning, logistics and production, are performed.

### 3.4. Understanding innovation with the industrial network approach

The model provides a possibility to reveal how the three dimensions of actors, activities and resources are linked to each other. This means that the actors, resources and activities are embedded in a larger network, not only involving binary and direct relationships but also involving other actors such as the customers’ customer or the suppliers’ supplier. Actors can be referred to as, for example, companies or organizations that control technical or organizational resources, such as competence and expertise, products and production facilities, by which activities, such as planning, logistics and production, are performed. It proposed that the three entities, actors, resources and activities captured the key aspects of relationships, both between firms, as in B2B relationships, but also within firms at all levels down to the relationships among individuals. As stated in Håkansson and Ingemansson (2013), and Havénvid et al. (2016), the connection between activities, resources and actors across the organizational borders of firms provides an opportunity to investigate change, such as innovation, in a specific way. Any large change that is introduced, such as substantial learning and a novel product, will not only affect the individual firm but also other parties. This means that such changes have to bring some renewal effect on the way these actors are related to each other, the resources they combine and the activities they coordinate in between. Here, renewal is a concept that covers changes in terms of both innovations and any adjustment that have a similar effect to an innovation (Håkansson and Ingemansson, 2013). Innovation as per Slaughter (2000) can be a product, process, or system that is novel to the company developing or using it, therefore, any change resembling an innovation would involve alterations from an industrial network perspective in the way parties in the network relate to each other, how resources are combined and activities coordinated in relation to each other.
3.5. Acknowledgement of the practicality of the ARA model

The ARA model represented a major step forward in terms of conceptualising B2B relationships and networks. Those ideas have targeted the interrelatedness among firms in business-to-business settings. Models such as the interaction model (Håkansson, 1982) and the ARA-framework (Håkansson and Snehota, 1995) have been developed to characterize and analyse dyadic relationships and networks (Gebert Persson et al., 2014). By adopting an inter-organizational framework of actors, resources and activities (the ARA model), it is possible to identify a variety of effects. The interactive perspective helps to reveal how construction clients can contribute to renewal such as innovation and learning, directly and indirectly, within a project. The model represents a specific analytical tool that can also be modified to fit the type of analysis required in a study. From the perspective of the ARA model, it is regarded that each element plays an important role in the analysis of the network, and all of these three layers have strong connection and relation with each other. Accordingly, there are two ways to look at what the analysis of network reveals, that is, we can look at what the analysis of each dimension reveals and also what the analysis of the whole network reveal by combining these three dimensions. By addressing three dimensions of inter-organizational interaction, the framework allows a variety of effects of implementing change to be revealed. Moreover, the model also allows for an investigation of how these dimensions are interrelated, i.e. how changes in the interaction between actors affect activities and resources, and vice versa. Finally, it addresses the interconnectedness of interaction on several levels, i.e. that the interaction between two actors can affect several related actors within and across projects. Thus, we can argue that using an inter-organizational approach and, in particular, the Industrial Network Approach (see, e.g. Håkansson et al., 2009) would be useful in understanding and analysing our case and research questions.

4. Method

In this chapter, we discuss about the specific method adopted to investigate the research questions. And also explain the reasons for choosing the particular approach that is used with the expected outcomes, advantages and disadvantages of the applied methods.

4.1. Modus Operandi

As presented in this paper earlier, the proposed research questions are to investigate the effect of clients’ requirements in relation to innovation on a project network of actors as well as capturing their insight on construction innovation. To investigate these questions, there is a need to have a deep insight into the matter, therefore the case project of “Ångström new building House 9 and 10” are taken into sight as a group’s focus, conducted, implemented and executed by organization of NCC construction, and its interaction with other actors, Akademiska Hus (landlord) and UU
(tenants), their performed activities and how they are dealing with the resources. The focus is notioned around the innovation, so the appropriate and suggested methodology to apply in this study is deemed to be Qualitative research approach. The intention is pursued in particular in the field of innovation therefore the appropriate and suggested methodology exercised to apply in this study is Qualitative research approach. Qualitative research methodology has the characteristics which enhance its expression to make it deal with specific events and relevant patterns which unfold with time. While on the other side quantitative methods are more applied when to deal with static data. For this specific study the need is to understand the organizational behaviours and their interaction with other actors to unfold the realities of the question for which we are cultivating for. That is why we consider qualitative research method is most appropriate and suitable for this study (Bryman and Bell, 2011).

Furthermore, while discussing the differences between qualitative and quantitative research methodologies as it replicates from the name, quantitative study is more to do with number of words (lexis) when we have the static data whereas qualitative strategy deals with the scenarios when we have the dynamic data (Bryman and Bell, 2011). Here we have the argument that to understand the structure of organization and its interactions with different actors and to reach the roots of innovation lying underneath, qualitative is the most appropriate and admired method to answer the research questions.

In order to seek how client’s requirements can influence the innovation in complex organizational settings like the construction industry, we follow the case study approach (Yin, 1984). This study involves the expansion of already existing Ångström Laboratory part of UU, carried out by raising two new buildings designated as House 9 and House 10. In order to trace the effects, we find it suitable to employ the ARA model in specified way by developing a framework to make it possible to discern the effects between the actors, how the resources are associated during different interfaces between the actors as well as the activities performed and coordinated. This model contributed a lot to understand and to investigate how these three dimensions coordinated and inter-linked to each other i.e. how the interactions between different actors bring out effects to the activities, resources, actors and vice versa which holistically refer to innovation (Havenvid et al., 2016). Many scholars have preferred the case study approach to find out the dynamic interactions between the different actors in the industrial sector brackets (Halinen and Törnroos, 2005; Easton, 2010).

**4.2. Semi-structured interviews**

In qualitative research, (Bryman and Bell, 2011) states that the public dialoguing and conducting interviews is the most accepted approach. There are two types of structures being used for interviewing in qualitative method i.e. semi-structured interview approach and unstructured interview method (Bryman and Bell, 2011)

In this case study, we performed the semi-structured interview approach for that we made a list of suitable questions with context to the topic we were supposed to cover the attributes, as a guideline
to the interviewer. The quality of this technique is that the interviewee has enough space how he/she wants to reply, while the interviewer has also leverage to exempt the defined pattern for the questions. The discussion could possibly raise more questions that are not being part of the guideline can also be sorted out. Every interviewee preferably asks almost the same questions in accordance with interviewee to interviewee (Bryman, 2011: 467). Flexibility in the semi-structured interview technique was also endorsed by Prasad, she writes that ‘there was no one set of questions administered to all interviewees and no specific sequencing of the issues raised’ (1993: 1408).

As explained above, the primary data of this paper was collected by the help of semi-structured interviews conducted with the different individuals, project managers, deputy project managers, site managers, consultants, project architectures from three major actors NCC, AH and UU to retrieve a calibre first hand knowledge and information that stand highly beneficial for the quality and voraciousness of the project. In total, 8 individuals were interviewed collectively from the above-mentioned project actors. The semi-structured interviews (Hesse-Biber and Leavy, 2011) were designed in such a way to investigate the innovation and its views, client and contractor relationships. Moreover, the interview guide was also developed to investigate the role of actors to trigger innovation in technology as well as system. Interviews conducted from the NCC as well as architects were held at the construction site and for individuals from UU and AH at their respective workplaces.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Interviewee’s role</th>
<th>date</th>
<th>duration</th>
<th>Interviewee’s reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC</td>
<td>Assistant project manager</td>
<td>10th July, 2019</td>
<td>01:24:26</td>
<td>Interviewee A</td>
</tr>
<tr>
<td>UU</td>
<td>End user</td>
<td>15th August, 2019</td>
<td>01:39:03</td>
<td>Interviewee B</td>
</tr>
<tr>
<td>AH</td>
<td>Project Manager</td>
<td>16th August, 2019</td>
<td>01:49:36</td>
<td>Interviewee C</td>
</tr>
<tr>
<td>UU</td>
<td>Deputy head of building division, Former project leader at the start of a project</td>
<td>15th August, 2019</td>
<td>01:32:02</td>
<td>Interviewee D</td>
</tr>
<tr>
<td>UU</td>
<td>Project Manager</td>
<td>15th August, 2019</td>
<td>01:32:02</td>
<td>Interviewee E</td>
</tr>
<tr>
<td>PROJEKTIDÉ</td>
<td>Consultant, Quality control certification</td>
<td>21st August, 2019</td>
<td>01:53:08</td>
<td>Interviewee F</td>
</tr>
<tr>
<td>PE Teknik and Arkitektur AB</td>
<td>General consultant architect and Project architect</td>
<td>29th August, 2019</td>
<td>01:43:12</td>
<td>Interviewee G</td>
</tr>
<tr>
<td>NCC</td>
<td>Site Manager</td>
<td>28th August, 2019</td>
<td>02:02:24</td>
<td>Interviewee H</td>
</tr>
</tbody>
</table>

*Table 1 List of interviewees*
4.2.1. Abductive reasoning

While conducting a qualitative research, as Jonker and Pennink (2010) argued that the qualitative research is having the fact that it carried out by the open questions and these questions are further developed during the research process, where as in project, both open and semi-opened approach has been exercised. As we go deep into the research, the meaning and periphery become vivid and definite, and this process in which the boundaries become more explicit are the outcome of the empirical cycle which is based on empirical standards.

Abductive reasoning normally begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the course. It also yields the kind of daily decision-making that does its best with the information at hand, which, in cases often is incomplete. It refers to use the conclusion and the rule to assume that the precondition could explain the conclusion, (Douglas, 2005). While conducting a qualitative research, as Jonker and Pennink (2010) argued that the qualitative research is having the fact that it carried out by the open questions and these questions are further developed during the research process, where as in project, both open and semi-opened approach has been exercised. As we go deep into the research, the meaning and periphery become vivid and definite, and this process in which the boundaries become more explicit are the outcome of the empirical cycle which is based on empirical standards.

Following the above theory, we argue that, for this case study where the space for innovation be sought out in a process that gives a conclusion and to propose new solutions, abductive approach is appropriate method to carry out and execute. The notion is extracted with observations what has led to conclusions and main rule that has been followed in the previous applications in the innovation processes. After the first interview being conducted, more deeper insights were gained regarding the organization as well as the problem which is supposed to be the base for research. So, by following this process of abductive, iteration and research we believe that the results of this case study by following the research question resulted from the abductive reasoning projected towards the most important factors to implement in process and besides that fulfil the expectations by generating the knowledge regarding the organizations involved.

