BI Norwegian Business School - campus Oslo

GRA 19502

Master Thesis

Component of continuous assessment: Thesis Master of Science

Digitalization and Knowledge Sharing in Construction Organizations

- A case study of how digitalization can facilitate knowledge sharing between projects in a Norwegian Construction Organization

Navn:	Cecilie Bech Blindheim, Kine Karlsen

Start:	02.03.2018 09.00
Finish:	03.09.2018 12.00

Master Thesis

by

Kine Karlsen and Cecilie Bech Blindheim

BI Norwegian Business School

Digitalization and Knowledge Sharing in Construction Organizations

A case study of how digitalization can facilitate knowledge sharing between projects in a Norwegian Construction Organization

Hand-in date:

29.06.2018

Supervisor:

Ragnhild Kvålshaugen

Program:

Master of Science in Business

Major in Strategy

Table of Content

Acknowledgements

Firstly, we would like to thank our supervisor, Ragnhild Kvålshaugen, for guiding us and helping us throughout the process of writing our master thesis. She has provided us with inputs and constructive feedback. We would like to thank her for her dedication and insightful comments. We have been challenged and motivated by her enthusiasm and knowledge about the subject. We appreciate everything she has contribute with.

Secondly, we would also like to thank BackeGruppen for letting us use their organization for a case study and for giving us insightful information. We appreciate the openness and friendliness we have been met with and are grateful for all the contributions. Thank you to the managing directors from both subsidiaries for providing us with documents and relevant information. We would also like to thank all the participants, both the interviewees and the ones who had meetings with us. All the contributions have been valuable. We would like to give a special thanks to the one project we visited the most. Thanks to the project manager and construction site manager for showing us the construction site and letting us use the barracks for interviews.

Finally, we would like to thank each other for a great collaboration and interesting discussions throughout the process. We have supported and helped each other through this stressful period. We are proud of what we have accomplished and our final work as Master of Science students.

Summary

The construction industry is one of the largest industries in Norway and one of the least digitized industries worldwide. Construction organizations are characterized by its complexity and project-based work. In these organizations, each project can be viewed as a separate unique organization, and therefore, sharing of best practices may be hindered. As a result, every project starts from scratch and the same mistakes repeat themselves in several projects. In other words, there is a low level of lesson learned.

There is a great potential for digital improvements in construction organizations as some are still using paper drawings and traditional methods. Digitalization has the potential to fundamentally change the manner of working in construction organizations by increasing information flow and coordination and integrating separate units and individuals. Digitalization in construction organizations is a highly important issue and several initiatives have been started worldwide to foster development in this area.

The characteristics of project-based work and the low level of both knowledge sharing and digitalization have inspired us to investigate these concepts further. Based on this, we formed the following research question: *How can digitalization facilitate knowledge sharing between projects in construction organizations?* With a qualitative case study, we wanted to do a contextual study to get an in-depth understanding. We conducted a single case study where we examined a Norwegian construction organization. In our study, we used a triangulation strategy with interviews as the main source for data.

In our study, we have managed to identify the importance of knowledge sharing in construction organizations. In addition, our findings show a recognition of knowledge sharing between projects as valuable, although it is currently not properly facilitated in the studied organization. We have recognized several barriers and possibilities for knowledge sharing between projects and have discussed how digitalization can overcome these barriers.

CHAPTER 1 – INTRODUCTION

"Success does not consist in never making mistakes, but in never making the same one a second time" – George Bernard Shaw

In the construction industry, there is a tendency to 'reinvent the wheel' (Newell, Bresnen, Edelman, Scarbrough, & Swan, 2006) and as a result, transfer of best practice occur at a low level. Also, the organization risks losing out on valuable knowledge. No project will be exactly the same (Turner & Müller, 2003), and the tendency to reinvent the wheel is a consequence of the uniqueness of projects. In project-based organizations, it is usual for the project members to treat the project as an island on its own (Engwall, 2003). When looking at every project as an island it becomes a major challenge for project-based organizations to share knowledge across project boundaries, as it is hard to recognize which knowledge should be made available in the organization (Bartsch, Ebers, & Maurer, 2013). With every project being treated as if it is one of a kind the results can vary greatly between comparable projects in the same organization (Blanco, Janauskas, & Ribeirinho, 2016). However, much of the literature from the strategic and organizational research fields show that learning from experience is of fundamental importance for the development of competitive advantage (Cacciatori, Tamoschus, & Grabher, 2012), and should be an area of focus. The construction process is highly fragmented and consists of a multitude of interacting elements and actors (Gidado, 1996). Each project brings together different teams who might not have worked together before, making every project unique in one way or another (Fischer, Ashcraft, Reed, & Khanzode, 2017).

Technology creates the possibility to enhance the integration of knowledge by increasing the individual's reach and simplifying the knowledge transfer across the organization (Agarwal, Chandrasekaran, & Sridhar, 2016). Digital communication tools have the possibility to create a platform that facilitates contact between the people seeking new knowledge and those who possess the knowledge. The level of digitalization varies across the construction industry, some use advanced digital tools while others still use paper-drawings, but in general digitalization is at a low level (Agarwal et al., 2016). Some of the main reasons for the slow digitalization

are the lack of awareness around digitalization in construction organizations, lack of competence and the complexity of the industry (Sjøgren, Krogh, Christensen, & Olsen-Skåre, 2017). However, several initiatives have been started worldwide to foster digitalization in the construction industry. The UK government is working on *Construction 2025*, a long-term strategy working towards an industry which by 2025 is leading in research and innovation, drives and sustains growth, attracts talent, and is transformed digitally (Blackwell, 2012). In Norway, similar initiatives have been developed. The project group Bygg21 is working on finding and applying the best practice from the industry, to increase the general efficiency of construction (Bygg21, 2013). Another initiative is *The Digital Roadmap*, a collaboration between several actors in the industry and managed by Byggenæringens Landsforening, which works towards a digitalized, competitive and sustainable industry (Sjøgren et al., 2017). The understanding on how technology should be integrated in knowledge-intensive work is increasing (Susskind & Susskind, 2015), but there is still work needed to assemble the industry.

1.1 Challenges in the Construction Industry

The construction industry suffers from low productivity and small margins. McKinsey reports that large projects typically take 20 percent longer than scheduled and are up to 80 percent over budget (Agarwal et al., 2016). A need for improvement is evident from these numbers. The report points to several problematic factors; uncoordinated project planning, inadequate performance management, and unsophisticated supply-chain practices. Earlier research have pointed to uncertainty, interdependence (Gidado, 1996), coordination challenges and a low level of integration (Shammas-Toma, Seymour, & Clark, 1998) as sources for inefficiency. The problems in the construction industry have been widely researched for several decades. Authors and researchers have "attacked" the issue from several angles, and complexity is a common denominator in their results. Winch (1989, p. 970) stated that "construction projects are amongst the most complex of all undertakings", while Dubois and Gadde (2002a, p. 2) wrote, "the complexity of the construction operations and the subsequent problem-solving capability needed is perceived formidable".

Another problematic factor is the low level of digitalization, as the construction industry is one of the least digitized industries worldwide (Agarwal et al., 2016). We are living in a digital era, an era based on an infrastructure embracing ICT. This new infrastructure is helping us do things better and more efficient than before. Also, it is enabling new, more effective ways of control, coordination, and collaboration on activities, at a lower cost. It is also changing how and where we work, and the way we interact and communicate (Cascio & Montealegre, 2016). Digitalization has the potential to fundamentally change the manner in which knowledge-intensive organizations create and capture value, their strategies and the organization's structure (Breunig & Skjølsvik, 2017). The possibilities for digitalization in the construction industry are numerous and this is an area many actors have started to focus on. Digitalization will greatly affect the industry in the future and is thus an area actors need to understand the importance of.

1.2 Motivation for the Study and Research Question

The uniqueness of projects, the lack of knowledge sharing in the industry, and the opportunities digitalization may generate, have been the main motivations for our research. These topics covers important challenges for construction organizations. Even though we were aware of the challenges construction organizations face, we were surprised to discover how far beyond these organizations are on digitalization. The more we researched, the more interesting the subject became. As the construction industry is one of the largest industries in Norway, we saw our research topic as highly relevant and hopefully something that could be of interest for many. By investigating knowledge sharing in a construction organization, and researching possibilities digitalization has for facilitating knowledge sharing, we hope to develop an understanding as to how knowledge sharing between projects can be facilitated by digitalization. With these issues in mind we have developed the following research question:

How can digitalization facilitate knowledge sharing between projects in construction organizations?

Our aim is to identify the importance of knowledge sharing within construction organizations, and based on theory, emphasize how digitalization can facilitate

knowledge sharing between projects. By this, our study will provide a contextual contribution that construction organizations can take into consideration. The purpose of this thesis is not to generalize our findings, but as we study a case of one construction organization, our findings may be relevant for other organizations as well.

1.3 Structure of the Thesis

The thesis is divided into six chapters based on the different relevant topics. For practical information about the thesis see Appendix 1 for an overview. The first part of the thesis is an overview of the relevant theoretical views. This part is divided into three main topics, project-based organizations, digitalization and knowledge sharing. After presenting relevant literature on these three topics, the theory is discussed and four sub-research questions are presented. Secondly, in chapter three, the methodology used in our research is described. The chapter includes an explanation of the research design and strategy, the data collected and applied, an explanation of our analytical process and lastly the scientific quality. The last part of the thesis presents our empirical findings and analysis, the discussion of the four sub-research question based on theory and findings, and lastly, practical implications and suggestions for future study.

CHAPTER 2 – LITERATURE REVIEW

In this chapter, we will discuss relevant theory regarding our research question: *How can digitalization facilitate knowledge sharing between projects in construction organizations?* The chapter is divided into three main categories: project-based organizations, digitalization in the construction industry and knowledge sharing. By reviewing, comparing and combining the literature and theoretical frameworks available on these different topics, we expect to develop a better understanding of what is known in the literature in regard to our research question, what may not be covered by theory today, and which areas we should focus on in our analysis. At the end of the chapter, we will discuss the theory presented and develop some sub-research questions that will be used to guide our analysis and help us with answering our main research question.

2.1 Project-Based Organizations

Project-based organizations are organizations whose capabilities and structure evolve around coordinating projects (Manning, 2017). These organizations have been argued to have a different organizational configuration and more complex operational process, compared with functionally organized firms (Blindenbach-Driessen & Van Den Ende, 2010). In general, organizations learn by capturing previous experiences and lessons and by making these available to their members (Ferriani, Corrado, & Boschetti, 2005). A project-based organization does not use history-based paths when making decisions, and consequently, it may not nurture its organizational knowledge. A project can be viewed as a unique temporary organization that dissolves as soon as it is completed for which it was set up (DeFillippi & Arthur, 1998). With every project being complex and unique, it is hard to identify previously used practice as relevant, which leads to a low level of "lesson learned" (Newell et al., 2006). In other words, there is a tendency to 'reinvent the wheel' when a new project is started, instead of learning from previous experiences. Project complexity is an evident challenge in construction organizations, but it tends to get neglected (Gidado, 1996). No two projects are identical, but that is no reason not to learn from experience (Blanco et al., 2016).

A common problem for project-based organizations is the lack of knowledge sharing between projects. Project-based organizations usually become increasingly

decentralized and loosely coupled (Lindkvist, 2004; Orton & Weick, 1990) where data usually is manually collected and the communication is poor. The majority of construction knowledge resides in each individual (Vakola & Rezgui, 2000) and construction industry practitioners believe that a better management of the corporate memory would help to overcome several challenges related to improvement in the industry (Lundkvist, Meiling, & Vennström, 2010)[1]. Knowledge sharing can also be difficult to facilitate due to the staffs' ignorance of feedback or the lack of time to facilitate feedback (Sterman, 2000). Projects are often not reviewed at all, and if they are, the review does not give real understanding, and the new information is not incorporated into organizational processes (Williams, 2008). Another factor relates to the autonomy and time-limitation of projects. This makes it difficult to create a common knowledge base among the members, and these members must jointly work together for better developing the collective knowledge needed to run the projects (Lindkvist, 2005). Therefore, a permanent organizational memory is not to be found in a temporary organization, and organizations like this are not able to draw on history or experience since there is no past to build on (Ferriani et al., 2005). As a result, when each project in construction organizations can be viewed as unique and complex, it complicates the transfer of best practice between projects (Pathirage, Amaratunga, & Haigh, 2007).

2.2 Digitalization in the Construction Industry

The focus of digitalization in the construction industry has increased rapidly in the last decade and there is expected great changes in the years to come (Agarwal et al., 2016). Froese (2010) has divided emerging construction digitalization into three different eras, where the first era focused on developing stand-alone tools to assist other tasks, the second era focused on computer-supported communication, while the third era is currently happening and is focusing on the usage of a cohesive overall system. In general, there is a lack of coherence between the digital tools used in the construction industry. For the industry to fully exploit the potential of ICT in the future, "the ability to integrate all project data must continue to improve

[1] This article refers to Latham (1994), but it does not specify anymore on the citation so we were not able to get access to the original source.

to the degree that the collective project dataset captures much of the inherent interdependencies of the real world" (Froese, 2010, p. 533). Meaning, digital tools have the potential to significantly increase the efficiency of designing and managing construction projects, if integrated (Froese, 2010). Through the development of new technologies more information can be absorbed and used (Prencipe & Tell, 2001), and a higher level of knowledge can be shared. However, to succeed with these improvements there need to be more than technical solutions. One common problem may be that organizations have tried to implement digital tools, without knowing how to share their knowledge or how to plan and collaborate (Fischer et al., 2017). Therefore, the full potential of digitalization cannot be realized without also changing the work tasks and knowledge of the project participants (Froese, 2010).

When an organization acquires new information, it interprets the information according to previous knowledge and experience. It is acquired via organization-specific processes, and it affects the behavior of the organization (Prencipe & Tell, 2001). When knowledge is transferred between different units and actors, there is a high likelihood for information to get lost, and the possibility for acquiring new knowledge disappears. In particular, when information has to go through many agents, as in construction projects, it is likely to become distorted (Hansen, 2002). This is an important part of what digitalization can improve. ICT has the possibility to improve knowledge sharing in project-based organizations by reducing time-based and spatial barriers between actors and simplify the access to knowledge (Hendriks, 1999). Also, digital tools can make it easier to store and reuse important experience (Prencipe & Tell, 2001). In a McKinsey report from 2016, there are identified five main trends expected to shape the construction industry's digital future: higher definition surveying and geolocation, next generation 5-D building information modeling, digital collaboration and mobility, the internet of things and advanced analytics, and future-proof design and construction (Agarwal et al., 2016). These five ideas are designed to work together to deliver greater impact. Two of the trends concern the usage of digital tools to increase interaction and integrate the different platforms used.

One of these trends, 5-D building information modeling (BIM), is one of the most discussed and anticipated trends in the industry. It has been described as a virtual

process that encompasses all aspects, disciplines, and systems of a construction project within a single, virtual model, allowing all the participants to collaborate more accurately and efficiently than when using traditional processes (Azhar, 2011). BIM can be viewed as a continuous process, with technology that is constructing an accurate virtual model of a building digitally. When compared to the traditional methods of using paper drawings, the interaction when using BIM is more flexible and overlapped, and a greater amount of information can be shared. Charles Hardy, director of the General Services Administration's Office of Project Delivery, stated that the use of BIM is 10% technology and 90% sociology (Deutsch, 2011). Meaning, there must be a common understanding throughout the project as to why the model should be implemented, and routines for use of BIM must be developed (Deutsch, 2011). It is not only about the implementation, but also about organizing the implementation.