4.3. Reliability and Validity in Qualitative Research

In this part of the thesis, the reliability and validity will be discussed regarding qualitative research. Before going deeper into it, it’s essential to first have a comprehensive understanding of qualitative research. Furthermore, how reliability and validity can be tested in qualitative research. How the definitions change when the paradigm shifts from quantitative research to qualitative research.

4.3.1. Qualitative Research

In qualitative research, the researcher focuses on a specific context related situation, in which there is no manipulation in the situation of interest (Patton, 2001: 39). Specifically speaking, qualitative research is defined as "any kind of research that produces findings not arrived at by means of
statistical procedures or other means of quantification” (Strauss and Corbin, 1990: 17). Rather it is a kind of research in which real-world situations dictates the results, where the situation of interest reveals naturally (Patton, 2001: 39). Qualitative research investigates illumination, understanding, and extrapolation to similar situations (Hoepfl, 1997).

The result of qualitative examination produces a different kind of information as compared with the quantitative examination. The key factor lies in when one approach examines the underlying philosophical manipulation with details while others rely on the compatibility of employed research methods (Glesne and Peshkin, 1992: 8). Furthermore, it’s stated that (Winter, 2000) in quantitative research the connection between the researcher and the possible research method is bleak, where researcher tries to stay away from research method. But in qualitative research, the connection exists, and the researcher holds on to the involvement of research methods. So, in this case study the authors adopted qualitative research techniques to draw out the results from the real situations happening with in the project, by applying different parameters of the qualitative research.

4.3.2. Reliability in Qualitative Research

Reliability is a term which is mostly associated with quantitative research for testing and evaluation. If the concept of testing is applied to qualitative research, it can be translated in terms of quality. The goal of a good qualitative study is to make understanding of the situations easier which are inherently confusing and complicated (Eisner, 1991: 58). The objective of reliability is to make qualitative research produce understanding (Stenbacka, 2001: 551). It is believed by Stenbacka (2001) that the introduction of the notion of reliability in qualitative research is irrelevant or can be even distorting and lead to the discrediting of research.

On the contrary, Patton (2001) believes that every researcher of qualitative study should include reliability and validity while planning their analysis and studying the results. This caters to the persuasion of a researcher by influencing the readers that the research findings are worthy of their attention (Lincoln and Guba, 1985: 290).

As reliability is about the repetition of the research. It is also stated that in qualitative validity is difficult to achieve as with time the social environment will be changed and characters will be replaced (Bryman and Bell, 2011). As in this case study because of the uniqueness of the project, maybe it could be not possible to study the same project because the respondent's answers will possibly not be able to achieve but the methodology could be used again to interpret the results.

4.3.3. Validity in Qualitative Research

In qualitative studies, the concept of validity is defined by different terms. As this concept is not accepted universally all over even have a single concept or fixed one. As (Winter, 2000: 1) describes that validity is “rather a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects”. Well, there is also an argument from some researchers that in qualitative research the term validity is not germane but at the same time,
there was a realization that there could be some parameter to measure their research standards (Golafshani, 2003). For example, Creswell and Miller (2000) suggested that validity have an influence which depends upon researchers approach of validity in their study and they approach the research paradigm. This approach ultimately results to ponder the researchers to develop their own concepts with more appropriate terms for their study such as quality, rigour and trustworthiness (Davies and Dodd, 2002; Lincoln and Guba, 1985; Seale, 1999; Stenbacka, 2001).

Furthermore, it was suggested that if the issues of “reliability, validity, trustworthiness, quality and rigor” is to differentiate “good” from “bad” research and then by testing to improve the quality of research to enhance the “reliability, validity, trustworthiness, quality and rigour” it would definitely important and beneficial for any research paradigm (Golafshani, 2003).

In this research study the external validity is low, hence the conclusions are drawn from it could not be generalized as the case depends upon a specific case with the defined parameters. While on the other hand we believed that the internal validity also termed as the casualty of the research is high. As the conclusions are drawn were made by using the qualitative approach and by doing the interviews with the persons who are much involved in the project and have a deep insight.

4.4. Qualitative research is intuitive

There is criticism viewed by the quantitative research followers that qualitative is evocative and conquered by subjectivism. This criticism entails because the findings carried out by qualitative research are evolving around the unsystematic cum random views that what matters and appeals to them. Qualitative research and its unstructured nature cause subjectivism subtle with the leaning and the influence of the researcher. Another aspect which creates subjectivism is the close relationship with the researcher and the person being researched with. Qualitative study systemizes in a way that it begins relatively with open-ended and leads gradually to narrowing the problem or research question. Research formulates writing derivations which furthermore hint out the clues that why specifically this area rather than the formulation of another (Bryman, 2011: 408). Qualitative mode allows the researcher to have open world argumentations, comments and ideas, which connects to brain-storming, help narrowing down the line of inquiry and increase the possibility of variety of results to solve problems holistically. Public poll survey-based solution is considered important for the outcomes and closure.

4.4.1. Difficult to replicate

Another major critique destined to qualitative research is difficult to replicate the qualitative study. As it depends upon the ingenuity of specific person going to be researched out, which make it still more difficult to replicate as there are not as many standards to be followed out. As it relies totally on the researcher, what he observes, heard and how he replicates and moreover result based upon the person being investigated how his/her interests are found and what he wants to show off (Bryman 1994; Bryman, 2011: 408). The approach can lead to numbers of prospects, when
accumulated, make easier to converge the frequent problems. Many individuals have been interviewed with different backgrounds with different views, to extract out a much clearer notion.

4.4.2. Problems of generalization

It is also concluded from the suggestions that outcomes of qualitative research are also restrained. Conclusions from the qualitative research are not generalized to all the scenarios. In participant observation and or as well for the unstructured interviews are conducted with the individual or with the small group of people sampled out from the organizations, NCC, UU and AH are the focused organizations of the study.

Innovation providers need to identify that the above-mentioned parties gating and advancing the innovation as well as their underlying motivations. They need to guarantee enough interaction between themselves and the actors and among the actors to leverage the positive momentum to overcome the resistance towards innovation. The construction industry is overall deemed huge and typically carries high business portfolios around the world. As the NCC, one of the giants in their own paradigm in Sweden based construction industry with its deep roots around the world is one of the major actors in this project with the two other main actors NCC (landlord) and UU (tenants). Apart from creative designing and high tech sustainable-technological applications, the shaping of framework conditions is derived in a way that ideas were always created in the company and implemented into successful innovations. The focus here is on organizational development activities. The management approaches lead to actual innovation, active search, development and implementation of ideas. Every organization and the community have different scenarios so by selecting an organization and further carry out the research with the individual cannot be generalized to all of the phenomena. Neither the Case study considered to be the sample picked out from the populace nor the who are interviewed in the qualitative is the representative on behalf of the rest of the population. Rather than that, a sophisticated act is that the outcome of the qualitative research is generalized to theory instead of the population (Bryman, 2011: 408).

4.5. Bias

It is observed that selection bias is very common, and in some cases, it can be a severe problem according to (Collier and Mahoney, 1996). There is a concept of “challenge”, which makes bias obvious to researchers. Challenge can be explained as a conflict that arises between the new information and the old interpretations. The intersubjective understanding is extortionately improved within the group members due to the inclusion of challenges, and it is indispensable when presenting to the outsiders. Especially, when there is incoherence in the date of analysis, the intersubjective understanding makes it possible to remove conflict and make it coherent. (Michrina and Richards, 1996: Ch. 1)
Another cause of bias to arise is when the major causal effects in an investigation of a case study are somehow under estimated by the author. On the contrary, there also exists the possibility of overestimation of the significance of the explanations revealed within a case study (Collier and Mahoney, 1996: 72). The thesis is a small contribution and a desired step towards the management world in the domain of innovation. The new information and old interpretations are classified and applied in unified way yet discriminated. The risk and probability of biasness is maintained, especially when dealing with systemic phenomenon or natural occurrences but challenges to advance the process without any favouritism is fully embraced.

During the interview session it was made sure that there was no intervene of different factors which enhanced the factor of biasness. Some of the examples are mentioned below.

**Social desirability bias** that the question and answer from the respondents are pretend in a way that it seems or hints that this will be appreciated and liked. (Kaminska and Foulsham, 2016). The approach helped interviewers to get the popular vote what could be seen as a collective problem and what to focus upon to solve the issues but has taken majors to keep the process neutral. The attention has been given to factors as not to generalize what is liked or demanded. Inclusivity is considered in the project so do the cross questioning and brainstorming for other various possibilities to mitigate the biasness.

**Leading questions and wording bias** as replicates from the name, elaborating the answers and putting your words in the respondent’s mouth leads towards the biasness. To avoid this, we make sure not to summarize the respondents, response in our own assumption and even not take what the respondent said further (Quirks.com, 2019). The project has been based on an open poll, so respondents’ genuine views and comments are deemed highly important and has been carried out. To mitigate the biasness, an impartial conversation with further discussions is embraced.

### 4.6. Ethical Consideration

Maintenance of the quality of the research which is additionally morally satisfactory should be ensured by the researcher. It means to stay within the boundary of global ethical norms, following customary national rules and laws, and obeying the guidelines associated with the field of research. (CODEX, 2015).

The researchers, also, have followed Diener and Crandall (1978) breakdown approach for the research about ethics principles which is ramified into four main areas.

Diener and Crandall (1978) breakdown the research ethics principles into four main areas.

- Regarding the *harm to participants*
- Regarding the *lack of informed consent*
- *Regarding that there is an invasion of privacy*
- *About the deception factor, whether involved or not*
As by Academy of Management code (AoM) of *ethical conduct*, it is mentioned clearly about the responsibility of the researcher to give full attention to the person who is being researched. It is necessary to make sure that the possibility of harm should be minimized. Market research society MRS’s also emphasize and even step forward as per AoM that it should be the responsibility of the researcher to make sure that the participant would not get any adverse effect directly from the research and even after. (p. 128)

For the project, the factor of anonymity is also valued, considered and discussed with the research participants with the factor to prioritize their wish and willingness as they demand. It has been an imperative for the researchers that the participants would not have any issues and concerns rather they should be anonymous, or their name could be revealed is honoured the same way as they want. Moreover, while before the interview started it was also made clear that the information would be used purely for the research purpose.

The principle of *lack of informed consent* is also employed in this research project. Nothing was hidden from the research participants. Before the interview everything was made clear to avoid any type of ambiguity. We exposed our identity; covert observation was fully ignored after their willingness; consent interview was conducted. The recordings which were made during the interview sections were informed prior as suggested by MoS *code of conduct* (p. 133)

*The MRS guidance for invasion of privacy is clear: ‘the objectives of any study do not give researchers a special right to intrude on a respondent’s privacy nor to abandon normal respect for an individual’s values’*. The principle is simultaneously exercised in this research study, also this guidance is kept in mind on every strep and with all the interviewees during research. There was sheer liberty regarding the questions given to the participants who want to ignore any specific questions whatever so reasons, they have for that to not reveal publicly.

Therefore, the moral principles and code of conduct has been applied while dialoguing and interviewing the people, have made it happened in a controlled non-disputed environment. The quality of research and its acknowledgement is true and retrieved, excerpted and taken from academic and professional sources. Global rules and laws are taken into consideration as an indispensable act to follow when performing required steps during the process. The discipline has fully worn by the researchers obeying the guidelines related to the field and its rudiments.
5. The case

In this chapter, we present the case studied and the focal project that is associated with it. The chapter also presents the different types of relevant data that were collected in the study. The chapter consists of four parts. First, we present a background to the focal construction project which we studied and the context in which the project is conducted, i.e. its initiation, objectives and expected outcomes. In the second part, we provide a description of the network of the main actors who are involved in the project. The third part of this chapter is dedicated to present 4 cases of innovations/new ways of organising construction in the project that were found through the conducting the empirical study. These areas illustrate the innovative aspects of the project which may as well generate various effects within the project network on various levels and the way the project is conducted. In the final fourth part we present how different project actors view construction innovation and related aspects. In the following chapters, the effect of these cases will be analysed and discussed with respect to the research questions.

5.1. Project background

Uppsala University (UU) is Sweden's first university, with history goes far back to the 15th century. It was founded as early as 1477. It is a broad research university with goals to conduct research and education of the highest quality and to collaborate with the surrounding community to contribute to a better world. The university has strategic plans to strengthen its position as a leading university in the world. Hence it seeks to continuously develop the academic environments to attract the foremost researchers and students. The University wants to serve as a meeting place for excellent research and education and a creative hub for local, regional and global development. Part of the educational facilities of the university is Polacksbacken which is a campus area of the university located 3 km south of Uppsala centre. At Polacksbacken, front line research is conducted in physics, information technology, chemistry, mathematics and material science. In addition to the training of natural scientists and engineers that is conducted in a strongly research-linked environment. The area comprises of both the Information Technology Centre (ITC) and Ångström Laboratory. The Information ITC is located in the former and historical regiment area. There, research is conducted in algorithms, program languages, database technology, computer architecture, human-computer interaction, control technology as well as other special research connected to computer science. The Ångström Laboratory is located just south of the former regiment area. The laboratory building is occupied by the Department of Physics and Astronomy, the Department of Mathematics, the Department of Engineering and the Institute of Space Physics-Uppsala Department, the Department of Chemistry-Ångström and other accompanying educational facilities. The research in laboratory house includes physics, chemistry, mathematics, technology, materials and energy research. Both information and technology campus and Ångström campus are part of the Faculty of Science and Technology of Uppsala university. Ångström lab consists of the main buildings (house 1) and other 7 wing buildings (houses 2-8). The campus was built in stages and the first stage was completed by the inauguration of the first parts of building in 1997.
As part of its recent efforts to maintain and up-bring the standards of education, decorum and cultural diversity, the university has recently engaged with Akademiska Hus (AH), a state-owned property owner of higher education buildings in Sweden, in the largest joint initiative ever through the expansion of the Ångström Laboratory. The new project is one of the largest projects in the history of UU in terms of project investments (Interviewee B, 2019). It represents the fourth stage of the laboratory building and consists of adding two new houses numbered 9 and 10 (see figure 4). Modern and state of the art, sustainable and environmentally compatible project, the two additions will add 30,000 square meters to the current 72,000 square metres area of the building. The initiative will require an investment of around 1.2 billion SEK. Part of the project work is also a renovation work to the already existing laboratory building.

![Figure 4 Top view of the new Ångström project buildings (9 and 10) (modified from uu.se)](image)

An internal dialogue in the university started in 2010 between the head of Divisions and heads of departments of the Faculty of Science and Technology. Ideas were discussed and there were suggestions for improvement work to the old regiment buildings which are occupied by the Information and Technology Centre department (ITC) but also, architectural proposal for new constructions were presented. AH, who is the property owner of both Ångström Laboratory building and ITC buildings and who is also specialized in constructing and management of higher educational institutions, were contacted by the university and cost analysis of several options were carried out. AH on its part tendered several major building contractors and an agreement was reached with NCC to execute the project construction work.
5.1.1. The needs behind the expansion

Certain needs came to surface that pushed the faculty to start thinking of expanding and rearranging the current campus facilities to fulfil the needs of the different departments in both Ångström and the ITC. Currently, more than 5000 students and researchers are performing their jobs in the existing buildings. The project also represents an important initiative for the city. Uppsala is expanding and consequently, there are expectations for the university to keep evolving and expanding, this is, in turn, puts a special requirement for the university to condition with Uppsala city aspirations for growth. Increased traffic to the city is expected in the upcoming years and UU is in the heart of this expansion (interviewee B, 2019). There are also many internal needs for the university departments that occupy Polacksbacken campus area. The most important need is to increase the available space for the educational facilities and have better-equipped laboratories for the affiliated departments and their future research. As Eva Åkesson-the Vice-Chancellor of UU—puts it: “In order to continue to teach and conduct research, it is important to continue to develop the knowledge environments we have. The internationally recognised Ångström Laboratory has an excellent reputation and this initiative will make UU even more attractive internationally,” (Akademiskahus.se, 2019). The need for more space recurred several times in the past starting from moving the campus from the city centre in the past. After that Ångström Laboratory was expanded in 2000 and then further expanded in autumn 2006 with House number 7.

The development of the Ångström Laboratory will begin with the addition of a new wing (House 9) to the south that will primarily include classrooms and office spaces. The next step will be a new cube-shaped main building (house 10) to the north that will house about 1,200 students and 400 employees. All the departments in Ångström will benefit from the expansion and get extra space except the mathematics department (Interviewee D, 2019). The departments of Ångström Laboratory will expand as a result of the addition of new space area in house 9. Furthermore, the same site has already a parking slot for 100 cars and if required in the future there is a capacity to increase the number of parking slots to 260. At the same time, the ITC department will relocate from the historical regiment buildings and to this new house number 10. The ITC department needs an educational facility that fit with the type of activities that take place in the departmental different sections. The current old regiment buildings do not exactly fulfil this need. For example, students in computer department need more small rooms to work/study individually or in groups. But the current buildings were not originally designed for this. This relocation comes in the highlight of another internal need to create an integrated research and study environment. The idea is to create a more open Ångström where research and education in the natural and technological sciences can meet in a natural way. Today many research areas cut through subject boundaries, such as energy and materials usage. Moving ITC close to the other science and engineering departments are expected to enrich the academic environment so it becomes more creative. Many research areas such as artificial intelligence and robotics are expected to benefit from this initiative.
“Today we go to campus to meet others in a dynamic, intellectual and stimulating environment and we want to build on that. My hope is that Ångström can become even more of a meeting place and stimulate creativity across the subject boundaries”

(Interviewee B, 2019)

Besides, there are also other needs that are associated with social trends and pedagogical developments to the educational systems. The design of the new buildings considers how the students and employees tend to spend their time on campus. The physical environment in general should promote the educational philosophy that the future tenants and students will work and study with. Therefore, students, teachers and researchers have been involved in the planning process (Interviewee B, 2019). The new building (house 10) is a stand alone building not a mere extension to Ångström and will be flexible to host both concepts of new teaching methods like Active Learning Classrooms (ACL) as well as traditional in-class teaching techniques. The new building (house 10) will contain auditoriums, lecture halls, atrium and meeting areas, a restaurant, cafe, study areas, a library, an improved reception and student services and special spaces for so-called Makerspace, it will also include an installation of big information panels. Another need for the project is associated with the improvement of accessibility of the building facility for people with disabilities and special needs. This comes to correspond with the Swedish regulations and requirements in relation to the matter. It was realized by the university that modifying the already existing building to meet these requirements would just be too expensive (Interviewee E, 2019). House 10 will consist of 7 floors in addition to one underground floor and house 9 will consist of one underground floor plus 6 upper floors. The construction work itself started in March 2018. The supposed occupancy by UU for House 9 and 10 will be in 2020 and 2021 respectively.

5.2. Main actors of the project network

The project is a big project for UU and AH and there are many organizations that are involved in the project life cycle. These actors have various roles and responsibilities in the project some are concerned with the design and planning and some have responsibilities with relation to the actual production and construction of the project. The following figure (5) shows a summary of the main actors involved in the project.
Figure 5 Project network of central actors

UU will be the house tenant after the project is complete. As a future tenant, UU will be the end-user who will occupy the house’s different areas and get the privilege of using the several facilities of both houses 9 and 10. The university has a building department (Byggnadsavdelningen) which is responsible for creating attractive and functional campus areas for the university’s activities, students and staff. The department aims to create well-functioning premises that are flexible and can be well adapted to changes (Interviewee D, 2019). The same department also acts as a front office when it comes to negotiation with external organizations (e.g. AH) that are connected with the construction of the university new building facilities.

Akademiska Hus (AH), is a public property developer and owner of higher education buildings in Sweden. It is one of Sweden's largest property companies. It is a state-owned company which promotes the sustainable long-term development of university and college campuses by building, developing and managing environments for education, research and innovation. In Uppsala, AH works with several academic institutions among the biggest are UU, the National Veterinary Institute (SVA) and the Swedish University of Agriculture (SLU). AH will be the owner of the new Ångström project houses and UU will rent it from it in the future. AH and UU are considered the two main clients in the Ångström project. AH is a client in the sense that it is the property owner of the new facilities and UU in the sense that it represents the future tenant and the end user of these facilities.