Digital collaboration and mobility is another trend mentioned, and it goes hand in hand with the second trend, BIM. Agarwal et al. (2016) describe this trend as "moving away from paper and toward online, real-time sharing of information to ensure transparency and collaboration, timely progress and risk assessment, quality control, and, eventually, better and more reliable outcomes". The use of paper creates difficulties for the information flow, and can possibly lead to miscommunication and misunderstandings. It is, therefore, a source for disagreements between actors and general confusion in the project (Agarwal et al., 2016). By using digital tools, a lot of these disputes can be avoided.

Consequently, digitizing workflows has the possibility to create substantial benefits both inside and across projects (Agarwal et al., 2016). To summarize, increased efficiency in designing and managing project, an integrated workflow (Froese, 2010), stronger collaboration (Azhar, 2011), more reliable outcomes (Agarwal et al., 2016), and simplifying storing of experience and reusing of knowledge (Prencipe & Tell, 2001) are some of the benefits increased digitalization may lead to in the construction industry.

2.3 Knowledge Sharing

Scholars have examined the question of the effectiveness of knowledge sharing in organizations, focusing on the difficulties of sharing knowledge of complex and tacit art across organizational subunits (Zander & Kogut, 1995). Tacit knowledge is referred to as the know-how and is developed through experience and socialization, and it is more difficult to share than explicit knowledge which is the knowing-about (Grant, 1996b; Spender, 1996). Knowledge sharing is "the exchange of knowledge between and among individuals, and within and among teams, organizational units, and organizations. This exchange may be focused or unfocused, but it usually does not have a clear a priori objective" (Schwartz, 2006, p. 498). The ability to share knowledge within an organization can contribute to the realization of organizational advantage (Ghoshal & Moran, 1996), but sharing best practice and knowledge can be difficult due to several factors, or what Szulanski (1996) described as internal stickiness. In his research, he discussed the *transfer of best practices* that relate to the organization's replication of superior and best internal practices. Knowledge sharing can also relate to the willingness of an individual to share acquired or created knowledge with others (Bock, Zmud, Kim, & Lee, 2005) and can happen either directly or indirectly, either via communication or some form of knowledge archive. Some scholars argue that knowledge sharing can be difficult due to an individual's fear of losing their unique value and their unwillingness to share knowledge (Bock et al., 2005). Osterloh and Frey (2000) argued that knowledge sharing will only be facilitated by the intrinsic motivation – the value for its own sake – or the obligation of personal and social identities (March, 1999, p. 377). Also, knowledge sharing among organizational members is the most important mean that affects the value of knowledge utilization (Yang & Farn, 2009) and it is a collective course of action (Bock et al., 2005). The ability to make tacit capabilities understandable to others and to transform it derives from the collective experience of the members that is organized by rules of coordination and cooperation (Zander & Kogut, 1995).

Many scholars view knowledge through the practice-based perspective. This perspective conceptualizes knowledge as socially constructed and embedded in practice (Hislop, 2013). As knowledge sharing between projects is viewed as problematic in construction organizations and the temporary nature of projects makes it hard to develop permanent organizational knowledge (Ferriani et al.,

2005), the practice-based view on knowledge seems fitting. The practice-based perspective has been used by scholars when discussing the process of learning and knowledge creation in situated practice (Amin & Roberts, 2008), and scholars have argued for the fact that situated practice can be a rich source for knowledge-formation (Brown & Duguid, 1998; Gherardi, Nicolini, & Odella, 1998; Wenger, 1998, 2000). These scholars do not focus on the specific knowledge the organization possesses, but on the utilization, or *how* an organization *uses* their knowledge (Carlsen, Klev, & Krogh, 2004). When knowledge is tied to practice, it is difficult for that knowledge to exist outside of a finite context or the group (Barley, Treem, & Kuhn, 2018). When arguing that knowledge can be held collectively, it is explained as generated through people working together in groups (Brown & Duguid, 1998). Therefore, as the organizational members in construction organizations work in temporary teams, the practice-based perspective is of importance, as it views knowledge as tied to practice and recognizes the difficulties for that knowledge to exist outside the group. A "collective mind" was forwarded by Weick and Roberts (1993) as a storage for knowledge related to group activities, and it is the combination of individual cognitive character and patterns, obtained through mutual experience (Berman, Down, & Hill, 2002). When several individuals are working together on a common set of goals, each individual is assigned a role and does not have the full knowledge required to do the job for the others. The knowledge that is required to meet the goals are diffused among the individuals, it does not reside in one of the individuals alone, it is the collectively held know-how. It requires a constant adjustment from everyone (Weick & Roberts, 1993).

This being the case, collaboration and communication are important but may be challenging in some settings, as in project-based organizations. Star (1998) developed the concept of boundary objects, objects that make it possible for different groups to work together without consensus. Across problem-solving contexts, boundary objects can be shared (Carlile, 2002) and create a common frame of reference. Boundary objects "create boundaries between groups through flexibility and shared structure, they are the stuff of action" (Star, 2010, p. 603). Boundary objects can be categorized into four, and we present Carlile (2002) adoption of the original categories: repositories, standardized forms and methods, objects or models, and maps of boundaries. *Repositories* provide shared definitions

for problem-solving, while *standardized forms and methods* provide shared format for problem-solving. Standardized forms and methods can be problem-solving methods or ways of reporting findings. *Objects or models* such as sketches, drawings, and computer simulations, can demonstrate current or possible "form, fit, and function" (Carlile, 2002, p. 451) of differences and dependencies. *Maps of boundaries* provide a systematic representation of functions or different groups and the dependencies and boundaries between these, such as workflow matrices or Gantt charts.

Common for all the presented categories is that they can be used across different functional settings. With the construction industry being highly fragmented, it can make it difficult to share knowledge across boundaries. Knowledge sharing is enabled and constrained through the artifacts of boundary objects (Bechky, 2003). In the view of knowledge as practice, the use of boundary objects contribute to learning and transforming of knowledge, and it allows different groups to share meaning (Carlile, 2002). Boundary objects are often technologies (Kimble, Grenier, & Goglio-Primard, 2010) and as ICT can reduce time-based and spatial barriers (Hendriks, 1999), and BIM can make interactions more flexible (Deutsch, 2011), digital tools have the possibility to act as boundary objects.

A recent review of knowledge management has been conducted by Barley et al. (2018). In their review, they look at 20 years of knowledge management literature and emphasize the tension between integrated and differentiated knowledge. Integrated knowledge is the knowledge that is common among organizational subunits, and is easy to share. Differentiated knowledge is the unique knowledge to each subunit specialized role and position, and is harder to share, such as the know-how. The authors used the term "knowledge trajectories" to distinguish and categorize previous literature, where the trajectories describe which of the two types of knowledge is the starting point for a knowledge management process. They identified four knowledge trajectories: (1) maintaining common ground (integrated to integrated knowledge), (2) producing common ground (differentiated to integrated knowledge), (3) producing specialization (integrated to differentiated knowledge), and (4) maintaining specialization (differentiated to differentiated knowledge). *Producing common ground* is most dominant in knowledge management literature, and describe knowledge management as a process aiming

at unifying various knowledge. We view this trajectory as an amplification to the importance of knowledge sharing in an organization, and as the majority of the knowledge in the construction industry resides in the individual (Vakola & Rezgui, 2000) the sharing and integration of knowledge can be of major importance. Information technology (IT) has played a major role in knowledge management literature focusing on this trajectory. It has been recognized that IT systems have the potential to both store codified knowledge and thus make a greater part of differentiated knowledge integrated, and also connect individuals with those who are the source for the differentiated knowledge. *Maintaining common ground* describe knowledge management as the practice of sustaining integrated knowledge. This can be viewed as a mean of retaining existing knowledge available for other actors, but this trajectory was represented the least in the study. *Maintaining specialization* is directed to the knowledge management view on retaining differentiation across tasks and time, such that organizations can seize a wider span of knowledge. *Producing specialization* starts with shared knowledge, but through processes, a small quantity of the integrated knowledge transforms to differentiated knowledge. Based on these trajectories one can ask questions of what knowledge to share and how to organize the knowledge management. Even with the discussion on which knowledge organizations should and can share, the importance of sharing knowledge throughout the organization is evident. This has also been emphasized by Inkpen and Dinur (1998, p. 456):

> 'Organizations cannot create knowledge without individuals, but unless individual knowledge is shared with other individuals and groups, the knowledge will have a limited impact on the organizational effectiveness. Hence, organizational knowledge creation should be viewed as a process whereby the knowledge held by individuals is amplified and internalized as part of the organization's knowledge base.'

2.3.1 Codification of Knowledge

Several researchers have examined if organizations forget the knowledge they learn, and considerable evidence has shown proof of knowledge decay or depreciation in organizations (Argote & Miron-Spektor, 2011). To prevent losing

valuable information and to be able to share best practice, knowledge can be codified. Codification has been referred to as the ability to structure knowledge into identifiable rules and routines that can easily be communicated (Kogut & Zander, 1992). Further, Cowan and Foray (1997, p. 596) defined codification as "the process of conversion of knowledge into messages that can be processed as information". In later years, knowledge codification has been described as the inscription of knowledge into text, drawings, templates, models and similar media (Cacciatori et al., 2012). Improvements in information technology have created a potential for an increase in codified knowledge. Both because it makes it easier to integrate differentiated knowledge, but also due to digital boundary objects (Kimble et al., 2010) that puts into a system the information on "who knows what" (Barley et al., 2018).

The question on if and how codification helps knowledge sharing has been widely debated (Cacciatori et al., 2012), and the discussion is divided into two different schools of thought based on the effects of conceptuality of knowledge (Cohendet & Steinmueller, 2000). Scholars of the first school argue that information about both the knowledge and the appropriate usage of knowledge can be codified. However, when codifying the context, a higher degree of costs are incurred, which influences the level of codification. Codification will be easier and cheaper in contexts that are easy to specify and less so in contexts that are difficult to specify (Cacciatori et al., 2012). The scholars belonging to the second school, argues that the meaning of codified knowledge is embedded in the social context and cannot be codified. Some argue that knowledge is needed to codify knowledge, and further, knowledge is needed to exploit the codified knowledge (Amin & Cohendet, 2004). Conclusively, in order for codification to be useful when sharing knowledge, there should be some sort of continuity in the relationship between sender and receiver, or the context must be reproducible to some extent (Cacciatori et al., 2012).

Benefits and Drawbacks of Codifications

Codification of knowledge creates benefits, as knowledge becomes more understandable and easier to share. This reduces uncertainties and information asymmetries in transactions between actors (Cowan & Foray, 1997). In research, some look at codification as an outcome while others view it as a process. When

looking at codification of knowledge as an outcome, it is often used to develop tools to provide routines and guidelines for future projects. In these instances, the codification is a way of providing information and/or facilitating routine replication (Zollo & Winter, 2002). Cowan and Foray (1997) refers to codification as a process and divides it into three aspects; creating models, creating languages and creating messages. We choose to look at codification as a process as we believe it is most suitable for our practice-based view on knowledge. When looking at codification of knowledge as a process, it has the possibility to enable the generation of new guidelines and changes to the organization's routines. Hence, it could identify the strengths and weaknesses of the current working routines (Zollo & Winter, 2002). This statement is supported by Lundkvist et al. (2010, p. 837) who states that "several improvements in a construction organization could be facilitated by knowledge about common defects", which codification would help identify. By exploiting this in construction organizations, the level of "lesson learned" may increase (Newell et al., 2006).

However, codification has not only been proven to create benefits. Encoding knowledge can be a costly process, particularly when the knowledge is highly experience-based (Cohendet & Steinmueller, 2000). Also, codified knowledge is less flexible than knowledge exchanged in person, and is, therefore, less useful for innovative products and processes (Cacciatori et al., 2012). Further, the possibility of codification of tacit knowledge is an important discussion. Firstly, many scholars argue that not all knowledge can be codified. Sharing of tacit knowledge is difficult due to the non-ability for a codification of this knowledge (Brown & Duguid, 1998). Secondly, there is a need for tacit knowledge to properly use the codified knowledge (Cowan & Foray, 1997). Whatever the intentions motivating the codification, the process of creating and using these codification tools requires an effort to "understand the causal links between the decisions to be made and the performance outcomes to be expected" (Zollo & Winter, 2002, p. 342), and consequently some ground of common understanding is needed.

Codification and Digitalization

Sharing and integration of knowledge are issues that both codification and digitalization could simplify. Codification streamlines the understanding and the

sharing of knowledge between individuals in the organization. Digital communication tools have the possibility to create a platform that facilitates contact between the people seeking new knowledge and those who possess the knowledge. These systems can both store codified knowledge and create an overview on the individuals with relevant tacit knowledge (Alavi & Leidner, 2001). So, even if tacit knowledge is hard to codify and might not be captured in the technology, the systems make knowledge of who knows what visible (Leonardi, 2007). Consequently, when combining codification and digital tools, the efficiency of knowledge sharing is increased. With technological advances, a larger part of knowledge has the potential to be codified, and thus to be shared and used efficiently (Lou & Bu, 2016). Nevertheless, even with technology advancing the codification of knowledge, the issues concerning which knowledge has the possibility to be codified remains. Argote, McEvily, and Reagans (2003) discussed the importance of a relationship between units when sharing knowledge. For knowledge sharing to be effective, a direct relationship is of importance (Uzzi & Lancaster, 2003). Although, the emphasis on how boundary objects connect different groups, argues that the usage of these objects makes it possible for groups to work together across contexts (Carlile, 2002; Star, 1998).

2.3.2 Knowledge Repositories

Acquired individual knowledge should be embedded in a repository which makes the knowledge available for others (Argote & Miron-Spektor, 2011) and makes it possible for an organization to reuse it. Alavi and Leidner (2001, p. 108) argued for the importance of the *application* of existing knowledge by saying:

> "It is less the knowledge existing at any given time per se than the firm's ability to effectively apply the existing knowledge to create new knowledge and to take action that forms the basis for achieving competitive advantage from knowledge-based assets."

The application of knowledge can be referred to as knowledge retention which is the reuse of knowledge and an organization's ability to store knowledge over time (Argote et al., 2003). By storing knowledge, organizations can make knowledge available for others, and it opens for the possibility to share good practices across units or groups. Organizations store knowledge in repositories, reservoirs and

knowledge objects. Walsh and Ungson (1991) presented five retention "bins" or what can be categorized into the *repositories* of knowledge in organizations: (1) individual members, (2) organizational culture, (3) the organization's standard operating procedures and practices, (4) organizational structures and individual roles, and (5) the organization's physical structure of the workplace. The word *reservoirs* derives from the French word "reserve" which means "to keep for future use", which denotes the retention of knowledge (Argote & Ingram, 2000). What constitutes reservoirs of knowledge are the three basic elements in an organization; its members, tools and task, and the combination of these basic elements (Argote & Ingram, 2000)[2]. Organizations also store knowledge in *knowledge objects* such as electronic databases and ICT-systems, documents (Olivera, 2000), procedures and routines (March, 1991). In project-based organizations, knowledge is also stored in the interpersonal networks (Ferriani et al., 2005; Grabher, 2004; Starkey, Barnatt, & Tempest, 2000). Shared experience and knowledge required for a task, and knowledge acquired through a task is spread between many individuals and therefore, stored in a collective mind (Weick & Roberts, 1993).

In accordance with the arguments above about different forms of repositories, boundary objects can take form as repositories (Carlile, 2002) as these enable interaction across context. Another form of a repository is the routines embedded in the organization (M. D. Cohen & Bacdayan, 1994). Organizational routines are repeated, interdependent patterns of action which specify how activities are performed and interrelated (Argote & Guo, 2016). Routines store the organization's past experience, and therefore, routines have the possibility to facilitate sharing of best practices throughout the organization. Through the years there have been several ways of explaining routines. Earlier studies often look at routines as automatic and repetitive (Gersick & Hackman, 1990), while more recent articles have researched the fluid feature of routines, and has looked into the specific context and situated actions through which routines are performed (Feldman, 2000). Several scholars now describe routines as a process as opposed to automatic behavior. Howard-Grenville and Rerup (2016) describes routines as emergent and generative, and not only entities that capture organizational knowledge. This

[2]This article refers to McGrath and Argote (2001) framework, but we were not able to get access to this book.

description is supported by Dittrich et al. (2016) who states that routines have the possibility to facilitate improvements in the organization through active talk and collective reflection. This underlines the importance of the routines in the organization, as it is the process of what the organization does and how they do it.

Social Capital

It has been argued that it is the collective knowledge that is strategically important (Spender, 1996), and shared tacit knowledge creates the foundation for organizational advantage. Researchers have found collective knowledge – the social capital – to encourage cooperative behavior, and by this facilitate creativity and learning (Nahapiet & Ghoshal, 1998). Meaning, when the organization socially share knowledge it fosters the development of new knowledge, and therefore the social capital can be a form of a knowledge repository. Further, Nahapiet and Ghoshal (1998) stated that organizations with the ability to create and exploit social capital have the potential to differentiate from their competitors, and are likely to be more successful.

In their study of social capital, Nahapiet and Ghoshal (1998) discussed the two different forms of knowledge creation and introduced knowledge creation through combination and exchange of knowledge. Combination is a form of knowledge creation through the combination of existing knowledge and experience. Knowledge can also be generated by the exchange of resources held by different parties. Further in their study, Nahapiet and Ghoshal (1998) identified four conditions for combination and exchange: (1) access to parties for combining/exchanging knowledge, (2) anticipation of value through the combination/exchanging of knowledge, (3) motivation to combine/exchange knowledge, and (4) capability to combine information or experience to create new knowledge. Even if the motivation is present, accessibility and the anticipated value of the combination and the exchange of knowledge, and the capability to combine this experience, must exist. Accordingly, Nahapiet and Ghoshal (1998) proposed the latter conditions based on the research of Szulanski (1996) on internal stickiness and his discovering of barriers such as the lack of capability to apply new knowledge. The capability condition can also draw the research by W. Cohen and

Levinthal (1990) on absorptive capacity. This term refers to the assimilation to recognize the value of new knowledge and the ability to use it.

When explaining the role of social capital in the creation of knowledge, Nahapiet and Ghoshal (1998) considered three dimensions of social capital, the structural, cognitive and relational dimension. The structural dimension is the overall structure of connection, it relates to the network of relations and the linkages between units and people. This dimension concern how and who you reach (Burt, 1992). The cognitive dimension refers to "those resources providing shared representations, interpretations, and system of meaning among parties" (Nahapiet & Ghoshal, 1998, p. 244). It is what the people believe and feel. The relational dimension concern the relationship that has been developed between people through time and interaction. Although it is a distinction between the three dimension, the features in each dimension are interrelated and the combination of these dimensions contributes to the generation of new knowledge.

2.4 Discussion of Literature

In our literature review, we have looked at project-based work, digitalization and knowledge sharing from a practice perspective. We have identified relevant topics related to our research question on *how can digitalization facilitate knowledge sharing between projects in construction organizations*? What we have established so far is that there are several challenges related to knowledge sharing between projects in construction organizations. For us to properly answer our research question, we need to discuss the topics of project-based work, digitalization, and knowledge sharing as one. We have identified four topics that need to be investigated further, as these seem to be areas that may affect how knowledge sharing is handled in construction organizations. To each topic, we have formed one sub-research question.

For an organization to be able to share knowledge, it is important that this is something the organization and its members are actively working on. We viewed literature on how knowledge sharing can be difficult due to its stickiness (Szulanski, 1996) and the unwillingness of individuals to share knowledge (Bock et al., 2005). Drawing on the dimensions of Nahapiet and Ghoshal (1998) it may be challenging

to share knowledge if it is not conceptualized in either the organizational structure, relationships nor in the perception of the organizational members. As project-based organizations can become loosely coupled (Lundkvist et al., 2010) the need for a good structure that facilities knowledge sharing is important. In addition, drawing lines to the relational dimension, the project-based organization may be hindered to share knowledge as the ties within the organization is weaker than within a single project, and therefore hinder knowledge sharing between projects. An interesting subject to bring forward is the use of digital tools and systems as boundary objects in project-based organizations. Even though these organizations can be decentralized (Orton & Weick, 1990), boundary objects can connect different functions and share knowledge without the time-based or spatial barriers (Carlile, 2002). This being said, the construction organizations are far behind on digitalization, and maybe there is something to it – lack of digitalization unable the project-based organization to connect all its member. Based on this we have formed the following sub-research question:

In what way is knowledge sharing valued in construction organizations?

The theory states that there are several types of knowledge repositories that exist, like culture, structure and practice (Walsh & Ungson, 1991), ICT objects (Olivera, 2000), routines (M. D. Cohen & Bacdayan, 1994) and social capital (Nahapiet & Ghoshal, 1998). As the organizational members work on temporary projects and often in differing teams, this may affect how they are able to share knowledge throughout the organization, and how different projects can apply others' knowledge. We suspect that the interactive nature of construction projects affect their use of knowledge repositories and also the importance of being able to store experiences. As it has been argued that projects are unique (Turner & Müller, 2003), we question if practices and routines can be common knowledge repositories. If a project is one of a kind, the practices will most likely vary and therefore make it difficult to store knowledge and make it available for others. It has been shown through the theory that digitalization has the possibility to facilitate stronger knowledge sharing (Fischer et al., 2017; Froese, 2010; Prencipe & Tell, 2001). As construction organizations are behind on digitalization, we believe that use of

digital knowledge repositories may not be properly developed, or if so, not fully utilized. Based on these issues, a second sub-research question was formed:

What types of knowledge repositories exist in construction organizations?

As theory describe knowledge sharing as a collective course of action (Bock et al., 2005), and as difficult to share due to its tacitness (Grant, 1996a; Spender, 1996), other challenges for knowledge sharing may exist. Therefore it is highly important to understand how the organizational members are interacting, as working in project teams characterizes construction organizations. As projects in construction organizations can be viewed as complex and one of a kind, sharing of knowledge may be difficult (Pathirage et al., 2007). A deeper look at the relations between projects and the interaction across teams will hopefully give us a broader understanding as to how knowledge sharing may be facilitated in the organization or why it may be hard to share knowledge between projects. In general, the combination of the two first sub-research questions and the topics discussed in this section will hopefully help us to understand how the organization is working on facilitating knowledge sharing and challenges the organization is facing in this regard.

What barriers and opportunities for knowledge sharing exist within construction organizations?

An important aspect of our main research question is how digitalization has the possibility to facilitate knowledge sharing. After having discussed the current barriers to knowledge sharing in the organization it may be easier to understand which problems digitalization needs to tackle to improve the level of knowledge sharing. Also, it will be of importance to understand if the barriers to knowledge sharing have the potential to be facilitated by digitalization or if it is a problem that digital tools cannot solve. Therefore we want to investigate the phenomenon of knowledge sharing further by applying theory on digitalization and ICT tools. The theory states that ICT tools have the possibility to better knowledge sharing by reducing the time-based and spatial barriers (Hendriks, 1999), but also that

digitalization is far behind in construction organizations (Agarwal et al., 2016). As project-based organizations can become decentralized (Orton & Weick, 1990), it will be of interest to investigate how digital boundary objects can connect the different projects and organizational members, and integrate a larger amount of knowledge (Kimble et al., 2010). In order to understand how digitalization can facilitate knowledge sharing between projects in construction organizations, it is of importance to investigate the current use of digital tools and which possibilities digitalization may create for the organization.

In what way can digitalization accommodate barriers for knowledge sharing in construction organizations?

All of the four sub-research questions are highly interrelated and will be part of the main conclusion. It will be of great importance to get a deep understanding of how the organization tackles these issues in their current work. By investigating the four sub-research questions, we will hopefully see if knowledge sharing is an important issue that should be addressed in construction organizations, and if so, which possibilities there may be for improving this with digitalization.

CHAPTER 3 – RESEARCH METHODOLOGY

3.1 Research Strategy and Research Design

In our research, we have decided to use a qualitative research approach. Qualitative research addresses questions about how social experience is created and given meaning and produces representations of the reality of the individuals considered (Denzin & Lincoln, 2011). As we are looking at knowledge sharing between projects, it is of great meaning to understand how the people working in the project view knowledge sharing, and to grasp their representation of reality. Further, qualitative study can be described as a research strategy that emphasizes words rather than quantification in the collection of data (Bryman & Bell, 2015). For us to comprehend how the organization focus on and use knowledge sharing, it will be important to talk to and interact with different organizational members and observe how the organization work. Meaning, our research will emphasize words and not quantification of data, which further explains why a qualitative study is fitting for our research. Further, qualitative data has been said to clarify complex social processes (Eisenhardt & Graebner, 2007), as knowledge sharing arguably is.

When investigating how knowledge sharing between projects in the construction industry can be facilitated by digitalization, we needed to study a specific organization to get an understanding of the organizational processes and look at the research in a real-world perspective. These elements are distinctive needs in a case study (Yin, 2014), and therefore, we chose to do a qualitative case-study. Case-studies are often contemporary descriptions of recent events (Eisenhardt & Graebner, 2007), and therefore a method of study that fits our research question well. As part of our research is looking into the theory of digitalization and the possibilities digital tools creates for the construction industry, our analysis is affected by the recent developments and trends in this area.

When doing a case study, it is possible to do a single- or a multiple- case study. For our research, we have chosen to conduct a single case study, as we wanted to do an in-depth analysis of one organization to get a deep understanding as to how knowledge sharing is facilitated and to get a clear image on which possible changes need to be made to better this aspect. As single case studies are acknowledged to

richly describe the existence of a phenomenon (Siggelkow, 2007), it was the fitting research design for our research question. Also, in cases where the company provides the researchers with unusual research access, a single case study is a good choice (Yin, 1994). As one of the researchers is employed with the company, we have had a very high level of access, giving our analysis even more substance.

3.2 Empirical Setting

In our study, we wanted to investigate a specific company within the construction industry in order to get an understanding of how the working methods and practices are. We chose the company, BackeGruppen, based on our interest for this company and based on the company's interest and openness for us to write our thesis using their company as a case. BackeGruppen is one of the top construction companies in Norway and it is a corporate group consisting of several subsidiaries. The group operates within four main business areas; contractor, project development, property management and rental of machinery. All the subsidiaries go under the parent AS Backe, and operate on a common set of values.

Based on our research question on knowledge sharing between project, we found it most suitable to look into the business area of contractor and chose Backe Entreprenør AS (contractor) as our unit of analysis. Backe Entreprenør, from now on referred to as Backe, consist of 10 locally anchors contractor companies. The project-portfolio consists of apartment buildings and commercial buildings in addition to public-private partnership. All the locally anchors contractors work according to a common total quality system (TQS). This system is a set of routines and minimum requirements related to working procedures and the construction process that is available in digital form through the intranet.

The reason for choosing Backe as our case was because we needed an empirical setting with descriptions of the phenomenon (Eisenhardt & Graebner, 2007) of knowledge sharing in project-based organizations. We saw the organization as a case that could provide us with rich empirical descriptions of project-based work. After discussions with Backe, we also recognized that our research question is of importance to the organization, which is another reason for choosing this organization as a case (Eisenhardt & Graebner, 2007). For our research, we looked

at the organization as the unit of analysis as we wanted a deep understanding of knowledge sharing *between* project, not within a single project. Further, we chose four sub-cases – four projects – to collect data from. Our target was to get an understanding of the practices and how the organization worked, and by this be able to analyze how the organization currently are working with knowledge sharing. Based on the structure of the group and that they have the same way of doing business, we gathered data from two of the contractor companies under Backe located near each other. The companies have approximately 100 and 65 employees, with a turnover of approximately MNOK 650 and MNOK 550. The companies have between seven and ten projects under construction yearly. As we gathered data from several projects it was important that the buildings were of the same type, and therefore we looked into projects of apartment buildings. The chosen projects were in different phases in the construction process, we looked at one that had just began, one that was nearly finished and two that were finished.

3.3 Data Collection

We used several methods of data collection in our research. When using more than one method or source to collect data on a social phenomenon it is called triangulation (Bryman & Bell, 2015). Yin (2014, p. 17) states that ‘’a case study inquiry relies on multiple sources of evidence, with data needed to converge in a triangular fashion’’. When using a triangulation strategy, the findings are being cross-checked and it can increase the validity. Using this strategy also substantiates our reasoning for choosing a case study as our methodological approach. Our sources for data were interviews, meetings, organizational documents, and systems (see Appendix 4, 5, 6 and 7). We also had access to the TQS were we looked into minimum requirements and routines for the construction process. All the collected data was being cross-checked, compared and contrasted. In the following sections, we will describe how we collected the data and how triangulation was executed.

3.3.1 Interviews

When using a qualitative method it requires the collection of qualitative evidence, and in a case study, the most important source of evidence comes from the interviews (Yin, 2014). We conducted semi-structured interviews with key project

members. In a semi-structured interview, the researcher has an interview guide with a list of questions of specific topics that need to be covered, but the researcher is free to go back and forth and ask additional questions (Bryman & Bell, 2015). This makes the interview-process flexible as it makes it possible to ask follow-up questions. In our interviews, we wanted to get an understanding of the working procedures in Backe. We wanted to investigate how the project-organization work at the beginning of a project and how they finish a project. We asked questions about the different positions and about the working routines related to the different phases. In all of our questions about the beginning of projects, we were interested in what happens after the round of tender is won, and therefore did not include any questions about this.

A total of fourteen interviews were conducted with project-members from four different projects (see Appendix 4 and Table 1). The first interview we conducted was a test to try out our questions and see if the interview guide was adequate. This interview lasted for approximately fifty minutes and it had a good flow where we got a lot of good answers, and therefore no further changes were done at that time. However, the rest of the interviews (without the count of one more of 50 minutes) lasted only for approximately 30 minutes. We asked open questions (see Appendix 2), but it seemed like the interviewees found it difficult to relate to some of the questions.

We made a second interview guide after ten interviews were conducted (see Appendix 3). The reason for doing this was because no new information was revealed and we needed a wider understanding of some of the aspects. Therefore we went back to theory to see if there were other relevant perspectives we should focus on to uncover new information. We also rephrased the research question as we noticed that several interviewees got confused by digitalization and thereby struggled with answering our questions as mentioned above. The second interview guide focused mainly on knowledge sharing and was divided into three categories based on the dimensions of social capital (Nahapiet & Ghoshal, 1998).

Most of the interviews were conducted face-to-face, but due to geographical location or the lack of time for the participants, we chose to conduct some of the interviews over phone or Skype. The face-to-face interviews were held at the

interviewees' choice of location, although all of them were cooperative to meet us halfway or to coordinate with other interviewees. We conducted two phone-interviews and two Skype-interviews. We were aware of the risk related to using the phone, such as not seeing their facial expressions and physical reactions, but the interviews were successful. The Skype-interviews also worked well. Although, we believe that this form of interviewing may have led some of the interviewees to answer in a shorter manner. The short answers could also be a consequence of the specific nature of the second interview guide.

We recorded all the interviews so both of us had the possibility to listen to the interviewee, and to eliminate any potential mistakes that can appear in written notes. By recording the interviews we could later transcribe them and easily get all the quotes right. The interviewees were informed of being recorded beforehand. We informed the interviewees that we would secure their anonymity by not revealing personal identifiable information, and only use the recording to strengthen our findings.