The main building contractor for the project is NCC Construction. NCC is one of Sweden’s largest construction companies. The company had secured a contract with AH to be the main contractor of the project. This means the company will carry out the construction work of the main parts of the project. NCC has also many subcontractors who are responsible for the production of some parts of the buildings and also some small designs, for example, a company called UPB is responsible for designing the frames of the buildings.
In the beginning of the project AH hired a company called TEMA (Temagruppen Sverige AB) to be the general consultant for the project designs. The company made the first landscape designs of the buildings. The company is one of Sweden’s leading companies in architecture, landscape architecture and project management. TEMA offers services in architecture, landscape architecture, project management, interior architecture, city building, process management, environmental services and Building Information Modelling (BIM). Among other things, the TEMA is known for work on Tele2 Arena, SVT’s new premises in Malmö and Slussen’s landscaping architecture. During the project, a very big consulting group company called PE (Projektengagemang AB) acquired TEMA and became responsible for the architecture and designs of the project. As the general consultant PE has a contract with AH to do the general design and also has contracts with sub-consultants to do designs of several parts of the construction work such as ventilation and fire safety. The company has roles to coordinate the design and planning with other subconsultants in the project. After the acquisition the people from TEMA who are working on the Ångström project remained the same (Interviewee G, 2019).

In the following sections of this chapter the findings of the study are presented in two main sections. First section (5.3) presents client requirements that found to have influence on innovation in the project. Following in section (5.4) we present points of view regarding construction innovation as captured from the conducted interviews.

5.3. Clients requirements giving rise to innovative effects

The aforementioned general demands from project clients which were described in the project background, results into some innovative effects within the project. To fulfil the demands some new ways are adopted in the process and new technologies are also introduced in both houses. Regarding organizational innovation two new things were experienced during the interviews as in comparison to the previous projects being done at UU, are project studio and project partnering. As for technical innovation carried out in relation to this construction are smart glass windows and ACL. By conducting an empirical study on the project in a similar approach to the study done by Havenvid et al. (2016), we wanted to identify the client’s impact on innovation by starting from a number of client requirements and tracing down the impact. In this section a number of client requirements are identified. These requirements involve innovative products and/or new ways of organising construction. We investigated how they came about and tried to capture their effects on the connection between project actors that could be considered as innovative. The requirements illustrated in this section generate various effects in the project network. In the following, the client requirements are given code numbers from (CR1) to (CR4) where each number indicates a unique client requirement, and the effects are also coded from (E1) to (E20) where each number indicates a unique effect. Later on, in the analysis chapter these effects will be sorted out into three layers (Actors, Resources and Activities) depending on the type of impact that it brings into the project.
Out of a total of four client requirements that were identified here, two come from AH (CR1 and CR2) and two from UU (CR3 and CR4).

5.3.1. Client requirements from AH

Two client requirements coming from AH were identified in this study. Below both of them are presented along with related effects on the project network.

**CR1: Project partnering between AH and NCC**

AH specializes in the management of higher education buildings, therefore managing the construction of the new Ångström project lies within its core competences. Nevertheless, AH felt that this project holds a particular importance for both AH and UU (Interviewee A and C, 2019). UU is considered a very important client and this project is a big investment and contribute greatly to the university and its development. Therefore, AH felt that there is a need for a special approach in the way of doing the project work that involves more collaboration between the project actors. As mentioned in the project background early in this chapter, the project is cost-sensitive to high extent for the tenants and also there is a need to satisfy a great number of parties (Various faculty departments) on the tenant side. For example, building 10 will become the new home building for the ITC department, therefore the success of constructing a building that meets their requirements is crucial for the future of the department.

The Ångström project stage 4 is not the first for NCC in relation to UU. In addition to the existing Ångström building (house 1-8), the Swedish construction giant had previously constructed several buildings for UU such as Bläshusen, Segerstedthuset (The administration house of UU) and also Biocentrum campus. NCC also has a collaboration agreement with UU that includes, among other things, joint research, the opportunity to study on NCC projects, internship and degree jobs and lectures from both directions. Hence, there is an established good relationship between NCC and the university that may be beneficial to any mutual project. For instance, there are several students who are doing a traineeship for the Ångström project. (Interviewee H, 2019).

In the highlight of the above-mentioned points, AH saw that a highly competent contractor is needed to be in charge of the construction work and help AH to manage the collaboration of the several actors. AH had chosen NCC among other big companies and suggested a partnering agreement to achieve project goals (CR1). The partnering agreement required more interaction and collaboration between the two sides in order to facilitate a more open and transparent relationship.

“There are of course other contractors who can do the work we do not just reach to one company and ask them to do the work but we make tender. As for NCC, we worked a lot with them and this project is a very big project for Uppsala University and NCC is a very competent company. But there are also big companies who have competency to pull of such a project. There is Skanska, Peab and NCC biggest companies in Sweden.”
There are many ways to do an agreement with a contractor for a construction project. One main type of agreement is a general contract agreement (Generalentreprenad), the client hires a contractor who in turn hire the subcontractors that are needed. In this case the client is in charge of design and planning. The client entrusts the responsibility of coordination to the general contractor and thus avoids many managerial risks to the work. One of several advantages of a Generalentreprenad agreement is that the client has only one contracting party and thus a smaller number of contacts to be managed during the contract. Another main type of contract is a total agreement type (Totalentreprenad); a contract in which the contractor is responsible for both design and execution and is the party that enters into agreements with any consultants. This type of contract is sometimes called functional contract, because the documentation that the client provides, only needs to contain the requirements where the intended function appears, not how something should look or be. It is the contractor's responsibility to find out, and inform the client, what requirements apply to the intended construction during the tender phase and the design phase. Interviewee C from AH explained: “Totalentreprenad is common in regular residential apartments but in Ångström is a special project.” According to several interviewees the project entails a great investment and its complex in term of requirements as the building will contain special academic facilities which need assiduous planning and execution work from different project actors.

As a result of the partnership between AH and NCC, they both agreed to do work in a Generalentreprenad type of work (E1) but also NCC get to participate in the design stage and participate in cost calculations and other parts of the design stage. This means that the type of contract is a hybrid type of Generalentreprenad (interviewee C, 2019) as this type will be beneficial for collaboration and getting high value of the project. The already existing parts of Ångström building (buildings 1 to 8) were constructed with a real Generalentreprenad agreement but now the work will be done with Generalentreprenad with an additional partnering agreement. The agreement dictates how they will work together. For example, by this agreement, when AH choose its consultants and NCC chose its subcontractors and suppliers, they discuss together this process before making their decisions (E2). AH provide access to their consultants and let NCC join the design stage and have a focal role in developing the designs of the building (E3) which is not so typical for a project with the same typical type of general contract.

“...So now still the real estate owner still in control of the design but the general contractor is involved as well in the design stage.”

(Interviewee D, 2019)

It is explained by some interviewees that this type of doing work necessitates a very good base of mutual understanding and trust. This trust could be seen for example in the way meetings are conducted one of the interviewees mentioned that its feel like working in the same team which makes the atmosphere more relaxed which affects the way discussions are held (Interviewee A, 2019). Some interviewees also explained that by working together in this project they feel as part of one organization, instead of two different separate entities. But at the same time, the agreement
between both parties is respected (Interviewees C and A, 2019). AH explained that it was really important for the project to get the main contractor to join the project as early as possible as interviewee C (2019) put it: “When they join early, we believe it is good for better quality and better price. We call it partnering (samverkan).” The University is aware of this partnership and think it is good for the project for example, interviewee D (2019) explain: “Partnering between AH and NCC where NCC sit early in the project and talk with consultants so they become part of planning and design process. This could be good for innovation as they bring their expertise to the early stages of the project.” As a result of the collaborative work that is pushed by AH and its agreement with NCC a project team was established (E4) consisting of individuals from AH, UU and NCC to work more closely and to increase project communication.

As mentioned above, this partnering had an effect on the economics of the project. If AH decided to hand in a finished construction documents to a main contractor without involving that contractor in the preparation process of these documents, the main contractor would assign a fixed amount of cost to execute the work and this cost could even increase with the development of project work. Because sometimes the poor design may result in conflict in the production work or if the client decided to add a building requirement in a later stage, it would be more difficult to be done. But instead in the current case with the agreement, AH and NCC work together to optimize the designs and construction planning which gives more flexibility to work on reducing the overall project cost (E5). This, in turn, would result in financial incentives as a result of cost-saving for both parties. Another effect is in the way both parties manage project parameters like cost management as in this way of doing the work they both participate in doing calculations and changes on parallel which is a change in the activity of cost management (E6).

“We at NCC look into different drawings come from the demands of the University. AH decide how to do things but we can also suggest doing things differently in terms of economics and quality”

(Interviewee A, 2019)

This comes as a result of the fact that NCC gets more knowledge (E7) when they join the construction site in the early stages which will help them plan for production stage. Interviewee C from AH explains it this way:

“We partner with each other and take care of problems together and handle money better. When NCC arrives early there is lots of knowledge in the construction site.”

Both AH and NCC got a unified goal for the project (E8) as a mission for their companies that may transcend the boundaries of their respective organizational. A change that pushes them to achieve what is best for the project and not only think for their own interests. The contractor (NCC) also by working closely with UU get more idea about the vision of UU as a future user of the building and what UU want to do with the building which helps NCC make better decisions for the project and give relevant advice when coordinating with the consultants.
“Yes, we always try to think for the project best interest we don't only choose what's best for NCC or AH. we are also open-minded.”

(Interviewee A, 2019)

“…Yes, this way NCC get more information about the project ... I think the project would be good if they know what we are going to do with the house when they are done with it. With that experience, they can suggest ideas. last time we talked about this partnering we all collaborate together in the project to get better results. Even though AH has its own Consultants and we have our own we work together.”

(Interviewee D, 2019)

Another effect of the partnering and collaboration is increased number of meetings between the two organisations (AH and NCC) in the beginning of the project and follow up meetings (E9).