Sample

We followed a purposive sampling method in our study. This method is a non-probability form of sampling (Bryman & Bell, 2015, p. 429) where the sample of participants is sampled in a strategic way. The reason for choosing this method is because we did not want a random sample, and we selected the organization and the participants because of their relevance to our study (Bryman & Bell, 2015). Several approaches of purposive sampling exist, and we used snowball sampling. This approach is a form of using the network of other people to get in contact with others (Bryman & Bell, 2015). As one of us worked in the chosen organization, we had access to relevant candidates and we asked them to set us in contact with other members of the organization that they thought would be relevant for our study. We conducted interviews with the managing director for both subsidiaries, project managers, construction site managers, project planning managers, production managers and one project chief (see Table 1 below for overview). We did not have many specific criteria for the participants, other than they had to be on different managing levels in the projects. We did not have criteria of experience or years in the industry as our research focus were not on the individual knowledge, but rather

how the organization works. There was a variety among the participants of years of experience, age, gender, and years in the chosen organization. We categorized the interviewees into three age-groups; young adult, adult and middle aged.

Subsidiary	*Project*	*Project Status*	*Position*	*Age Group*	*Interview (type and length)*
X	-	-	Managing Director	Middle-aged	Face-to-face Approx. 50 min
X	A	Start-up	Project Manager	Adult	Face-to-face Approx. 30 min
			Construction Site Manager	Young adult	Face-to-face Approx. 30 min
			Project Planning Manager	Adult	Face-to-face Approx. 50 min
X	B	Completed	Project Manager	Middle-aged	Face-to-face Approx.- 30 min
			Construction Site Manager	Young adult	Face-to-face Approx. 30 min
X	C	Completed	Project Manager	Middle-aged	Face-to-face
			Project Planning Manager	Adult	Skype Approx. 25 min
			Production Manager	Middle-aged	Skype Approx. 25 min
Y	-	-	Managing Director	Middle-aged	Phone Approx. 25 min
Y	-	-	Project Chief	Middle-aged	Face-to-face Approx. 20 min
Y	D	Ongoing	Project Manager	Young adult	Face-to-face Approx. 40 min
			Construction Site Manager	Young adult	Face-to-face Approx. 25 min
			Previously Construction Site Manager	Adult	Phone Approx. 30 min

Table 1 – Overview of sample

3.3.2 Meetings

During our research, we conducted several meetings with different people of interest for our study as a part of our triangulation strategy. We had several meetings with key personnel working with digitalization (see Appendix 5). The purpose of the meetings was to get to know the organization and how they are currently working with development of digital solutions. The first meeting with two of the people working with digitalization in Backe was a brainstorm on relevant topics and some issues to address, in addition to getting ideas on how to angle our research. We also had a meeting with someone from Backe Prosjekt (project development) that is working with digitalization. We had this meeting in order to get inspiration for our research and to get insight into what possibilities that exist. Even though we did not collect any data in these meetings, they were necessary in order to get to know the organization and how they are working to develop digital solution today. The meetings also gave us inspiration and a wider understanding. At the end of our research, we had a meeting with one of the HSE managers in one of the subsidiaries. The purpose of the meeting was to get to know how the organization is working on knowledge sharing. We got a presentation of how this subsidiary is working with deviations and human injury, and how they are trying to share experiences related to this subject. We also got a tutorial on how the organization register deviation in their deviation system.

In addition to the meetings with the organization, we had one meeting with Bygg21 in the early stages of our research. The reason for having this meeting was to get some background information and to understand major challenges in the construction industry.

3.3.3 Organizational Documents

As another part of our triangulation strategy we looked into organizational documents on evaluation reports, meeting schedules and minutes from meetings among project managers, construction site managers, and chairmen (see Appendix 6). Documents we requested were sent to us from the managing directors through e-mail. We looked at evaluation reports to get an understanding of how the organization evaluates projects, while we viewed the minutes to see how the organization gather knowledge and make it visible for other organizational

members. The plan was also to do observations and participate on some of these meetings in order to see what was being discussed and compare it with the minutes, but this was unfortunately not something we managed to do. A schedule of the settled meetings within the organization and across functions were used in order to get an overview of how the organization works together when managing the project-based working method. We also looked into Backe's routines from the TQS to match this up with answers we got about this from the interviews, and to see if there were any important routines not mentioned. As we asked a great deal about the routines, it was important to explore this further. In addition, we wanted to get an understanding of how the organization works according to their routines. When doing this, the TQS was our source of data.

3.3.4 Organizational Systems

In addition to the TQS, we looked into other organizational systems (see Appendix 7). Looking into these systems was part of our triangulation strategy to match up what the interviewees said, or to identify what was not being mentioned but still of importance for our research. We had access to the organization's project portal, an overview of all the ongoing projects. This portal contains project-specific information that is accessible for all the organizational members. The reason for looking into this system was to get an understanding of how the organization makes project information available for others, and to see the type of information available.

Another system we looked into was the informal intranet. This platform is a place where all the organizational members can be part of different groups and share experiences. This is a place to front good solutions, share experiences and keep everyone updated on what is going on in the organization. We looked into this platform because we wanted to see how the organization are currently trying to share experiences, and which platform they use for interaction. We also viewed the organization's deviation system. We did not have access to this system, but we got a presentation and demonstration of how it works. The deviation system was a topic of discussion in the meeting with the HSE manager.

3.4 Data Analysis Strategy

3.4.1 Analytical Process

When conducting research there are several approaches to use. In our analysis, we have applied the abductive approach. Dubois and Gadde (2002, p. 559) describe studies using the abductive approach as ‘’the original framework is successively modified, partly as a result of unanticipated empirical findings, but also of theoretical insights gained during the process’’. This approach creates a broader base of analysis by combining established theoretical models and new concepts derived from the data collection. When applying this to the methodology, there is the possibility to go back and forth between framework, data sources, and analysis. It has been argued that data should not be forced to fit preconceived or preexistent categories, asserting rather that the categories are to be developed from data (Glaser, 1978). In our research, we have used the abductive approach as we did not want to be trapped to any preconceived views but wanted the ability to continuously go back to theory to reassess our data collection.

Dubois and Gadde (2002b) introduced the systematic combining approach following the abductive reasoning by going back-and-forth in the research. Although the simultaneous process is stated as especially useful for developing new theories, we found it suitable for our study as well. Systematic combining is the result of two processes; matching and redirection/direction (Dubois & Gadde, 2002b). Redirection and direction is important in order to do the matching, and is concerned with the impact of multiple sources of data. When using different sources of data we may discover unknown aspects, and even though our research is specifically directed, the revealing of something unknown may force us to redirect our study.

When starting an analytical strategy Yin (2014) mentions “playing with the data” as a good starting point. This is to recognize different patterns, insights, and concepts that might otherwise have been overlooked. These could emerge by manipulating the data through exercises as comparing interviews, making a matrix of categories and placing the evidence within such categories, and putting information in chronological order. All of these manipulations were used by us

when we examined our data. However, we went through several steps in our research before we started the process of analyzing our data.

First, we began by looking into theoretical frameworks and different literature on knowledge, project-based work, digitalization and the construction industry. This gave us a perspective on what we were missing, other literature we should look into and which topics could be relevant to investigate further. Also, it gave us an understanding of how we should proceed with our research. When we had thoroughly investigated the relevant theory, we developed three sub-research questions and the data collection started with interviews. As previously mentioned we changed the interview guide due to confusion and a need for a deeper understanding. This is part of the systematic combining approach as we went back and forth between the data and the theory to find new ways to extract the relevant data from our interview-objects to strengthen our research (Dubois & Gadde, 2002b).

When the interviews had given sufficient intel for us to start analyzing, we began coding the information in Nvivo. As we started, we categorized the data into three main categories based on our theory and the sub-research questions we had developed. When the data from the interviews were divided into the main categories, we went through all the information in the three categories, created a mind map in Nvivo and then divided it into sub-categories (Appendix 8). By doing this we got a clear overview of the data to better compare the statements and see the contrasts between them. Thereafter, we combined the categories in matrixes to see how different categories were related and to see if we recognized any interesting patterns (Yin, 2014). When reviewing the data, we noticed several interesting concepts that we wanted to analyze. To get a clearer structure of the analysis and to make sure we researched all concepts we needed for answering our research question properly, the three sub-questions were altered and a fourth was created.

After coding the interviews, we gathered and analyzed the additional data. We took a closer look at the TQS and viewed other systems the organization use on a regular basis. We examined the categories routines and procedures in Nvivo and tried to put the relevant coded statements in chronological order to get an overview of how a project emerge. This also gave us an idea as to how the interviewees' opinion on

routines differ, which was important for the analysis. These statements were compared with the TQS, to see how aware the interviewees were on the actual routines, and to see if something was missing in their statements. Moving forward with our analysis, we went through the sub-questions and used those as the foundation for our focus. When doing the analysis, we wrote down important concepts from the theory that either supported or contradicted what we were writing. This gave us a clearer understanding of our findings and made it easier when we started on the discussion.

3.5 Scientific Quality

3.5.1 Quality Criteria

When conducting a qualitative study, quality criteria such as reliability and validity need to be considered. *Reliability* is concerned with the question of whether the results of a study are repeatable (Bryman & Bell, 2015, p. 49) and it can be divided into external and internal reliability. The degree to which a study can be replicated relates to the external reliability. We are aware that it can be problematic to replicate a qualitative study, but we tried to secure the external reliability by informing the interviewees of how we would secure their anonymity. By explaining this, we hoped to make the interviewees comfortable with providing us their honest answers. Internal reliability is whether a research team agree upon their observations. Our research team consisted of the two of us, and we were aware of the fact that our interpretations of the observations could differ. Being aware of this, we secured internal reliability by recording the interviews and transcribing them afterward. By doing this, we could go back and listen to or read what the interviewees had said if our interpretations varied.

Validity is concerned with the integrity of the conclusion that is generated from a piece of research (Bryman & Bell, 2015, p. 50), and in qualitative studies, validity can be divided into internal and external validity. Internal validity relates to the degree of accordance between what the researchers observe and develop of theoretical ideas. One way we secured the internal validity was by the use of triangulation. This method enabled us to cross-check the data. We read thoroughly through the organizational documents, looked into the systems, and compared and

contrasted it with the interviews. By doing this, our reasoning and arguments were supported by several sources of data. External validity is whether the findings can be generalized across social settings or not. As mentioned in the introduction, our aim is not to generalize our findings. This would also be problematic as we conducted a case study of one specific organization with a small sample. The external validity is therefore not an issue of concern for this thesis.

3.5.2 Limitations of the Study

Before deciding to conduct a case study, we thoroughly looked at the potential weaknesses of this method. Easton (1995, p. 379) identified three types of weaknesses in case study research:

> ''Some case studies are simply rich descriptions of events from which the reader is expected to come to their own conclusions. Others are really examples of data that appear to provide, at best, partial support of particular theories or frameworks and are used in a quasi-deductive theory testing way. A third kind employs multiple "case studies" in a way that suggests that they are relying on some notion of statistical generalization.''

We were aware of these weaknesses and continually went through our research to avoid these common deficiencies in our case study. To reduce the possibility of encountering these weaknesses, our case study has a stronger reliance on theory, which also can increase the explanatory power of our case study (Dubois & Gadde, 2002). Our research will end with a rich conclusion including practical implications, which eliminates the first weakness. Also, by the use of detailed findings, we will both agree and contradict the researched theory, and thus hope to eliminate the second weakness. Finally, as our research is of a single case study and is not meant to generalize, the third weakness is not of relevance.

Further, we have identified some additional limitations connected to our research. As mentioned, some interviews were conducted by phone and Skype. This may have an impact on our research, as we missed out on the interviewees' expressions and how it possibly led to less comprehensive answers that may have resulted in

relevant information being missed. Another limitation was that sometimes it was difficult to get the necessary data as the organizational members were quite busy, and from time to time forgot our inquirers. This resulted in not getting all the documents we had originally asked for.

In our discussion, we will mainly support our argument based on the theory of digitalization, and not empirical findings. The reason for deciding to do this was because the use of digital tools varies between the projects and digitalization, in general, is still at an early stage in the organization. The fact that we will have limited empirical findings on the subject of digitalization, may hinder us to be critical to theory in the discussion of opportunities for digitalization.

3.5.3 Ethical Considerations

As ethical issues could arise when conducting the research, we discussed possible considerations beforehand to increase our awareness on these issues. In our study, we view harm to participants and lack of informed consent (Bryman & Bell, 2015) as most relevant.

Harm to Participants. We acknowledge that it is our responsibility as researchers to assess carefully the possibility of harm to participants, and ensure that the participants will not be harmed by our research (Bryman & Bell, 2015). As we wanted to get an understanding of the organizational members practices and how they work, their personal opinions were needed. Consequently, the participants are anonymous. Further, as we are investigating a company, we got clarification if the company wanted to be anonymous. Although this was not the case, we specified that we would not reveal any organizational information that was viewed as confidential or specific to the operating strategy.

Lack of informed consent. When conducting the study, the participants were fully informed about the nature of our research and why we view their participation as necessary. As we were collecting data from one company we saw no reason to avoid mentioning some parts of our research or present the research as something it was not. We also gave the participants the opportunity to withdraw at any point.

Another ethical consideration is the management of data afterwards. During our research we received several organizational documents and had access to the intranet as one of us was employed in the company. After our study is over, all of the organizational documents will be deleted as we do not have any more use for them. We asked permission for using the intranet and the accesses available through the employment for our research. Recorded interviews and the transcriptions of these will also be deleted so it will not be possible to use them for other study purposes unknown to the participants.

CHAPTER 4 – EMPIRICAL FINDINGS AND ANALYSIS

In this chapter, we will present our empirical findings and analyze the data in order to properly prepare for a discussion in the next chapter. The sub-research questions will be used as guidelines in our analysis in order to focus the findings on the overall research question on *how can digitalization facilitate knowledge sharing between projects in construction organizations?* We will use quotes from the interviews in order to support our analysis (see Appendix 9).

In what way is knowledge sharing valued in construction organizations?

The nature of project-based work makes the organizational members frequently change where, how and whom they work with. By having temporary teams and change in projects, the method of their work has to be adjusted regularly. This makes new knowledge frequently available, but it could also make it harder to develop interpersonal knowledge as the working environment is constantly shifting. Based on the meeting schedules from subsidiary X and Y (see Appendix 6), it seems like one way the organization connects its members is by having several regular meetings for the different organizational members, across projects. Some of the meetings include members across functions while other meetings are for specific positions. The frequency varies, and the topics of discussion are project status and other current issues. For instance, in the meetings for the project managers, the topics concern project status for each project and different challenges and solutions that can be of importance to others. In subsidiary X the construction site managers and project planning managers (in addition to stab functions) have monthly meetings. We looked into the minutes from one of these meetings and it was not divided into specific topics and had no set structure. As we had not been a part of this meeting, we found it very difficult to understand what had been discussed. On the contrary, in subsidiary Y there are monthly meetings for construction site managers, where the agenda is specified. In these meetings, they address issues such as project status on all the different projects. Knowledge sharing is also a separate category for discussion. However, when viewing the minutes it was hard to recognize the actual conversation of the meeting, as the notes were concise and uninformative.

Although, the meetings can be viewed as arenas to share knowledge and experiences with people in the same position as oneself, or others in the organization. Some of the interviewees mentioned how they use these meetings to exchange knowledge and discuss challenges and relevant experiences. As we looked into several minutes of different meetings, it was difficult to say anything specific about what was being discussed. For this reason, the minutes may be hard to understand for organizational members outside the meetings which may make the sharing of knowledge limited to the participants in the meetings. If the message from these meetings is made understandable for a broader audience in the organization, the knowledge can possibly be shared to a higher degree.

Several interviewees talked about the importance of interacting with colleagues inside and across projects which indicates interaction as an essential source of knowledge. It was also discussed how each project experience unforeseen events that may lead to problems and these problems have a tendency to be repeated.

"*Problems often occur along the way and are repeated in each project."*
Construction Site Manager

This may be a reason why the interviewees seem to view interaction as highly important. As problems may be repetitive in different projects, someone may have been exposed to these problems before. This was the view several of the interviewees had, and they described being sent between colleagues in order to get to the person with the knowledge to solve their issue. Some also mentioned only talking to the people in the same project, and thereby if none of the members had experience with a situation, they tried to solve it on their own instead of looking across projects. One interesting comment from an interviewee related to this was that there is a tendency in the industry that people need to make the mistakes themselves. Others also mentioned how people are set in their ways and do their job as they always have. However, who they talked to varied between the interviewees as some mentioned that they talked to their nearest supervisor or their colleagues in the same project, while others interacted with the whole organization to get the information they needed. Nevertheless, the majority described it as "low threshold" to reach out in the organization.

"There are no barriers there, it is quite a free flow. So if you are wondering about something, you can pretty much call anybody."
Construction Site Manager

Our findings show a common recognition of the value of other organizational members' knowledge, that interaction and communication are important in order to share knowledge. Based on this it seems as the interviewees value knowledge sharing, but that they do not execute it as often as they want or need. Further, several of the interviewees talked about how they all should be better at seeking new knowledge and share experiences across the organization, but they felt a need for arenas to meet and share knowledge.

"I believe that we could learn a lot from each other, and perhaps be a bit more proactive and have better knowledge sharing."
Construction Site Manager

"There may be too few arenas to meet, and it may not be allocated enough time and resources to do the job, it requires a little extra."
Production Manager

When talking about the nature of projects it was discussed whether projects are different and unique, or have similarities. Several of the interviewees pointed out how each project is one of a kind. It can be argued that having this view impair the perception of the importance of knowledge sharing between projects. In other words, the people with this point of view may find it difficult to understand how knowledge from other projects is relevant to their own. On the contrary, some mentioned how each project has similarities as projects have the same processes and procedures. The same phases repeat themselves in each project, and many of the same problems and challenges occur every time. From this point of view, it can be discussed that knowledge sharing between projects is relevant as one can learn from previous experiences. Meaning, by following the same processes and practices while sharing knowledge between projects, it may be possible to develop best practices.

"The projects are unique, that's what makes a project a project."
Managing Director

"... every construction project is, in fact, the same because you have to go through the same processes, solely the execution differs, but the process is exactly the same."
Project Chief

Based on our findings it seems like knowledge sharing is acknowledged as important. The organizational members value knowledge sharing through interactions with others, and several view knowledge from other projects as relevant, and in addition have a desire for arenas to share knowledge. Further, the findings also show that the organization values knowledge sharing to some degree as it has meetings where this is a topic on the agenda. However, it may seem like the organization is not facilitating knowledge sharing and do not encourage the organizational members to learn from other projects.

What types of knowledge repositories exist in construction organizations?

In order to study which repositories exist in the organization, we looked into the working procedures and organizational routines. What we found when viewing the procedures at the beginning of a project was that it varies which project members are available from the start. It was also mentioned that it varies to what degree the project manager is prepared for the project, if he has been a part of the calculation phase or not.

"It is often that some of the people that are going to be part of the project at a later point are occupied on other projects."
Construction Site Manager

When a project starts without all the project members, difficulties may occur. As knowledge seems to be based on the individuals' experience, valuable knowledge from the absent project member may be unutilized. In addition, when not all of the projects members are available at the beginning, the foundation for common knowledge may be weaker, as the team may lack a collective understanding. With

these variations at the beginning of a project, storing of knowledge can be difficult. As a result, knowledge in interpersonal groups may be limited.

"A great deal is based on what is kept in your head."
Construction Site Manager

"We have routines as a basis, but how it is carried out depends a lot on the resources or the people that are a part of that exact project."
Project Manager

When discussing the phase of closing a project, the interviewees described it as being hectic. There are many activities to be performed and different tasks to handle simultaneously. With these premises the time is limited and this affects the project members' priorities. According to the TQS, an evaluation meeting is a requirement at the end of the project. However, several of the interviewees mention that this was usually something the projects did not have time to carry out, or that it was not prioritized. Overall, several describe the closing phase as chaotic and stressful which leads to variation in the practices between projects. In addition, it was also described how it was common for project members to quickly transfer to new projects. When the members have started in new projects, previous experiences may have been forgotten and evaluation does not seem necessary or it happens too late. When there is no evaluation of the project, the gained knowledge and experiences may be difficult to keep for future use. It can also be a barrier for the project group to properly reflect upon the project. Without any reflection or common evaluation, storing of knowledge from the project can be complicated. This can also argue against the individuals' perception of knowledge sharing as valuable.

The time problem was also mentioned as a limitation for the individuals to evaluate and reflect upon their work after a project. Several of the interviewees talked about how they wish they were better at reviewing their performance. Some mentioned how they tried to write down what they have learned, while others said they only thought about it, or that they did not reflect upon it at all. It was acknowledged by some interviewees that the lack of reflection could make them miss out on possible valuable knowledge.

"Personally I write a journal and use Drop-Box … So I collect all the good experiences in a folder there which becomes my personal experience bank."
Project Manager

"Sometimes you wish you were better at taking notes as you go because you quickly forget."
Construction Site Manager

Further, several of the interviewees also spoke about the uniqueness of projects, and how this makes it hard to reuse knowledge. Both the lack of reflection and the uniqueness of projects may have an impact on how the individual reuse knowledge. As projects are unique, the project members may not see the value of storing knowledge for future use. This can also be a factor on how they prioritize their time at the end of the project when they decide to not evaluate their work. Nevertheless, the most common way of reusing knowledge was mentioned to be individually. Several of the interviewees talked about how they learn from their own experiences and apply this to new projects.

"You learn a lot from that. Mistakes you have made in earlier projects. Make sure you don't take these with you on to the next one."
Project Manager

When talking about the general working procedures, several of the interviewees described their work as complex with many parallel activities. Some indicated that parts of their working methods are inefficient due to factors such as the manual handling of several tasks and the fact that each project starts from scratch.

".... we often start over again, instead of researching and searching for experiences."
Project Planning Manager

In addition, some of the interviewees also mention the complete overview of a project as complex. This was due to the usage of several systems that causes a separation of the information connected to one project. As a result, project members create their own personal solutions for some activities. For instance, a few of the

interviewees mentioned that they would rather or that they felt the need to create separate personalized documents as support to the project's systems. This separation of data and the use of personalized solutions that make it harder for the organizational members to share experience, can be barriers for later reuse of knowledge.

"It should be followed up in the ---- system, but there we did not have the whole overview so we needed to do the additional work in an Excel-sheet. In theory, it should not be necessary, but I needed it in order to have control."
Construction Site Manager

As every project is different and tends to start as a separate entity with no history to draw on, some of the interviewees described facing obstacles that are unknown. Some of these situations need to be handled immediately and due to the time crunch, people tend to use a quick fix. This is instead of searching for other colleagues' knowledge or trying to find the optimal solution by properly assess the situation. This can make it difficult to learn from mistakes and therefore hinder the ability to reuse knowledge.

After identifying the working procedures within the organization, we looked into the routines related to the construction process. When talking about the routines in the organization, many of the interviewees referred to the TQS. Some described using it regularly, while others mentioned it as a tool. The latter described using it more freely, and in addition to developing their own method of working in some activities.

"There is a routine in the total quality system, but it is not followed."
Managing Director

"The different production managers do it generally in their own ways, even though there are routines in the total quality system, where it describes how we are going to do it, we solve it in our own way anyway."
Production Manager

In addition to the interviews, we looked into the TQS and the belonging documents and templates. Much of what the interviewees said about routines was in accordance with the set routines, although some important ones seemed to be unmentioned, and we will come back to this. This being said, someone described the TQS as a collection of best practices, and many of the interviewees referred to it as some kind of "knowledge bank". Based on this, the TQS may be viewed as a repository, but the fact that the organizational members use it to a various degree points to it not being fully utilized. A reason for this may be that some of the organizational members do not see the full potential of the system, and do not comprehend that it is a source for best practice, but more as steps in the construction process that need to be followed.

"The TQS is a collection of all bad experiences. So, if you follow the TQS, you will most likely succeed. ..... So, that is our experiences bank in regards to operating projects in a good way."

Managing Director

Beside from the TQS, the organization also uses other digital systems to store and update documents related to a project. One of the systems, the project portal, was mentioned by some of the interviewees as a source for previous project documents and reports with relevant information. Although, it does not seem that this is something the majority take advantage of. It was not recalled that this platform was a natural choice to search for information. Even though the platform contains project relevant information, it seems like project members need to know what they are looking for to easily find it. When we viewed this portal, we found it challenging to navigate as it seemed to contain a lot of information without any distinct structure. However, the informal intranet seems to be a platform that is more frequently used to front good solutions. Although, it does not seems like the organization utilizes the full potential of the platform as a source of knowledge sharing, as none of the interviewees mentioned it in that regard. Through our meeting with the HSE manager, we were told that at the turn of the year a group named "Learning from mistakes" was made available through the informal intranet for the whole corporation. This group was made as a mean to share experiences and learn from mistakes others have made. However, only approximately eight percent of the employees in the corporation is part of the group. When viewing the informal

intranet and this group, we found it to be impractical to navigate as the posted mistakes appear as a list without the possibility to search. As both the project portal and the informal intranet seem to lack a clear structure and the fact that the use of these systems are not a part of the organizational routines, it seems that the organization is not able to take advantage of these potential digital knowledge repositories.

As already established, the interviewees talked about how each project is different and unique. On one hand, the interviewees mention facing the same problems in several projects and thus expressing the need for some type of repository to collect experiences. As this is something they mentioned not having, it may lead to reappearing problems and mistakes which could have been avoided if previous experiences were available.

"There is a great deal that is reinvented in each project."
Construction Site Manager

On the other hand, the interviewees also spoke about always facing new challenges. Even as several stressed the importance of an overview of common mistakes and solutions, they also recognized that some mistakes will be different and that previous solutions may not be suitable. Another issue that the interviewees talked about regarding problems, was the way they register the deviations. There is a strict routine on how both HSE and quality deviations have to be registered digitally. According to the TQS, the documentation of deviations are meant to provide opportunities for learning within and across projects. In the deviation system, project members register the deviation and send it to the actors responsible for the profession needed to solve it.

"You take pictures when a mistake or deviation occurs on the phone etc., and then you write what it is and send it, both on HSE and quality deviations. Then you send it to the person responsible for closing the deviation."
Project Planning Manager

A challenge several of the interviewees mentioned was how the deviations "disappear" when fixed and closed. This makes it hard for the project organization

to reflect on substantial deviations, and it may create a barrier for learning in other projects. This can indicate that the organizational members fail to see the deviation system as a source for knowledge. Further, the organizational members can only view deviations related to their own project, and there is no way of reporting the level of risk of the registered deviation. These factors may be barriers for using the deviation system as a digital knowledge repository in the organization. The repetitive problems may have been possible to avoid if the deviation system had some form for categorizing the level of risk and a way of searching for previous mistakes done by others.

One of the routines in the TQS describes how deviations should be assessed to see if there is a learning potential. An interesting finding was that none of the interviewees mentioned this routine at all, and when specifically asked how they evaluate deviations, none described this as a part of their working procedure. When the interviewees talked about the process of handling deviations, it started with registration of the deviation and then closing it without any further thought. Some mentioned how they discussed deviations in the regular operating meetings, but this was only on a primary level without details. With the low level of evaluation of the deviations, it may indicate that the organizational members do not understand the potential learning opportunities from the deviations. Consequently, the routines for evaluation may not be knowledge repositories.

The routines are altered to the whole construction process and are the same for all projects. The TQS has been developed based on experiences and the organization try to keep it as updated as possible. As mentioned before, an important part of the routines is regular meetings, both inside and across projects. As the meetings can be used as platforms to share experience, the members can regularly share and evolve their knowledge, both individually and together. When the meetings go between the different functions and across the organization with all employees, it may contribute to the possibility to reuse knowledge to a higher degree. Internal project meetings are also a part of the beginning procedure, and are held between the projects members in order to plan and prepare for the project. Throughout the project, there are also internal meetings concerning project status, and a fixed point on the agenda is to have an evaluation of the project so far. Having these meetings as a part of the routines can lead to a common understanding and may be a source

for knowledge evolvement inside the project group, and as a result, maybe a possible knowledge repository in the organization.

During evaluation in the closing phase, the only minimum requirement is project evaluation and the related routine is to document and store the project evaluation so it is available for other organizational members. The reason for having this routine is to transfer experience and reuse knowledge in new projects to come. Not much of what was being said in the interviews supported this routine. As we have mentioned previously, the time problem often leads to not prioritizing evaluation. Several of the interviewees also mentioned that it was, in fact, a routine to evaluate the project, but that they do not always follow it through. This could result in a low degree of knowledge being stored, and by this prevent the organization to learn from earlier projects. In addition, the evaluation reports are comprehensive and contain quite project-specific information. What can be viewed as the most relevant and useful information, like "matters of improvements", might disappear in the extensiveness of the report. Consequently, organizational members may not see the relevance of using these reports as a source of knowledge. It seems that these evaluation reports are meant to be repositories of knowledge, but the organization is not able to do this in an efficient manner.

".... it quickly becomes a report that is just written and to most pleasure for the person who wrote it, but it is placed in a drawer and disappears."
Managing Director

Although the TQS provides the organizational members with a structured and systematic approach, several of the interviewees acknowledged the fact that the working procedures differ from the routines. It seems as some of the routines are not followed fully in practice which leads to a difference between the organizational routines and individuals' working procedures. Consequently, the routines are not fully utilized as knowledge repositories in the organization. The TQS, the project portal, the informal intranet and the deviation system are to some degree knowledge repositories, but it seems like there is no common method for using them in order to store and search for knowledge. As consulting with other colleagues is a part of the daily work, it seems like knowledge sharing is implicit in the practices. Based on this, it may be argued that interpersonal networks are forms of knowledge

repositories. Another knowledge repository seems to be the individual and their working methods. As the individual knowledge is highly experience based, it may be hard to codify this knowledge and store it in a collective repository. All in all, it seems as the organization has several possible knowledge repositories but do not currently utilize these to the full potential. In general, there seems to be lack of a proper repository of good and bad experiences to share and learn from.

What barriers and opportunities for knowledge sharing exist within construction organizations?

In the previous sections, we have identified several barriers and opportunities for knowledge sharing. We have elaborated on the findings of how the organizational members view each project as unique, the lack of evaluation of projects, lack of arenas for the organizational members to share experiences and other factors that may prevent knowledge sharing. Also, interaction, teamwork, the individuals' valuation of knowledge sharing, and standard routines have been emphasized as factors that may facilitate knowledge sharing. In addition, we have identified several other factors that may be barriers and possibilities for knowledge sharing.

Many of the interviewees talked about how knowledge is entrenched in the way they work, and something that is "in their head". The knowledge they possess is something that has evolved over time. The very experienced interviewees talked about how they have developed their own working method based on years of practice. As their working methods happen instinctively it may not be obvious that this is experience others possibly could benefit from. This may result in valuable knowledge not being recognized and therefore not shared. It can also be difficult to share knowledge as it is developed through personal experience and may not be as easy to express.