CR2: Project studio

NCC is one of the main actors of the new Ångström project where there are many liabilities to the construction works. NCC is the one who secured the contract with AH to fulfil the obligatory tasks of constructing the new houses 9 and 10. In our interviews, we observed that the interviewees at NCC are not only open and keen towards innovation but also wants to adapt to changes as possible. They also explained that the company strives to bring renewal to its profession and be in a good competitive position among its peers. When it comes to construction work. For example, Interviewee A, (2019) explained that the company is already researching concepts related to the buildings of schools and how these buildings could look like in the future. And also, how the company experimented with special type building blocks that make the construction work be performed in a modular way.

A concept of work that was developed and used by NCC in its previous projects is known as Project studio. The concept is used in the Totalentreprenad projects where NCC owns the design and planning as well as contracting process. Project members from NCC and its consultants and subcontractors are seated in the same big room to discuss the design and construction phases and to get the benefits of mutual knowledge, brainstorming on the problems and information flow and in order to find quick solutions for project problems and challenges. In this project AH hire a general consultant and involve the main contractor (NCC) in this process. AH wanted the best ways for collaboration in the project and bring the important actors together to solve problems. Then AH pushed for using the concept of Project studio in the project and agreed with NCC to use the concept in the project (CR2). NCC on its end also felt that using this concept would be beneficial for the project. Interviewee A from NCC (2019) explained this:
Traditionally. We have all the consultants working in their offices back home and then every second or third week we have meetings for hours but here we meet with the consultants together on a weekly basis. We solve all the problems together including NCC, the Consultants, the Architects and the University.”

The different consultants get to sit with the contractor and clients to discuss and plan for the project (E10). In this project all AH consultants, people who are working on the project from AH, UU, NCC and in some occasions some subcontractors like UPB who is responsible for the frameworks of the new houses, they all participate in the project studio meetings. But something we noticed from the interviews that not all the individuals in the project were familiar with the concept of the Project studio but almost all of the interviewees provided positive comments about using in the project studio concept. Some explained some difficulties associated with it. For example, architects had to come to the construction site in a frequent way which altered their usual ways of doing work (E11).

“Project studio is costly for us architects require more time and movement but it increases efficiency and reduces mistakes.”

(Interviewee G, 2019)

This way of doing work between different parties added more man hours (E12) to the project meetings between several actors and also less need to book individual meetings (E13) (Interviewee H, 2019). But at the same time, it saves man hours that would be spent in fixing problems or just be waiting for other parties to be available to discuss and solve work challenges.

“In the past, if you have a question you may wait for days until the next meeting with that person.”

(Interviewee D, 2019)

It was found that the frequency of these meetings (Project studio) is more in the earlier stages of the project and then get reduced with the progress of the project. As the work is described to be more efficient by some interviewees (Interviewee F, 2019). Project studio also brought positive social aspects between project individuals as they get to have more face time although in the beginning many may found it strange and did not know what exactly is required to be done in those meetings (Interviewee E, 2019). Because not every meeting has a special agenda; sometimes parties need to be available for others if help is needed or something need to be clarified. With time these individuals got used to it more and learned that they can bring their own work to the studio and just be available. This is due to the fact that not all actors in the studio work only with dedication to the Ångström project, some individuals have other projects they are working on especially the small subcontractors and designers (Interviewee E, 2019).
“...Project studio is also a process innovation and it is very good because in it we can talk directly with each other. It is a social aspect and I think it is good for everyone. Problems are solved more easily. You have the chance to get to know each other and the communication is better. Consultants like the fire safety and the special assistance consultants for the disabled persons, they have much less work but they are very important they often visit and sit. The studio also helps save time and help in making the right decisions.”

(Interviewee F, 2019)

Project studio resulted in resolving problems in much quicker and efficient way (E14) (interviewee C, D, E, G and H, 2019). For example, NCC suggested major changes to the design of the glass roof of building 10.

“NCC changed the glass roof for better design and quality and price that worked well in a recent project. The initial design was not difficult to execute but it has risks associated with its maintenance and may have leakage problems. After investigation, we agreed on our solution.”

(Interviewee A, 2019)

Using project studio in this project is a first for many actors which brings them new knowledge (E15) that could be useful in other projects.

“We have project studio it is a new thing that NCC have often when they build private housing. The project consultants meet weekly and work together and have big and small meetings and if you don’t have a meeting to attend you can sit and do your own work and be available. Its new thing for university projects. AH, and the university has never done it before. Usually, you have lots of meetings scattered in time and place but here we are sitting together and you have the project schedule presented on the wall and posted papers. And available working space and desks.”

(Interviewee E, 2019)

5.3.2. Client requirements from UU

Two client requirements coming from AH were identified in this study. Below both of them are presented along with related effects on the project network.

CR3: The use of ChromoGenics Smart glass windows

The smart glass is a special product requirement from UU. The glass itself is a substituent for the ordinary glass windows. As the name suggests it does not function the same way as the ordinary
glass installed previously in the building. In house 9 instead of the ordinary windows, the facade of the building facing the south is planned to be installed with the smart glass. The smart glass is considered as an innovation. It is fairly new material that has been developed for almost 20 years (Interviewee C, 2019). An interesting fact about this innovation is that its development and evolution was carried out in house at Ångström Laboratory. Latter, it got patented and registered as a firm called ChromoGenics. The company provides the dynamic glass which has the ability to control heat and light transmission. The company is based in Uppsala, Sweden. Using the glass promise benefits in saving a considerable amount of energy which make the building a more sustainable and environmentally friendly. As this smart glass coming from the research labs of UU decided it would be great if they can implement it into the buildings of the project and pushed for using it in the new project. Interviewee E from UU building department (2019) elaborated on this:

“The idea comes from the steering groups but you then also compare options and types for building but then the university found it would be interesting and even fun to use something from the university”

Also, interviewee D from the same department (2019) explained:

“ChromoGenics is the company developed from UU. The university wanted to use some innovation from inside the house. It affects energy cost and has to do with the indoor climate and also the environment. As it will eliminate the need for outside curtains.”

It was later decided in the design stage that it will be implemented in the south side of building 9 (CR3) as that side is the side that faces the sun most of the year and it would be more practical to be used there. In addition to this the smart glass is more expensive than the normal glass and there were some risks associated with it. Therefore, its implementation was limited to part of the project buildings as a trial (E16). Various interviews are conducted from UU, AH, NCC everyone admired the adoption of the idea of this innovative technology but there was also some critics regarding the risks associated with it.

“The Smart windows are a good thing if it works, they are very smart thing but it is very early they have some problems of costs”.

(Interviewee F, 2019)

“I think it is a clever solution instead of having a mechanical system that is sensitive to wind and external environment that can break down it is clever to have this inside the glass. But it is new and some people are skeptical which is normal when you have something new. We had lots of discussions and then decided together to use it. You would like others to try it first and see if it works.”

(Interviewee A, 2019)
One effect in the project because of this requirement is a confirmed delay in the production phase for house 9 \textit(E17). The reasons behind this is that the supplier company for this glass need to undergo a long process to deliver the product as this process involves moving the product between several countries outside Sweden. As the company is relatively new and does not own its own factory yet, this may make it difficult to meet project needs as promised. Interviewee H from NCC (2019) who is the site manager for house 9 elaborated on this:

“\textit{Probably there are risks regarding it, we have delivery problems with it. The company is relatively new and they have suppliers from different countries, which they are dependent on. Which means that this is a small company they do not have the muscles may be to push them on.}”

Although the first cost of the ChromoGenics glass can be greater than the cost of regular glass, on the long run the overall cost is anticipated to be less due to less maintenance requirements as it eliminates the need to install external curtains to the windows \textit(E18) and also due to its energy saving properties. The product is also new and add new knowledge to the project actor \textit(E19).

According to many interviewees it was the first time for them to work with this type of material. Also, there is a learning process in how to handle its procurement and implementation into the building. This experience then may benefit future projects related to the current building or other buildings.

\textbf{CR4: Active learning classes (ALC)}

All over the world, the trend among universities for educating students is changing. There is an attention towards using the concepts of Active Learning Classrooms (ALC) as an option to enable the students to learn and grab knowledge and skills in different ways (Interviewees B, D and C, 2019). ALC concepts enable students to learn more actively in the lectures from the teachers or by other activities of direct teaching rather than passive learning. The basic and key strategy lying behind ALC is to make students cooperate in the learning process. This should be in a practical environment so they can work in groups to achieve the defined learning tasks related to their academic assignments and solve problems by utilizing their intellectuals and brainstorming in quest of solving the problems. There has been some research on ALC techniques. It revealed that students who were being the part of active learning are more achieved and accomplished academically as well as practically, the experience showed more positive and greater retention as a comparison to competitive and individual learning. In the new Ångström building the design considered flexibility to the needs of the present and future teachings styles as possible. Hence, ALC was one of these needs that are considered in designing the buildings. The university put it among the requirements for designing the classrooms in building 10 (\textit{CR4}). In several interviews with people from UU they explained how this will be a good thing for learning process by building this type of educational environment.
“All the classrooms in the new building can be used with the traditional way of teaching where you have the teacher in the front and could be rearranged so students can work in groups. Every room except the auditorium is flat and equipped with easy moveable furniture. So, we think this is an innovation in teaching styles and pedagogics. There are also many screens in the rooms so when the students are working in groups, every group has its own board and screen and they can show other groups their work on the screens interchangeably. We are preparing to have this equipment in every room.”

(Interviewee E, 2019)

One effect that is generated by implementation of ACL into the design is that when planning for the construction work of building 10. The increased complexity of the house structure required the use of prefabricated structure parts (E20). Interviewee H from NCC (2019) explained that house 9 is done in the same way as the rest of Ångström Laboratory building but house 10 is totally different type of building with glasses and other things. House 9 is built using cast-on-site method done by NCC but house 10 is constructed using pre made structure by a foreign company from Latvia meaning addition of supplier (E21). But there are no differences in the design and planning procedure for the buildings. Interviewee A from NCC (2019) elaborated on this:

“Building number 10 has to be made with prefabrication because of the way of the spaces and the length of the floors. It will be very difficult to use the cast on-site with building number 10 and it will cost more but with prefabrication, it is more flexible. It may also play a part in the aesthetics and appearance of the building but it is more connected with the big classrooms and high ceilings and they do not want pillars in the middle of these rooms so there be good visibility and unobstructed view for the audience.”