"I have to use the experiences I have gained over these years, to solve it the best way possible."
Project Planning Manager

Although, some of the interviewees also spoke about their experience as a source of learning for others. It was mentioned that when preparing organizational

members for different management positions in a project, the organization uses training in practice. The trainee follows a project member in the specific position and gets to observe and participate in the working procedures. By following this training method it may be easier to share knowledge and experiences. This can be one way of sharing personal experiences as it is not only described by words, but also expressed.

"It's evident that I have much to teach based on my experiences."
Project Manager

Knowledge and experiences have been described as being based on the individuals' experience. At the same time, the majority talked about how interaction with other project members was a large part of their working procedure. Working in groups like this may lead to the evolvement of group-specific knowledge and experience and this can create the possibility to share knowledge within the project group. However, as the knowledge may be group specific, it may be hard to share this knowledge outside the group and between projects.

"We become a small organization in a way, we who sit out on the barrack…."
Project Planning Manager

Previously, we analyzed several factors that point to the construction process being unpredictable. Also, as we have identified, the working procedures differs and varies from the organizational routines. This may affect the extent to which the construction process can be standardized. With the lack of standardizing it may be hard to store knowledge in the operating procedures and as a result, it may be difficult to share knowledge.

Even though projects can be viewed as small organizations that dissolve when the project is delivered, it was a common understanding among the interviewees that knowledge and experiences from other projects are relevant for their own. However, according to the interviewees' descriptions of their working procedures, it does not seem like they are actively working on bettering the knowledge sharing between projects, or that they understand how they can find relevant knowledge in an effective manner.

"You actually use more money and frustration on searching, then to just close your eyes and get it over with."
Construction Site Manager

The fact that searching for knowledge is not embedded in the way they work and that the organization is missing a proper repository may be barriers for knowledge sharing. Nevertheless, it has been indicated that the organizational members view knowledge sharing as important but struggles to understand how to effectively do it. This may be an opportunity for knowledge sharing if the organization is able to facilitate it in a greater manner as it will most likely be well received by the organizational members.

As explained in previous sections, there are several barriers and possibilities for knowledge sharing in the organization. The uniqueness of projects, the group-specific knowledge and the differing working methods are among the barriers for knowledge sharing. Based on the findings, it seems to be a low degree of knowledge sharing throughout the organization, which creates possibilities to improve the facilitation of knowledge sharing between projects. These opportunities stem from what we have discussed in this section and in the sections above about the evaluation of knowledge and knowledge repositories. As there is a foundation for knowledge repositories and good routines, there is a great potential for facilitating knowledge sharing. In addition, as there is a desire for better knowledge management, and much knowledge is held individually or exist within projects groups, there exist knowledge that has the potential to be shared.

In what way can digitalization overcome barriers for knowledge sharing in construction organizations?

One interesting finding with regard to digitalization was how some of the interviewees found it hard to comprehend this subject. Some expressed how they were surprised by questions related to digitalization, even as they knew what the topic of our research was. Also, when asking questions of how they thought digitalization could simplify some of their working methods, some of the interviewees found it difficult to relate to this issue.

"I am not quite able to see what could have been, or how you can get a more digital flow."

Managing Director

When asked about digitalization (see Appendix 2 and 3), the interviewees' responses and knowledge varied. Some elaborated on the tools they currently use, and which possibilities there are for the future, while others had less to add. Also, the topic of digitalization meant different things for the different age groups. Even though the degree of knowledge of digitalization varied, the general perception of digitalization was optimistic. Although, there was a slight trend for the middle-aged group to be more critical to digitalization, and to value the craft work in the organization. Some of the interviewees emphasized the importance of manual labor and how it is the *people* with competence that create the value. This may complicate what can be digitized in the organization.

"We must not get a system that dehumanizes the sharing of experiences, where we sit in our office and search in a database to figure it out."

Managing Director

On the contrary, the trend of the young adult was forwarded as positive as this group only focused on the possibilities of digitalization. In general, their knowledge on the topic seemed to be greater. The variation in the organizational members' opinions on digitalization may have an impact on how the organization currently use digital tools and platforms and may affect how they should proceed with the integration of digital tools in the future.

"In my opinion, a great deal should have been digitized."

Construction Site Manager

"In the future, there may be more digital checklists, that you get help to check that all previous experiences are kept."

Project Manager

In their daily work, the organizational members use several digital tools, and a frequent statement was that there is a need for a common platform. As they are using different systems, and also use personalized solutions, it may be hard to gather the information in a cohesive matter. When information is scattered on several platforms, it may be harder to gather the information related to one project, and thereby complicate the storing and reuse of possible valuable knowledge.

"We do not have any systematic bank."
Managing Director

"It could be possible to develop a system where everything is present when you open it."
Project Manager

Several of the interviewees mentioned lacking a common repository with experiences and knowledge, and that this was something that could be possible to create with digital solutions. It seems like digitalization can improve the level of knowledge sharing by creating a common platform where knowledge is gathered and shared. This argument is based on our findings related to the TQS and the project portal, that these are digital systems that are functioning, but do not function properly as places to store and share knowledge.

"For all the things that appear, it would be an advantage to have it digitally, in some way, when you move on to the next similar project. Then you can use the previous experience to avoid some of the mistakes."
Construction Site Manager

"A great deal is based on experiences. The more we get digitally, the easier it is to retrieve it and use it for others."
Construction Site Manager

By establishing one common digital platform, sharing of both individual and collective knowledge may be facilitated, as it provides the organizational members with a forum that encourage knowledge sharing. Also, it may reduce the number of repetitive mistakes as earlier experiences will be easier to access and potentially learn from. Digitalization may have the possibility to make a greater amount of

knowledge available. Overall, based on the findings, several of the barriers for knowledge sharing in the organization may be overcome with the application and proper usage of digital knowledge repositories.

CHAPTER 5 – DISCUSSION

In this chapter, we will discuss our findings and draw lines between the literature and the empirical findings. The discussion will be based on the previous analysis and we will again use the sub-research questions to guide our discussion. We will conclude after every sub-research question so that we can answer our research question on *how can digitalization facilitate knowledge sharing between projects in construction organizations?*

In what way is knowledge sharing valued in construction organizations?

For knowledge creation and sharing to be utilized, it must exist a foundation of individual knowledge. Even as the practice-based view of knowledge may not categorize the knowledge as a possession, it can be argued that knowledge can be developed through practice, both for the individual and the organization. Our reasoning is based on Inkpen and Dinur (1998) argument on how sharing of individual knowledge is necessary for organizational effectiveness. Through the interviews, it was indicated that the organizational members' working methods are to a high degree based on their individual competence and personal experiences. As the members possess different personal experiences, it is important that they are able to share this knowledge with each other to strengthen the overall knowledge of the organizational members.

Even though the organizational members are highly interactive, they are working in temporary teams. Drawing on Nahapiet and Ghoshal (1998) relational dimension, it can be argued that the time-limit of projects may be a barrier for creating strong relations. The lack of relation could hinder the willingness of the organizational members to share acquired or created knowledge with others (Bock et al., 2005). This could be one factor for internal stickiness as Szulanski (1996) argues for. Even though theory emphasizes these problematics, this was not an issue mentioned by the interviewees. None of the interviewees discussed willingness to

share knowledge with others as a factor for the low degree of knowledge sharing but pointed to the uniqueness of projects and the lack of a common repository.

Even with the projects being characterized as unique, there is an acknowledgment throughout the organization that the same mistakes have a tendency to repeat themselves. This may be a result of not learning from others' mistakes as it seems like the organizational members need to make the mistakes themselves. This may indicate that personal experiences are more valued than others. If we draw on argument by Osterloh and Frey (2000) on the intrinsic motivation for knowledge sharing, it may seem that the organizational members do not see the true value of others knowledge and that they work in their own ways.

As it seems like the interviewees have a preconceived belief that every project is full of problems, it may create a shared representation on knowledge from other projects as irrelevant. Even though it was also emphasized how the organizational members see others knowledge as relevant, it is mostly connected to solving problems. It seems as there is no structure for preparing a new project by drawing on experiences from other projects, it is only when the crisis arises that the organizational members look across projects for relevant experiences. This being the case, transfer of best practices may be difficult or in some way ignored as the focus is on solving problems, not optimizing the construction process. This can be factors that lead to internal stickiness and hinder transfer of best practice (Szulanski, 1996) and organizational learning. The organizational members' common attitude may illustrate the impact the cultural-cognitive aspect has in an organization, how shared representations are of great importance (Nahapiet & Ghoshal, 1998).

The lack of repositories and arenas to meet may indicate that the organization is missing an overall structure to connect organizational members across projects. Interactions were important in the organization, albeit in regards to interacting inside the project and not across project teams. This may indicate that the linkages between projects are weak. By applying the contribution of Nahapiet and Ghoshal (1998), interaction between units is indicated to be fundamental for collective knowledge to exist. The low level of interaction between projects limits the reach and may be a barrier for the organizational members to search for knowledge from other projects. Consequently, the utilization of others knowledge and experiences

is confined. In order to combine and exchange knowledge between projects, the organizational members must have access to other members (Nahapiet & Ghoshal, 1998), which was also prevailed in our findings. In a way, the organization is connecting the different projects members by having different meetings and the informal intranet, but these were not forwarded as arenas to share knowledge. As there is a need for a common repository, according to the interviewees, one way the organization could make connections stronger is through the use of boundary objects (Bechky, 2003).

To conclude, there are several factors that affect how knowledge sharing is valued in the construction organization. When applying the dimensions by Nahapiet and Ghoshal (1998) and viewing them as interrelated we have identified how the construction organization values knowledge sharing. Interactions are highly important and part of how the organizational members work and this strengthen how the individual members value knowledge sharing. However, the cultural-cognitive perception can hinder knowledge sharing, as it may weaken the common understanding of the importance of knowledge sharing between projects. Also, the missing structure on how and where to share knowledge hinder the ability to share knowledge and thus the understanding of the value of knowledge sharing.

What types of knowledge repositories exist in construction organizations?

It has been analyzed how the working procedures differ from the organizational routines, and how this may hinder the organization to utilize the routines as knowledge repositories. The TQS is a collection of best practices that have emerged over the years, and as stated before, it can be a knowledge repository. Our argument is based on how Howard-Grenville and Rerup (2016) describe routines as something more than just capturing the organizational knowledge, that routines evolve over time. However, to facilitate the evolvement of routines, there need to be a collective reflection in the organization (Dittrich, Guérard, & Seidl, 2016). As the perception of the purpose of the TQS seems to vary between the organizational members, it may complicate using the routines in the TQS as knowledge repositories. This being the case, it may lead to – as in accordance with the findings – the procedures differing from the routines. Meaning, organizational practices are potential knowledge repositories (Walsh & Ungson, 1991), but it is difficult to use

the practices in this manner as the working procedures differ between the organizational members.

The interviewees discussed knowledge as something that was stored in their individual mind and that their actions are based on personal experiences. In this way, knowledge is stored in the individuals' role (Walsh & Ungson, 1991), but it is not made available for others. It has been argued in theory that individual knowledge should be made available to others (Argote & Miron-Spektor, 2011) and this is also reflected in the findings. The use of individual working methods and the lack of individual reflection and evaluation describe how the organization does not make tacit knowledge explicit. These factors may be consequences of the lack of standard operating procedures and repositories in the form of boundary objects. Boundary objects as repositories and standardized forms and methods provide respectively shared definitions for problem-solving and shared format for problem-solving (Carlile, 2002). The results show that there is no shared format for problem-solving as the organizational members use their own methods. Even though the organization provides definitions for problem-solving through the TQS, it does not seem like these definitions are shared as the organizational members' perception of the TQS differ. Without these shared formats and definitions, it is difficult to know what knowledge to share and how to make it available for others. Consequently, the tacit knowledge is not made explicit.

The description of how organizational members are working in teams and that they need to interact and consult with others, substantiates the literature on how knowledge is something that exists in groups (Berman et al., 2002) and is socially shared (Nahapiet & Ghoshal, 1998). As knowledge is socially shared, it is argued that this kind of knowledge is stored in interpersonal networks (Ferriani et al., 2005; Grabher, 2004; Starkey et al., 2000). However, as the organizational members are regularly changing teams, the issue of how knowledge can be stored in interpersonal networks arises. When projects are time-limited and autonomous it is difficult for the organizational members to create a common foundation of knowledge (Lindkvist, 2005). This may further hinder the development of collective knowledge which may complicate the use of interpersonal networks as repositories as there is a lack of common knowledge to store. This being said, it exists interpersonal networks outside the project organization as well. The frequent

meetings outside the project-organization develop networks that can be permanent as they are not related to the specific project, but to the specific function of the members. If drawing on the contribution of Nahapiet and Ghoshal (1998) on social capital, these meetings create linkages between organizational members of same functions and develop networks of relations where knowledge can be stored.

Several potential digital knowledge objects have been identified, such as the TQS, the project portal, the informal intranet and the deviation system. These systems contain codified knowledge and make it available for the organizational members to use. However, these systems are not connected or integrated which leads to the fragmentation of knowledge. When having several digital knowledge objects, it may be inconvenient to use them all as repositories. When evaluation has lower priority due to the time limitation of projects, it is reasonable to conclude that storing and sharing of knowledge will not be in focus if there is not an efficient way of executing it. However, digital systems have the possibility to integrate all project data (Froese, 2010), and the use of boundary objects can these reduce time-based barriers (Carlile, 2002). If the organization is able to utilize these opportunities, a digital system can be an important knowledge repository.

There are several knowledge repositories that exist in the construction organization, but it varies to what degree these are being utilized. Our conclusion is that the dominant repository in the organization is the individual members. Further, the permanent interpersonal networks are also a potential knowledge repository, contrary to the temporary project specific relations. The construction organization also store knowledge in its routines, but as a result of variation in working procedures, this repository is not fully utilized. Finally, digital knowledge objects are to some degree used as knowledge repositories in the construction organization, but not to their full potential.

What barriers and opportunities for knowledge sharing exist within construction organizations?

Literature reveals how the lack of proper evaluation may hinder improvements in the organizational processes, and fail to give the organizational members new understandings (Williams, 2008). As evaluation of a project is of lower priority,

knowledge sharing between project may be hindered and the organization may fail to improve the construction process. We base our reasoning on the fact that mistakes repeat themselves in different projects. This is in accordance with Newell et al. (2006) and their statement on a low level of lesson learned in the construction industry due to the uniqueness of projects. With projects being viewed as one of a kind, it is difficult to create standardized operating procedures. As discussed, this hinders storing of knowledge in the operating procedures and consequently creates barriers for knowledge sharing. On the contrary, as Blanco et al. (2016) argues, even though projects are different, this is not a reason not to learn from other projects. As it has been expressed that knowledge from other projects is, in fact, relevant, the uniqueness of projects is not necessarily a barrier for knowledge sharing.

It has been discussed that knowledge is embedded in the individuals' practice and in interpersonal networks. What we also have identified as a barrier for knowledge sharing is that much of the working methods and knowledge is of tacit art as it is based on experiences and therefore difficult to share. This can be supported by theory on how tacit knowledge is difficult to share as it is complicated to make this knowledge explicit (Brown & Duguid, 1998), and as this knowledge is unique to the specialized role and position (Barley et al., 2018). Codification can contribute to sharing knowledge as it can convert knowledge into transferrable information (Cacciatori et al., 2012; Cowan & Foray, 1997). However, as sharing of knowledge currently seems problematic in the organization, it can indicate that the knowledge is hard to codify. Further, much of the knowledge has been identified as tacit, which may explain why it may be hard to codify.