Using prefabricated structure offer more flexibility for the building’s design. It was also mentioned that using cast-on-site method will be costly for the case of house 10. There are also many ways to use prefabricated structures but choices might be limited to which type is more readily available and the local industry already accustomed to (Interviewee G, 2019).

5.4. Innovation views from the new Ångström construction project

The interviewees presented different opinions of their concepts of innovation and construction innovation in specific. There might be part of different organizations i.e. UU, NCC, AH but they work in the same industry and are subject to somewhat similar influence by the characteristics of the industry. One of the interviewees from UU explained that she/he is not very close with what happens inside the industry but more concerned by building a good construction and facility for the university that can be a hub for creating innovation by doing research.
“A difficult question that is what is innovation? ... I think what we are doing is constructing buildings to facilitate innovation. New developments, new technical ideas, natural science discoveries, new ways of cooperation, new business arrangements. It could result in an innovative thing like a new medicine or battery or an application. Or a way of doing things in cooperation which could be innovative.”

(Interviewee B, 2019)

Following the above pattern another interviewee who has a role in the function of project management in the project was requested to give his views for the innovation in construction:

“I think innovation is good to implement but on a smaller scale. Trying new things is important for the society but when we come to building projects you can not just use new products. When you start building, they must have been already tested before and make sure that they are okay before we use them in the building. It is also the law in Sweden that the new products, materials are tested before they are used in the construction. Innovative products that come to the market should be tested beforehand by the suppliers and then introduced to the Market.”

(Interviewee F, 2019)

Most of the people who were interviewed (except those who represented UU as an end-user) have good professional experience and aware of the characteristics of the construction industry. Almost all of them had years of experience doing work that is highly connected with construction work, either technical or managerial. The first impression while doing the interviews was that they are aware that the construction industry has a reputation of being not so innovative. They also explained how people in the industry are in general tend to be resistant to new things.

“The construction industry is not innovative and quite old fashioned. In general, we like to do what we have always been doing.”

(Interviewee A, 2019)

“Some people don't like innovation, they like things to remain the way they are. for those people it is pretty tough to introduce new things. And it is not always about old people, they could be young people as well. But me personally I like innovative things. I want to adopt and try new things as it brings the effectiveness to the system as you know.”

(Interviewee H, 2019)

“... People's mindsets could be a hindrance to innovation because they might not want changes.”

(Interviewee F, 2019)
There was a special consideration to the usage of new materials in construction. Many of the interviewees said it is always risky to introduce a new material into construction. Some gave historical examples of occasions where usage of new material caused problems in constructions in Sweden. Changing materials can cause issues during construction but also sometimes these issues might arise years after the completion of the project. The choice of using certain material is not only about the costs of these material but depends on following policies related to safety and sustainability and intrinsic properties like reliability and durability and market availability of the materials. Costs also mentioned to play a role in the choice of building materials.

“In construction, you have to take it easy with innovation in using new material because the buildings will stand for another 100 years.”

(Interviewee E, 2019)

“Often when you build a house you do not want to try many new things. We try to build with a very well-known material because there is a lot of money invested in the houses and it should be functioning well and you cannot just do experiments in the project. AH want to build with good material because they will take care of the house for a long time”

(Interviewee D, 2019)

“In Sweden, for example, we have a lot of problems with the humidity it happened that a material fails as later on they realize that it was because of the material that was not well tested before. I am a bit restricted to this. Before introducing a product, you should do all of the tests and controls before you supply it.”

(Interviewee F, 2019)

In construction, choosing materials that are good for the environment and sustainability is important as explained by Interviewee H (2019) from NCC:

“We don’t want to damage the environment all around us and for our kids in the future. So, we should try to develop more innovative material to save the environment. But some new materials get trickier to work with. Also, some materials may not be harmful to the building itself but it may pose a danger to the workers when they install it, sometimes they need to use dangerous substances to work on it so we take that into consideration as well as ergonomic aspects in general”

Some interviewees also mentioned that work in construction is organized in a project-based environment almost all the time. Some explained how this could be both positive and negative on construction innovation.

“Some say some of the reasons why construction innovation is slow because it consists of project-based work. New projects with people changing. Yes, you can say that but
There are things that looks the same like windows and walls it looks the same but it is a little bit different each time we do it and some changes happens on a small scale.”

(Interviewee A, 2019)

Some interviewees expressed in a clear way that process innovation i.e. how project actors do the project work together would result in more direct benefits to the project overall as it will help solve more problem and help in bringing more ideas to the surface that would be of great value to project work. Also changes in processes is more noticed than new materials or products in their work environment.

“I think most of the innovation is about how we do the work with AH and the other teams of consultants and how to do better drawings.”

(interviewee A, 2019)

“... if you are talking about organization processes it is good to make innovation that make the processes better but not using new materials you do not know if it will work or not”

(Interviewee C, 2019)

When it comes to new ideas and innovation in the project it can come in anytime during project phases. However, Interviewees mentioned many times that the likelihood is greater during early stage of the project either during the pre study or the first stages of planning and design of the design Programhandlingar\(^1\) and Systemhandlingar\(^2\). This is because they are the stages were ideas are discussed and options compared and the window is opened for new suggestions and ideas. In addition to this the cost of changes typically increases with the progress of the project work because many actors are involved in work execution, and late changes will result in more adjustment and may disrupt project workflow and result in added costs to the final budget of the project.

“I think the most important thing that happens is during the design process and during the 3D modelling, how we look at the drawings, how we work together in the project, we do it together to solve issues. I think we are more innovative there than in the production stage”

(Interviewee A, 2019)

\(^{1}\) During this stage basic decisions are made about the size of the building, technical standards and design in general. The documents are a summary of the prerequisites for a project and form the overall basis for decisions on continued planning.

\(^{2}\) The documents provide a picture of the planned building’s construction design, technical installation systems and form the basis for a cost calculation for the upcoming work. The project’s environmental plan and work environment plan are also laid down at this stage.
“I would like to say new ideas come more in the stages of making the Systemhandlingar, but sometimes during the construction stage when Suppliers may propose better things/ways”

(Interviewee F, 2019)

Some explained that the timing of innovation and generating new ideas might be connected to the type of innovation whether it is a new product or a material or a process.

“If it is about material utilization it is when preparing the system documents because consultants storm ideas and look at which materials should be used and which systems are, we choosing. In program documents stage you don’t talk much about material, you discuss about functions in the house and the details comes later.”

(Interviewee E, 2019)

“New ideas or specifications better be as early as possible to come up with. If it comes in later stages it will be difficult to integrate. Better before finishing the designs (system documents)”

(Interviewee C, 2019)

Not all ideas get to be implemented in the project but a discussion may rise anyway and could have future value for future projects. For example, interviewee D from UU (2019) gave this example:

“The concept of IOT (Internet of Things) was up for discussion but of course the department needed something that is well tested and not the new houses to be a testbed.”

Costs were a very important variable that plays a role in innovation and the project work in general. UU as future tenant appeared to be highly sensitive in relation to this.

“Costs are very important in decisions like this and we don't want the building to be very expensive because you need to save money for research and not spend all the money on providing space”

(Interviewee D, 2019)

It is also important to understand that in this project UU as the tenant is a conglomerate of several end users with various needs that can be similar or may conflict in some areas. For example, some research groups that are supposed to use the new facilities may change during the planning stage. A new group of researchers may come with different needs which require a revision to the set of requirements. Also, it is not easy to anticipate the future needs for the departments many years in
advance. Therefore, making decisions and preparing requirements for the building’s functions can be a long and complicated process. This is also expressed by other actors in the network that in general customer demands are getting more complicated and it is becoming more difficult to agree on final requirements.

“...Previously it wasn't this difficult to agree with customer, but now it takes more time”

(Interviewee C, 2019)

Actors in the project network can be a source of innovation (tenants, consultants, contractors, etc.). In this case AH has internal departments that can provide innovative solutions.

“We have a small department concerned with innovation but ideas come more from our department of energy and technology. They come with new ideas and technology to use or materials. Sometimes we use it when we think it is a good idea and sometimes, we decide it is too early to use it.”

(Interviewee C, 2019)

Clients can be a source for innovation but also a driver in an indirect way. Providing unusual demands may push other actors to make innovative change in the project. Also, sometimes as in this project client requirements may keep changing during the project this may result in continuous responses from other parties in the network. An example from the current project is when the tenant UU changed their mind about having a restaurant in building 10 due to increased associated costs as well as an underground garage that was removed from building plans later. But then they decided on later stage that they want a big restaurant in house 10 because costs went down. The request and the associated changes were later fixed by AH and NCC. This change costs more than if it was implemented in the design in early design stage. There was also a parking garage that was removed from the design.

“The university drop ideas continuously like they said they want restaurant it was too late but we fixed it.”

(Interviewee C, 2019)

One good point mentioned by one of the interviewees at NCC that the way new ideas are introduced in the workplace may be critical to its success and future implementation.

“Because one thing that I have learned is that if you show somebody and you give them something that you think is good for them to use and then it does not work, then you totally destroy it. You can never introduce it again. So, it is really important, that things you develop, or you want to introduce in a project that help learning should be well tested, if it does not work, then you shoot yourself in the foot.”

(Interviewee H, 2019)
There are other risks related to introduction of new things to the project like the functionality of the end building and possible increased costs.

“The risk that the house will not function properly. And the increased costs could also affect tenants and the teaching if gadgets do not work properly.”  
(Interviewee D, 2019)

“Experience may be needed for new stuff and more resources may be needed to operate new things (like adding new support staff for new technical gadgets)”  
(Interviewee G, 2019)

6. Analysis

This chapter consists of the analysis part. The analysis part is divided into five subsections. Throughout the first four parts of the analysis section, the ARA model which was presented in the theoretical framework chapter is used to demonstrate the different effects on the project network across the three dimensions of actors, resources and activities for every one of the four identified client requirements. Below table (2) summarize the captured effects across the three dimensions. Then the fifth part analysis is done on the project actors views on construction innovation in the focal project.