Nevertheless, even with a great part of the knowledge being tacit, there are still possibilities for improvements in the sharing of knowledge in the organization. We have already concluded that the organizational members value knowledge sharing, based on the findings and the contribution of Nahapiet and Ghoshal (1998). The fact that the organization has arenas and boundary objects with the potential for better knowledge sharing, combined with the organizational members desire to share, creates opportunities for knowledge sharing.

To conclude, the discussed problematics throughout this chapter may be barriers of knowledge sharing. The most important barriers are the lack of a proper knowledge repository and knowledge management, the cultural-cognitive perception within the organization, and the tacit nature of both individual and collective knowledge. Several opportunities for knowledge sharing exists as well, such as the expressed need for arenas for knowledge sharing and proper knowledge repositories, and the basis the current boundary objects provide. By the use of theory on digitalization, we will discuss how the opportunities can be realized and if the barriers are something digitalization can overcome.

In what way can digitalization overcome barriers for knowledge sharing in construction organizations?

Based on the identified barriers, we have defined three main issues in the organization; the problematics of (1) which knowledge can be shared, (2) how and where to store knowledge, and consequently (3) how to share knowledge.

The problematics of which knowledge can be shared is based on the findings of how knowledge is held individually and in interpersonal networks and is of tacit art. As this knowledge is unique to the specialized role and position (Barley et al., 2018) and hard to communicate (Kogut & Zander, 1992), it might be hard to understand what knowledge has the possibility to be shared. Digitalization has the potential to increase the amount of codified knowledge as it can integrate tacit knowledge to a higher degree (Barley et al., 2018). However, it is important to not ignore the fact that much of the working methods in the organization is dependent on human interaction. This finding is supported by the research by Cohendet and Steinmueller (2000) on how knowledge cannot be codified when embedded in the social context. This being said, not all tacit knowledge should be codified, but by the use of digital boundary object, there is a potential to put into system the information of "who knows what" (Barley et al., 2018; Leonardi, 2007). This enables the organization to share knowledge in a greater manner without dehumanizing it.

When knowledge is tied to practice as in interpersonal networks, it is difficult for that knowledge to exist outside the network (Barley et al., 2018) and therefore to be

shared throughout the organization. This combined with the time-limitation for projects are reasons why group knowledge may be difficult to share. However, by applying digital boundary objects these barriers can be eliminated as boundary objects reduce spatial barriers. Therefore, it becomes possible to retain the knowledge in the interpersonal network even after the project dissolves. This makes it possible to share group-specific knowledge between projects as it can be used across contexts (Carlile, 2002).

Organizations can store knowledge in knowledge objects such as electronic databases and ICT-systems (Olivera, 2000). As knowledge seems to be stored in different repositories, it may be hard to integrate and capture all the knowledge. However, by the use of digital systems, the organization has the possibility to enhance the integration of knowledge by increasing the individuals' reach and by this simplify the knowledge sharing (Agarwal et al., 2016). The organization is currently using several digital systems, but these are used to a various degree and do not communicate. As a result, the organizational members desire a common digital platform where experiences can be shared. The need for a common cohesive system is supported by Froese (2010) who argues for the importance of an integrated system. To successfully implement a digital system, there must be a common understanding as to why this system is needed (Deutsch, 2011).

The limited findings on digitalization can be based on the fact that some of the organizational members found it difficult to relate to this concept. The organizational members are set in their ways of working, and it is argued that the full potential of digitalization cannot be realized without also changing the work tasks and knowledge of the project participants (Froese, 2010). The currently used digital repositories do not seem to facilitate knowledge sharing, and there is no standard operating procedure on evaluation nor on sharing of knowledge. When investigating how to share knowledge by the use of digital solutions, it is not only about facilitating for the usage of digital systems, but also developing a common understanding of why knowledge should be shared in a digital system. When a common understanding is developed, digitalization has the potential to overcome barriers for knowledge sharing by creating a cohesive overall system where a greater amount of knowledge has the possibility to be shared.

CHAPTER 6 – CONCLUSION

6.1 Practical Implications

In our analysis and discussion we have concluded on our sub-research questions as a foundation for answering our research question: *How can digitalization facilitate knowledge sharing between projects in construction organizations?* Our conclusion is based on our findings and the presented and discussed literature. When answering the research question, we will refer to the theory only when it is cohesive with our findings.

Throughout the research we have managed to identify the importance of knowledge sharing in construction organizations. Based on our study, the construction organization needs to focus its attention on improving knowledge sharing between projects. As the results show, the organizational members are confident in their working procedures which results in ignoring the routines to some degree. This confidence, combined with the time-limitation of projects, results in many reusing their own experiences instead of searching for knowledge from others. When important routines are overlooked, it may be difficult to create standardized procedures. Consequently, the issue is not only about implementing digital solutions that can facilitate knowledge sharing, but also changing working methods to facilitate the implemented digital solutions. We have discussed how digital tools and boundary objects can increase knowledge sharing, but based on our empirical findings, digitalization cannot facilitate knowledge sharing without changing the working methods.

For the organization to be able to facilitate knowledge sharing with the use of digital tools, we have identified some areas of improvements in the organization:

- *Create a common understanding for knowledge sharing.* The organization should work on increasing the awareness and understanding of why knowledge between projects is important. Even though projects are unique, the same mistakes repeat themselves, and by sharing experiences this can be avoided.
- *Develop a better system for evaluation.* The organization should focus on developing a better system for evaluation that simplifies the evaluation of both projects and consequential deviations. As time-limitation leads to not

prioritizing evaluation, a simplification of this process can influence the organizational members' priorities.

- *Decide where to store knowledge.* As there is no clear structure on where to store knowledge, the organization should decide and agree upon where to store knowledge to prevent fragmentation and loss of valuable knowledge.
- *Decide how to share knowledge.* The organization should figure out how to systematically share knowledge by considering if knowledge sharing should be a part of the routines or if it should be assigned in the working procedures.

When the organization has focused their attention on these areas of improvements, digitalization has the possibility to increase knowledge sharing by:

- *increasing the amount of knowledge shared*. As a majority of knowledge is individually held (Vakola & Rezgui, 2000), digitalization can facilitate knowledge sharing between projects as it increases the individual's reach (Agarwal et al., 2016) and thereby makes it possible to utilize others knowledge in a higher degree as it is more accessible.
- *increasing the amount of tacit knowledge shared*. By putting into system "who knows what" a larger amount of tacit knowledge can be shared (Barley et al., 2018; Leonardi, 2007). Not because digitalization codify all the tacit knowledge, but as it can provide an overview of the individuals with the tacit knowledge. As much of the knowledge is experience based and difficult to make explicit, digitalization meets an important challenge of knowledge sharing.
- *simplifying sharing of knowledge.* The use of digital boundary objects makes it possible to reduce time-based and spatial barriers (Carlile, 2002), and digitalization can make it easier to store knowledge (Prencipe & Tell, 2001). It can simplify the process of sharing knowledge between projects as it can facilitate the organizational members wish of a common platform where knowledge can easily be stored and searched for.
- *increasing the integration of projects.* Digital boundary objects can contribute to a larger degree of knowledge sharing between projects as these object connects and integrate different units (Carlile, 2002). Integration is of major importance for sharing of knowledge between projects, due to the fact that projects are independent.

6.2 Recommendations for Future Study

Throughout our study we have identified several interesting topics and angles related to our research. We would like to recommend a future study of what specific digital tools could facilitate knowledge sharing, and the effects on knowledge sharing when using these tools. Also, it would be interesting to view this study at a managerial and organizational level on how to implement new routines with digital tools with the purpose for knowledge sharing. With this angle it would be suitable to further study the areas of improvements we have discovered. It would also be interesting to do an organizational psychology study of how to get the organizational members to change their personal working methods.

References

Agarwal, R., Chandrasekaran, S., & Sridhar, M. (2016). Imagining construction's digital future. *Capital Projects and Infrastructure.* Retrieved from https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future

Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 107-136.

Amin, A., & Cohendet, P. (2004). *Architectures of knowledge: Firms, capabilities, and communities*: Oxford University Press on Demand.

Amin, A., & Roberts, J. (2008). Knowing in action: Beyond communities of practice. *Research policy, 37*(2), 353-369.

Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational behavior and human decision processes, 82*(1), 150-169.

Argote, L., McEvily, B., & Reagans, R. (2003). Managing knowledge in organizations: An integrative framework and review of emerging themes. *Management Science, 49*(4), 571-582.

Argote, L., & Miron-Spektor, E. (2011). Organizational learning: From experience to knowledge. *Organization science, 22*(5), 1123-1137.

Azhar, S. (2011). Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadership and management in engineering, 11*(3), 241-252.

Barley, W. C., Treem, J. W., & Kuhn, T. (2018). Valuing Multiple Trajectories of Knowledge: A Critical Review and Agenda for Knowledge Management Research. *Academy of Management Annals, 12*(1), 278-317.

Bartsch, V., Ebers, M., & Maurer, I. (2013). Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management, 31*(2), 239-251.

Bechky, B. A. (2003). Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organization science, 14*(3), 312-330.

Berman, S. L., Down, J., & Hill, C. W. (2002). Tacit knowledge as a source of competitive advantage in the National Basketball Association. *Academy of management Journal, 45*(1), 13-31.

Blackwell, B. (2012). Industrial strategy: Government and industry in partnership–Building Information Modelling: HM Government.

Blanco, J. L., Janauskas, M., & Ribeirinho, M. J. (2016). Beating the low productivity trap: How to transform construction operations. *Capital Projects and Infrastructure.* Retrieved from https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/beating-the-low-productivity-trap-how-to-transform-construction-operations?cid=soc-web

Blindenbach-Driessen, F., & Van Den Ende, J. (2010). Innovation management practices compared: The example of project-based firms. *Journal of Product Innovation Management, 27*(5), 705-724.

Bock, G.-W., Zmud, R. W., Kim, Y.-G., & Lee, J.-N. (2005). Behavioral intention formation in knowledge sharing: Examining the roles of extrinsic

motivators, social-psychological forces, and organizational climate. *MIS quarterly*, 87-111.
Breunig, K. J., & Skjølsvik, T. (2017). Digitalisering av kunnskapsarbeid–utvikling, hindringer og drivere i virtuelle advokatfirma.
Brown, J. S., & Duguid, P. (1998). Organizing knowledge. *California management review*, *40*(3), 90-111.
Bryman, A., & Bell, E. (2015). *Business reseach methods*. Oxford: Oxford University Press.
Burt, R. S. (1992). *Structural holes: The social structure of competition*. Cambridge MA Harvard university press.
Bygg21. (2013). Hva er Bygg21? Retrieved from http://www.bygg21.no/no/om-bygg21/
Cacciatori, E., Tamoschus, D., & Grabher, G. (2012). Knowledge transfer across projects: Codification in creative, high-tech and engineering industries. *Management learning*, *43*(3), 309-331.
Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, *13*(4), 442-455.
Carlsen, A., Klev, R., & Krogh, G. v. (2004). *Living knowledge : the dynamics of professional service work*. Basingstoke: Palgrave Macmillan.
Cascio, W. F., & Montealegre, R. (2016). How technology is changing work and organizations. *Annual Review of Organizational Psychology and Organizational Behavior*, *3*, 349-375.
Cohen, M. D., & Bacdayan, P. (1994). Organizational routines are stored as procedural memory: Evidence from a laboratory study. . *Organizational Science*, *5*(4), 554-568.
Cohen, W., & Levinthal, D. (1990). Absorptive Capacity: A New Perspective On Learning And Inno. *Administrative Science Quarterly*, *35*(1), 128.
Cohendet, P., & Steinmueller, E. W. (2000). The codification of knowledge: a conceptual and empirical exploration. *Industrial and Corporate Change*, *9*(2), 195-209.
Cowan, R., & Foray, D. (1997). The economics of codification and the diffusion of knowledge. *Industrial and corporate change*, *6*(3), 595-622.
DeFillippi, R. J., & Arthur, M. B. (1998). Paradox in project-based enterprise: The case of film making. *California management review*, *40*(2), 125-139.
Deutsch, R. (2011). *BIM and integrated design: strategies for architectural practice*: John Wiley & Sons.
Dittrich, K., Guérard, S., & Seidl, D. (2016). Talking about routines: The role of reflective talk in routine change. *Organization science*, *27*(3), 678-697.
Dubois, A., & Gadde, L.-E. (2002a). The construction industry as a loosely coupled system: implications for productivity and innovation. *Construction Management & Economics*, *20*(7), 621-631.
Dubois, A., & Gadde, L.-E. (2002b). Systematic combining: an abductive approach to case research. *Journal of business research*, *55*(7), 553-560.
Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of management Journal*, *50*(1), 25-32.
Engwall, M. (2003). No project is an island: linking projects to history and context. *Research policy*, *32*(5), 789-808.
Ferriani, S., Corrado, R., & Boschetti, C. (2005). Organizational learning under organizational impermanence: Collaborative ties in film project firms. *Journal of Management & Governance*, *9*(3-4), 257-285.

Fischer, M., Ashcraft, H., Reed, D., & Khanzode, A. (2017). *Integration Project Delivery*. Hoboken, New Jersey: John Wiley & Sons.

Froese, T. M. (2010). The impact of emerging information technology on project management for construction. *Automation in construction, 19*(5), 531-538.

Gherardi, S., Nicolini, D., & Odella, F. (1998). Toward a social understanding of how people learn in organizations: The notion of situated curriculum. *Management learning, 29*(3), 273-297.

Ghoshal, S., & Moran, P. (1996). Bad for practice: A critique of the transaction cost theory. *Academy of management review, 21*(1), 13-47.

Gidado, K. (1996). Project complexity: The focal point of construction production planning. *Construction Management & Economics, 14*(3), 213-225.

Grabher, G. (2004). Learning in projects, remembering in networks? Communality, sociality, and connectivity in project ecologies. *European urban and regional studies, 11*(2), 103-123.

Grant, R. M. (1996a). Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration. *Organization science, 7*(4), 375-387. doi:10.1287/orsc.7.4.375

Grant, R. M. (1996b). Toward a knowledge-based theory of the firm. *Strategic management journal, 17*(S2), 109-122.

Hansen, M. T. (2002). Knowledge networks: Explaining effective knowledge sharing in multiunit companies. *Organization science, 13*(3), 232-248.

Hendriks, P. (1999). Why share knowledge? The influence of ICT on the motivation for knowledge sharing. *Knowledge and process management, 6*(2), 91.

Hislop, D. (2013). *Knowledge Management in Organizations: a critical introduction*. Gosport, Hampshire: Oxford University Press.

Howard-Grenville, J., & Rerup, C. (2016). A process perspective on organizational routines. Langley A, Tsoukas H, eds: The SAGE Handbook of Process Organization Studies (Sage, Thousand Oaks, CA). Forthcoming.

Inkpen, A. C., & Dinur, A. (1998). Knowledge management processes and international joint ventures. *Organization science, 9*(4), 454-468.

Kimble, C., Grenier, C., & Goglio-Primard, K. (2010). Innovation and knowledge sharing across professional boundaries: Political interplay between boundary objects and brokers. *International Journal of Information Management, 30*(5), 437-444.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization science, 3*(3), 383-397.

Leonardi, P. M. (2007). Activating the informational capabilities of information technology for organizational change. *Organization science, 18*(5), 813-831.

Lindkvist, L. (2004). Governing project-based firms: promoting market-like processes within hierarchies. *Journal of Management and Governance, 8*(1), 3-25.

Lindkvist, L. (2005). Knowledge communities and knowledge collectivities: A typology of knowledge work in groups. *Journal of management studies, 42*(6), 1189-1210.

Lou, Y., & Bu, J. (2016). How valuable is information and communication technology? A study of emerging economy enterprises. *Journal of World Business, 51*(2), 200-211.