<table>
<thead>
<tr>
<th>Client Requirement</th>
<th>Actor</th>
<th>Resources</th>
<th>Activities</th>
</tr>
</thead>
</table>
| CR1: Partnering between AH and NCC | Establishing a team of different project actors (E4)  
Increased interaction between two actors (E9) | Establishment of special contract (E1)  
Efficient use of resources (E5)  
Establishment of a new resource (E8) | Change in activity coordination between AH and NCC (E2)  
Change in activity coordination between AH and NCC (E3)  
Change in activity coordination between AH and NCC (E6) |
| CR2: Project studio | New interaction between actors (E10) | More resource requirements (E12)  
More resource requirements (E13) | Change in activity (E11) |
6.1. Analysis of CR1: Partnering between AH and NCC

The first client requirement is the partnering between AH and NCC in the project. As elaborated in the previous chapter (section 5.4.1), this requirement generated a number of effects in the project in all the three dimensions (Actors, Resources, Activities). In the actor dimension, there was an increased interaction between AH and NCC by working more closely in the project and doing some of the project activities in a parallel way such as costing tasks. The high level of transparency between the two parties reflected on project quality and work efficiency as mentioned by several interviewees. However, it did not only affect how these two actors engaged in their agreement, but also affected the way in which several other actors interacted and became interrelated throughout the course of the project. For example, there was an establishment of an inter-organizational team consisting of individuals from different actors in the network including the two clients in the project.

In regard to the resource dimension, a better use of resources took place in the form of reduction in project costs. This was a result of NCC involvement in different stages of design and planning from the early stages which allowed for more efficient utilization of material and knowledge resources, as well as better coordination of both planning and production activities. Both organizations had a sense of working toward a unified goal as both parties agreed on the
importance of the project. The history of both parties working together for projects related to UU and many other projects add to their intention to continue working with good performance which may be transferred into future joint projects. Additionally, in the selection of organizations for the project, the two partnering actors could jointly choose to work with a group of firms they had collaborated with in earlier projects and thus continue to exploit the resources of these earlier collaborators.

In the activity dimension, the two parties now choose to engage more in joint decision-making activities. The agreement enabled the two actors to link activities in new ways, for example by the jointly choosing the project consultants and subcontractors. While they had always handled this separately in the past. This results in combining resources in terms of their knowledge and previous experiences working with different external partners i.e. design consultants and building installation subcontractors. They can choose together which parties are best suited to the project needs and requirements. This reflected in project costs and quality as well as increased flexibility in meeting end-user demands that sometimes change with the progress of the project.

6.2. Analysis of CR2: Project Studio

Using the project studio concept in the project may go hand in hand with partnering agreement between NCC and AH. This deepen further the actor bond between NCC and AH because typically NCC would not allow other contractors to use their internally developed concept. As the concept of project studio come from NCC way of handling their own work when they are working with their own consultants. Using project studio in the current project show that there is a good understanding between NCC and AH to bring their own different contracted project actors such as the general consultant, sub-consultants and sub-contractors together in one table.

Several effects were recognised in the three-dimensional levels of project network (Actors, resources and activities) as a result of this requirement. In the actor dimension level, there was a big impact on how several actors interacted during the course of the project, how they combined resources (knowledge) and how both planning and production activities were organized. There was lots of software tools and modelling programs in the project that might not be very clear how to be used. Then some of the actors in the network elaborate it to the rest of the actors. Also meeting in a more frequent way helped to solve problems in a quicker way and helped the different actors to be on the same understanding level of project aspects.

In the actor dimension, the use of project studio intensified the interaction between the actors in the organization of the planning process, as there was a continuous need to coordinate the drawings and information from various actors into one consolidated model like using Building Information modelling system (BIM). Moreover, this also made changes to project scope easier to be implemented and less costly.
In the resources dimension, project studio made a sizable change on the time needed to carry out project-related meetings. It had reduced the requirement for many meetings between actors and the associated complications by bringing all the actors together in one room frequently. The studio also leads to better utilization of existing knowledge of the actors. Furthermore, it represented a new knowledge for some actors of the project network.

In the activity dimension, the project studio brought change to the consultants who had to alter their way of doing work. Instead of working in their offices they had to come to the project site and meet with the other actors there. Although the dedicated man hours increased for some actors, it was for the benefit of making things easier and reducing the number of mistakes and later design changes.

6.3. Analysis of CR3: The Use of ChromoGenics smart glass

The smart glass is a special requirement from UU. It is a special material for one component of the building. In the actor dimension, the usage of this new material did not have a visible effect on how the different main actors in the project network relate to each other. The material required changes in the material specification of the building documents. In the resource dimension, one change is a reduction in resources by eliminating the need for extra building components. As the glass has a function to control the light and heat getting to the building, there was no need to install additional external mechanical curtains. The smart glass was new to some individuals in the network of actors which means it presents new knowledge for them to work with the new material and get to get familiar with its suppliers.

As for the activities dimension, there was a delay in the production stage because the product was not delivered exactly according to the planned dates. This effect was very less likely to happen if the traditional glass was used instead in the building. Especially that the supplier would be a local supplier.

6.4. Analysis of CR3: ALC (active learning classes)

Incorporating the concept of ACL in the project did not impose much change in the project as it was well integrated early in the design and planning stage. One change was the need to use a different way of installing the building structure parts by using prefabricated components for house 10 instead of the cast-on-site method. There was a possibility to use either of the two ways to make construction in house 9 but for doing the construction of house 10 using prefabricated plates was the only way due to the complexity of some parts of the building which is a result of the special design of the building. As for the costs as mentioned in section overall the cost of prefabricated concrete is less if implemented for the new house 10. As for NCC doing cast-on-site means the work will be done internally with well established processes and no need for a foreign subcontractor to do the work.
In the resource dimension, this also resulted in the effect of using additional supplier for the structure work in house 10.

6.5. Reflection on construction innovation from the Ångström project

As presented in the previous chapters, several project actors from the Ångström project network were interviewed. We tried to capture their views on construction innovation in general and also in relation to the Ångström project. It was noticed by the authors that the role of the individuals in the project network may affect their views on certain aspects related to construction innovation. Some positions seem to allow more experimentation and trying new things and other roles discourage individuals from pursuing innovation. Therefore, individuals in such positions are more likely to follow strictly processes and plans. This issue was recognised in the literature. In product and process innovation scenarios it was noted that some of the relevant issues noticed repeatedly is that some employees were being hesitant to adopt the change while some are worried because of increased costs (Brandon and Lu, 2008). It was also noted that in order to implement new products or processes, there should be some sort of incentive to the project actors that come with their introduction.

6.5.1. Views in relation to the characteristics of the industry

A pattern was noted throughout the interviews in relation to some topics. One point that was clear in the interviews was the recognition of the construction industry as being not very welcoming to innovation and experimentation. This supports the argument found in literature that the industry is typically slow in producing innovation (Slaughter, 1998; Winch, 2003). This does not mean that the project is not successful as the project is considered successful as long as it meets the defined set of goals and requirements set by stakeholders (Bourne and Walker, 2005). This can be measured after the project is complete. Another related point was that work in construction is project based (Cox and Thompson, 1997; Shirazi, Langford and Rowlinson, 1996) and the discontinuity of project network of actors between different projects may have an effect on how work is executed in every new project. Despite this, one of the interviewees debated that although each project may involve totally new set of actors and individuals working together for the first time, small incremental (Marquis, 1969) changes that could be regarded as innovations can take place in the project. These changes can lead to realized benefits in efficiency or reduced costs in the respective organization. Meaning these innovations will mostly be on the level of the individual firms internally.

It has been argued that working on a short-term perspective does not favour innovation and technical developments (Dubois and Gadde, 2002). But also, by partnering across projects a form of standardization may take place between the partnering actors as mentioned by one interviewee (Interviewee F, 2019). We may argue that this could be true only for organizational innovation but the stability may be beneficial for technical innovation.
It is argued in the literature that some of the relevant issues noticed repeatedly when it comes to technical innovation, is that some employees were being hesitant to adopt the change while some are worried because of increased costs (Brandon and Lu, 2008). This issue was brought up by several interviewees, especially the cost issue. Competitive tendering lead actors to the perception that subcontracting will be carried out at the lowest possible cost (Cox and Thompson, 1997). In this case it was recognised that AH did not contract NCC based on lower costs but the competence of the contractor played a great role. NCC is the construction company that AH has contracted mostly in Uppsala during the last 20 years (Crespin-Mazet et al., 2015). According to AH, the company's unique focus and its local presence make a proactive long-term partner to the customers in developing their business. Another point is that by partnering both parties may reduce project costs and get incentives.

Other different factors that influence construction innovation were mentioned by the different interviewees. Some of these factors reflect their point of view on the project. Environmental impacts were mentioned to push the construction project teams for the development and implementation of innovation (Slaughter and Cate, 2008). The Smart glass is a sustainable product that might be new. But with more development on the supplier's side with better reliability of delivery and reduced-price it could be a great product for the environment. In addition to this an interviewee from the general consultant group of the project highlighted that some clients may look for prestige and green certification as a way to enhance public relations and image. It may also affect insurance.

6.5.2. Technical innovation vs organizational innovation

Another major point mentioned many times was how changes in processes of doing the project work, i.e., organizational innovation (Anderson and Manseau, 1999), and how different actors interact to each other bring great benefits to the project and these benefits may extend beyond the project into other projects. An obvious example in the project was the partnering agreement between AH and NCC and the positive impact reported by many individuals in the project. Also, the use of Project studio concept had positive reported impacts on the project in terms of resource utilization and better coordination between the different actors of the project. Previously, in the construction industry, there was no concept of Big room among different stakeholders. But currently, Big room exists, furnished with the desks in the curve shape and along with the smart boards (Fundli and Frode, 2014) or just a large open office (Knapp et al., 2014). In the large projects, project members are seated in the same big room to discuss the design and construction phases and get the benefits of mutual knowledge, information flow, and brainstorming on the problems in order to find quick solutions for the problems (Fischer et al., 2014).

It was argued in the literature that the construction industry has failed to adopt acknowledged techniques that have helped other industries to improve their performances. Among them was partnering with suppliers (Cox, 1996). The construction industry may not resemble other industries like the automotive industry. But the concept of partnering can still be used in a way that suits the industry and improve the performance. Although many of the interviewees agreed that using new materials can be very risky to introduce a new material into construction. Nevertheless, in the
Ångström project the ChromoGenics smart glass was used although it is a new developed material and may involve certain risks. This may be a result of the power of UU as an end user. Also, AH agreed to share the risks with UU for the possible negative impacts of this decision. This could result in some cases in an increased cost for UU but decreased costs for the property owner AH in the long run. The major contractor NCC will not be responsible if things go wrong as a result of using this new material which could be understood.

6.5.3. Client’s influence on construction innovation

When it comes to laying conditions for construction innovation, some actors play more integral roles than others, particularly clients have been identified as more prominent in provoking change (Blayse and Manley, 2004; Hartmann et al., 2008). Also, according to literature, clients have also been identified as likely to trigger innovative behaviour among other project actors within the inter-organizational network (e.g. Winch, 1998; Håkansson and Ingemansson, 2013). Completing the project tasks also depends on the involvement of a wide variety of actors. An addition to this point was noticed on the side of UU as one of the clients in the project. It was clear that even the client can sometimes involve a network of several stakeholders that have different requirements (see section 5.1). Two impacts from this phenomenon were captured in the Ångström project. First it caused prolongation to the planning process from the end users’ side which caused the project to come to hold for a long time before construction work started. The second impact was unclear set of requirements that disrupt the other stages of the construction work. It was mentioned by interviewees that providing clear and complete set of building requirements as early as possible make things a lot easier and smoother construction operations. But from what we have noticed in this project this might not be easy in the case of a complex academic building like Ångström Laboratory. Here we see a great potential for organizational innovation in the level of project network to play a role in minimizing the disruptive effects of client requirements uncertainty. These building requirements must be provided early and communicated clearly but the same disruption may lead to innovation in the project network when the project actors try to find ways to solve arising problems. The Ångström building is a special building as it could be considered a vessel for bringing other innovations in house. The building will act as a hub for interdisciplinary academic research which will bring innovation. The ChromoGenics smart glass can be seen as an example of a product innovation that come from Ångström Laboratory.

7. Concluding discussion

In this chapter, we discuss the findings of the analysis section and present the conclusions of the paper. This is followed by a discussion on the future research and ethical implications.

Q1) How can client’s requirements affects construction innovation in a project network?

The presented case and the first part of the analysis with the use of the ARA model demonstrated how client requirements can generate certain effects in the dimensions of the business network of
a construction project (actors, resources and activities). As seen from the results, these effects may take place through changes in the structure of actors and the way they relate to each other. For instance, the interaction between some of project actors increased. Also, a new actor was introduced to the project as an effect of one requirement. The effects in the resource dimension took the shape of improvements in utilization of resources and sometimes the creation of new resources. Some project activities changed as well in the way they are coordinated. Based on the business network theory these changes are interrelated and change how actors, resources and activities are related. It is anticipated that some of these effects will be carried along to subsequent projects that involve some of the actors working in the current focal project. As shown in literature, construction work is a special case. The involvement of a large number of actors makes the introduction of new solutions and the pursuit of innovation a negotiation process between the project actors (Winch, 1998). An innovation like the Project studio is found to facilitate this negotiation process. Such an organizational innovation may act as a base for more innovations even on a bigger scale. AH pushed for the Project studio and NCC agreed. An agreement that was dependent on their established relationship.

Q2) What views do individuals have on construction innovation in a project network?

The view of the interviewees was to a great extent in accordance to what described in the literature review. Researchers shows the positive attributes towards relationships and their bondage strengths as having a conclusive impact on the development and prosperity of innovation. Hence, sharing of knowledge by means of informal networks have also a significant role by making the adoption more effective (Bossink, 2004; Frambach and Schillewaert, 2002). To that end, relationships within the construction industry are considered a key factor which can enhance or hinder the innovation. The reason why they are important is that they have the capability to facilitate knowledge that flows through interactions between individuals and different actors within the industry. This knowledge flow result in impacts like costs reduction.

There are many factors that can foster or hinder construction innovation. A study by Blayse and Manley (2004) shows there are primary influences on construction innovation. Among these influences was the relationships between individuals and firms within the industry. The new Ångström project is considered a big construction project in terms of investment. It was expected that the project work may involve some type of innovation even if this innovation might be limited to the current project. The influence of relationship was clear in the study. AH’s long-term strategy includes increasing and intensifying collaboration with customers. This was demonstrated by the special partnership agreement with NCC. It was noted from the interviews that a stepwise approach for introducing and implementing innovation lead to greater chances of success. Interviewees emphasized that good relationships between individuals and firms have positive impacts on project. The construction process can become complex and the different stages may overlap. For example, one interviewee (Interviewee G, 2019) explained that the design process starts from bigger parts of the building and then go down to the smaller details of the building. In contrast, production activities start in the opposite direction as the construction start from the bottom up.
Also, for house 10 construction work started before the design stage is finished. Therefore, it is important for the designers and constructors coordinate with each other.

Client requirements may benefit from a flexible building that can accept future changes. This flexibility is a desired characteristic but is expensive at the same time. Clients should try to balance this aspect and try to do better planning. Finally, another shared view among the interviewees that is important to mention that it is important for new technological innovations to be well tested by the suppliers before its introduction to the work site.

7.1. Conclusions

In this section, we present the conclusions from the study empirics and analysis. The purpose of this research was to investigate the effect of client’s requirements on different actors of a construction project network in the dimensions of actors, resources and activities. For the second research question the purpose was to capture the different views of different main actors on construction innovation in the construction project. After investigating the main actor’s network in the project, we reached few conclusions.

We argue that partnering relationships between project actors could be a way to facilitate different types of innovation through promoting trust and understanding as well as sharing the risks. Our study clearly shows that partnering has led to an increase in productivity and efficiency of carrying out project works. This actually resonate with exciting theory. As there is a need for more innovation to escalate the productivity in construction (Gann, 2000). Studies also show that companies are becoming more interested in building closer connections with their customers and users, which have traditionally been weak (Blayse and Manley, 2004). We also conclude therefore that relationships between individuals and firms are very influential in relation to construction innovation (Blayse and Manley, 2004).

We found that clients can act as drivers for innovation within project actors which is similar to what the existing literature show (e.g. Winch, 1998; Håkansson and Ingemansson, 2013). By doing the analysis using the ARA model it is found that clients can trigger changes and sometimes innovation through their requirements. How direct the effects can vary depending on the type of requirement. The client’s important role starts from providing clarity with their requirements since early stages. This was a clear finding in the current study and also confirm what found in the literature (Kulatunga et al., 2011) Implementing innovation may involve and affect several actors in the project network through their interactive relationship. It is also found that process innovation may generate greater effects on the actor's network than product innovation. Therefore, we advocate that process innovation may provide greater potential when it comes to innovation. Moreover, in the current study there were two types of clients with different levels of expertise and competency. This also confirm what have been argued in the literature as it was found that if the clients are more challenging and already experienced there will be a chance that they impact more on the innovation (Barlow, 2000). Therefore, we further argue that a client with greater level of competency is more likely to have greater influence within the project network.
A number of studies have addressed the clients’ role in driving innovation (Nam and Tatum, 1997; Gann, 2000; Briscoe et al., 2004; Ivory, 2005; Manley, 2006; Brandon and Lu, 2008; Hartmann et al., 2008; Harty, 2008; Håkansson and Ingemansson, 2013). More specifically, this study has replicated an empirical study similarly to the one done in Havenvid et al. (2016). The study done on a different situation and a different context, to determine if the basic findings of the original study can be applied to other circumstances. Our findings further support the findings of that study and shows that the findings could be generalized carefully in different contexts.

7.2. Future Research

After conducting this case study, it is worthy to mention that we tried to investigate questions regarding the innovation in the construction project from inter-organizational perspective. Looking at how clients can play a role in the innovation process. The study was done on an academic building project setting. The theoretical framework and analysis adopted in this study could be replicated in different project contexts which may result in more understanding on the type of effects that can generate as a result of client requirements.

As for the second research question data collection was done but due to the limited scope of the project, there is still capacity to go more deep insight to analyse further on the broader scale by investigating more actors special the smaller actors of similar projects, which may develop more authenticity to the findings. Furthermore, investigating more thoroughly the type of contractual agreements between partners in such project may be helpful to understand their effects on the innovation process.

7.3. Ethical Implications

By considering the ethical implications of this carried out research, we anticipate that it would contribute to better results for the construction sector and it will be helpful to innovate the industry. As it was discussed previously in the introduction chapter regarding the role of construction industry economically and its contribution for the economic welfare not for the industry level but also on the state level. Construction innovation can play a key role in boosting the economy of Sweden as by raising the standards of living. Furthermore, better quality features in the academic buildings. Another ethical implication is that innovation is important for sustainable development as well. In Sweden laws are getting stricter as well as client’s requirements that favour more sustainable features for the sake of protecting the environment for future generations.
References


Appendix

Interview Type A

1. How was the new Ångström building project initiated?
   A. What are the expected outcomes/benefits of the project?

2. How long have you been working on this project and on which stages of the project?
   8. Where is the project right now?
   9. Is the design and planning phase finished?
   10. Is the design and production ongoing at the same time?

3. Who are the clients in this project?
   A. What do you think are the main responsibilities of a client in a construction project?

4. What are your roles in relation to the new Ångström construction project (In what way do you contribute to the project?)

5. From your point of view, who are the main actors (contractors/consultants. Etc) in the project network?
   A. Which actors do you work with directly and with which actors do you work with in an indirect way, previously?
   B. Have you worked with any of these actors in a previous project?
   C. What types of activities are performed between you and these actors?
   D. Do you share any internal or external resources with any of the actors i.e. knowledge, skills, ideas etc?

6. What is new in this project as compared to previous projects in Ångström in perspective of organizing the project differently, new material, demands, requirements, products?

7. What do you think of the importance of innovation in the project?
   A. What are the focus areas when it comes to implementing innovative in this project?
   B. What are the sources of innovation ideas?
   C. In which stages do most innovative ideas come about?
   D. Do you think there are risks associated with implementation of innovative ideas?

8. Do you have examples of innovation in the project?
   A. What impact these new aspects have on you as an actor, on other actors?
   B. How does it affect the project and the ways of working in the project?
9. What role do clients play in the innovation process (positive and negative)?
   A. How do other actors influence the innovation?
   B. How relationships of you with other actors may affect the innovation process?
   C. How client requirement can influence innovation in the project?
   D. How do you communicate innovative ideas to the actors of the project network?

10. Which factors can drive the innovation and which factors hinder it?

11. What changes do you think will help clients contribute positively in boosting innovation in the project?