Lundkvist, R., Meiling, J., & Vennström, A. (2010). *Digitalization of inspection data: a means for enhancing learning and continuous improvements?* Paper presented at the Annual ARCOM Conference: 06/09/2010-08/09/2010.

Manning, S. (2017). Building Core Teams and Flexible Partner Pools for Interorganizational Projects: The Rise of Project Network Organizations.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization science, 2*(1), 71-87.

March, J. G. (1999). *The pursuit of organizational intelligence: Decisions and learning in organizations*. MA and Oxford: Blackwell Publishers, Inc.

McGrath, J. E., & Argote, L. (2001). Group processes in organizational contexts. *Blackwell handbook of social psychology: Group processes*, 603-627.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management. The Academy of Management Review, 23*(2), 242-266.

Newell, S., Bresnen, M., Edelman, L., Scarbrough, H., & Swan, J. (2006). Sharing knowledge across projects: limits to ICT-led project review practices. *Management learning, 37*(2), 167-185.

Olivera, F. (2000). Memory systems in organizations: an empirical investigation of mechanisms for knowledge collection, storage and access. *Journal of management studies, 37*(6), 811-832.

Orton, J. D., & Weick, K. E. (1990). Loosely coupled systems: A reconceptualization. *Academy of management review, 15*(2), 203-223.

Osterloh, M., & Frey, B. S. (2000). Motivation, knowledge transfer, and organizational forms. *Organization science, 11*(5), 538-550.

Pathirage, C. P., Amaratunga, D. G., & Haigh, R. P. (2007). Tacit knowledge and organisational performance: construction industry perspective. *Journal of Knowledge Management, 11*(1), 115-126.

Prencipe, A., & Tell, F. (2001). Inter-project learning: processes and outcomes of knowledge codification in project-based firms. *Research policy, 30*(9), 1373-1394.

Schwartz, D. G. (2006). Aristotelian view of knowledge management. *Encyclopedia of knowledge management*, 10-16.

Shammas-Toma, M., Seymour, D., & Clark, L. (1998). Obstacles to implementing total quality management in the UK construction industry. *Construction Management & Economics, 16*(2), 177-192.

Siggelkow, N. (2007). Persuasion with case studies. *The Academy of Management Journal, 50*(1), 20-24.

Sjøgren, J., Krogh, E., Christensen, L., & Olsen-Skåre, K. H. (2017). *Digitalt veikart - For en heldiagnisert, konkurransedyktig og bærekraftig BAE-næring*. Retrieved from www.bnl.no:

Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic management journal, 17*(S2), 45-62.

Star, S. L. (1998). The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving *Distributed artificial intelligence* (pp. 37-54): Elsevier.

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, & Human Values, 35*(5), 601-617.

Starkey, K., Barnatt, C., & Tempest, S. (2000). Beyond networks and hierarchies: Latent organizations in the UK television industry. *Organization science, 11*(3), 299-305.

Sterman, J. D. (2000). *Business dynamics : systems thinking and modeling for a complex world*. Boston: Irwin McGraw-Hill.

Susskind, R., & Susskind, D. (2015). *The future of the professions: How technology will transform the work of human experts*: Oxford University Press, USA.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic management journal, 17*(S2), 27-43.

Turner, J. R., & Müller, R. (2003). On the nature of the project as a temporary organization. *International journal of project management, 21*(1), 1-8.

Uzzi, B., & Lancaster, R. (2003). The role of relationships in interfirm knowledge transfer and learning: The case of corporate debt markets. *Management Science, 49*(4), 383-399.

Vakola, M., & Rezgui, Y. (2000). Organisational learning and innovation in the construction industry. *The Learning Organization, 7*(4), 174-184.

Walsh, J. P., & Ungson, G. R. (1991). Organizational memory. *Academy of management review, 16*(1), 57-91.

Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative science quarterly*, 357-381.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*: Cambridge university press.

Wenger, E. (2000). Communities of practice and social learning systems. *Organization, 7*(2), 225-246.

Williams, T. (2008). How do organizations learn lessons from projects—And do they? *IEEE Transactions on Engineering Management, 55*(2), 248-266.

Winch, G. (1989). The construction firm and the construction project: a transaction cost approach. *Construction Management and Economics, 7*(4), 331-345.

Yang, S. C., & Farn, C. K. (2009). Social capital, behavioural control, and tacit knowledge sharing—A multi-informant design. *International Journal of Information Management, 29*(3), 210-218.

Yin, R. K. (1994). Case study research: Design and Methods, Applied social research methods series, 5. *Biography, Sage Publications, London*.

Yin, R. K. (2014). Case Study Research: Design and Methods: SAGE Publications.

Zander, U., & Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization science, 6*(1), 76-92.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization science, 13*(3), 339-351.

Appendix

Appendix 1 – Practical Information

The table below gives an overview on practical information related to the thesis.

What?	*How?*
Translating direct quotes	As we conducted the interviews in Norwegian we had to translate when using direct quotes. We have tried to translate each word directly in order to not change the meaning or interpretation from what has been said. Some places direct translation was not possible, but it was translated without the change of the meaning. Quotes included "----" refers private organizational information.
The usage of pronoun	We will only use the pronoun of "he" in our thesis were relevant. This is in order to avoid the phrase "he/she".

Appendix 2 – Interview Guide I

Forskningsspørsmål:
Hvordan kan digitalisering øke kunnskapsdeling mellom prosjekter i byggebransjen?

Innledning:
Vi skriver vår avsluttende masteroppgave om digitalisering i byggebransjen. Målet med oppgaven er å kartlegge hvordan digitalisering kan bidra til bedre kommunikasjon og kunnskapsoverføring mellom prosjekter. Vi har en formening om at byggeprosesser kan bli mer effektive, med reduserte kostnader dersom man tar med seg erfaringer fra tidligere av, og at digitalisering kan være en nøkkelfaktor til at deling av kunnskap kan bli gjort enklere og bli mer tilgjengelig for alle.

Tema	*Spørsmål*

Bakgrunn	- Fortell litt om deg selv og jobben du gjør i BackeGruppen.
	  - Alder
	  - Utdannelse
	  - Stilling
	  - Antall år i Backe
	  - Antall år i bransjen

Informasjonsflyt, kommunikasjon, gjenbruk av kunnskap	- Fortell oss hvordan du går frem når dere starter et nytt prosjekt. - Hvordan er rutinene deres ved oppstart av et nytt prosjekt? - Fortell hvordan du tar med deg tidligere erfaringer inn i et nytt prosjekt, *både dine egne og andres.* - Hvilke aktiviteter som gjøres i oppstarten hadde hatt fordel av å være digitalisert?
Digitalisering	- Hvilke digitale hjelpemidler bruker dere i dag? - Hvilke av disse ser du som mest relevant?
Kunnskapsdeling, kunnskaps-overføring, kunnskapslagring, nettverk	- Hvis du møter på uventede eller ukjente situasjoner, hva gjør da? - *Oppfølging:* Finnes det rutiner rundt dette? - Hvem er det du snakker med dersom du lurer på noe i forbindelse med et prosjekt? - Fortell oss hvordan du går frem ved avslutning av et prosjekt. - *Oppfølging:* Hvordan er rutinene deres ved avslutning av et prosjekt?
Avslutning	- Er det noe mer du tenker du burde dele med oss?

Appendix 3 – Interview Guide II

Justert forskningsspørsmål:
Hvordan kan kunnskapsdeling i byggebransjen bli fasilitert av digitalisering?

Innledning:
Vi skriver vår avsluttende masteroppgave om kunnskapsdeling og digitalisering i byggebransjen. Fokuset er på kunnskapsdeling mellom prosjekter, og vi ønsker å undersøke hvordan digitalisering kan bidra til å mer effektivt dele kunnskap på tvers i organisasjonen.

Tema	*Spørsmål*

Bakgrunn	- Fortell litt om deg selv og jobben du gjør i BackeGruppen.
	  - Alder
	  - Utdannelse
	  - Stilling
	  - Antall år i Backe
	  - Antall år i bransjen

Strukturelle forhold	- Hvordan jobber prosjektorganisasjonen sammen i oppstarten av et prosjekt? - Hvilke felles systemer brukes i oppstart av et prosjekt? - Kan du fortelle om hva slags møter dere har i oppstarten av et prosjekt? - Hva diskuteres i disse møtene? - Hvordan håndteres avvik underveis i prosjektet? - *Oppfølging:* Hvordan evaluerer dere disse avvikene? - Hvordan jobber prosjektorganisasjonen sammen i avslutningen av et prosjekt? - Hvilke felles systemer brukes i avslutningen av et prosjekt? - Kan du fortelle om hva slags møter dere har i avslutningen av et prosjekt? - Hva diskuteres i disse møtene? - Hvordan evaluerer dere avvik ved avslutning av prosjektet?
Relasjonelle forhold	- Hvem snakker du med dersom du lurer på noe i forbindelse med et prosjekt? - *Oppfølging:* Hvordan er det å ta kontakt med andre

	utover prosjektet, altså i andre avdelinger, på tvers av enheter eller andre Backe selskap? - *Oppfølging:* På hvilke andre måter henter du inn informasjon dersom du lurer på noe i forbindelse med et prosjekt?
Kognitive forhold	- I hvilken grad tror du kunnskap og erfaringer blir delt i Backe? - *Oppfølging:* Hva tror du er årsakene til liten/stor grad av kunnskapsdeling? (Avhengig av hva vedkommende svarer) - *Oppfølging:* Hvor relevant tror du kunnskap fra andre prosjekter er for ditt eget? - I hvilken grad reflekterer du over egne erfaringer i forkant av et prosjekt? - I hvilken grad reflekterer du over egne erfaringer i etterkant av et prosjekt?
Avslutning	- Er det noe mer du tenker du burde dele med oss?

Appendix 4 – Overview of Sample

Subsidiary	*Project*	*Status Project*	*Position*	*Age Group*	*Interview (type and length)*
X	-	-	Managing Director	Middle-aged	Face-to-face Approx. 50 min
X	A	Start-up	Project Manager	Adult	Face-to-face Approx. 30 min
			Construction Site Manager	Young adult	Face-to-face Approx. 30 min
			Project Planning Manager	Adult	Face-to-face Approx. 50 min
X	B	Completed	Project Manager	Middle-aged	Face-to-face Approx.- 30 min
			Construction Site Manager	Young adult	Face-to-face Approx. 30 min
X	C	Completed	Project Manager	Middle-aged	Face-to-face
			Project Planning Manager	Adult	Skype Approx. 25 min
			Production Manager	Middle-aged	Skype Approx. 25 min
Y	-	-	Managing Director	Middle-aged	Phone Approx. 25 min
Y	-	-	Project Chief	Middle-aged	Face-to-face Approx. 20 min
Y	D	Ongoing	Project Manager	Young adult	Face-to-face Approx. 40 min
			Construction Site Manager	Young adult	Face-to-face Approx. 25 min
			Previous Construction Site Manager	Adult	Phone Approx. 30 min

Appendix 5 – Overview of Meetings

Type of meeting (topic)	*Participants*	*Grounds*
Brainstorm meeting	The research team and two people from Backe Entreprenør working with digitalization	- Identify the company's interest areas and challenges - Identify what we could contribute with - Sharing and discussion of our ideas and thoughts
Inspiration and background	The research team and a key person from Bygg21	- Get background information - Get inspiration outside the case - Opportunity to discuss and ask questions about our thoughts
Brainstorm meeting	The research team and the same participants from the first brainstorm meeting	- More specific discussion related to our chosen research question - Input on different angles of our study - Get constructive critique to our research question
Inspiration	The research team and one leader from another business area working with digitalization	- Get an understanding of possibilities and challenges with digitalization - Get concrete examples of what digitalization can contribute to - See what another business area is working with - Get input on our research question from outside the case
BIM and possibilities of digitalization	One of the researcher and one person from Backe Entreprenør working with digitalization	- Get insight on how the organization use digital tools today - Discussion about the research topic
Deviation and knowledge sharing	The research team and the HSE manager in one of the subsidiaries	- See how the organization register deviations - Identify other topics related to knowledge sharing - Identify how the organization is currently working on knowledge sharing of deviations and human injuries.

Appendix 6 – Overview of Organizational Documents

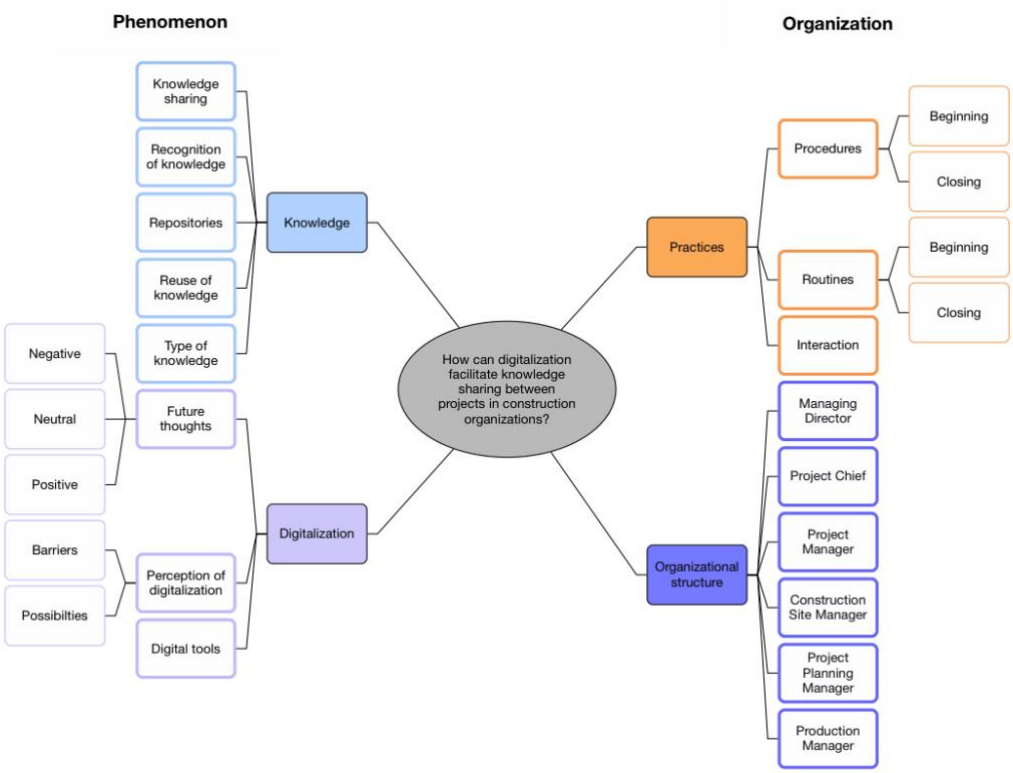
Type of document	*Retrieved from*	*Grounds*
TQS	Intranet	- View routines for the construction process - Match up what was being said in the interviews - Identify routines of knowledge sharing - Get an understanding of the working routines
Evaluation reports	Managing director in subsidiary X	- Match up what was being said in the interviews - See what kind of evaluation reports are used today.
Meeting schedules	Managing directors in subsidiary X and Y	- Identify how the organization facilitate knowledge sharing across projects
Minutes from meetings	Managing directors in subsidiary X and Y	- Identify what is being discussed in the different meetings - Identify what issues are highlighted - Match up with what the interviewees said about how some of the meetings are platforms to share knowledge.

Appendix 7 – Overview of Organizational Systems

System	*Description*	*Grounds*
Project Portal	- An overview on all the projects in the organization. - Access through the intranet. - Structured folders with content of project specific information. - Not all organizational members have access to all the folders.	- Identify how the structure of the platform are. - See what type of documents are available based on what the interviewees say.
Informal Intranet	- Intranet to front good solutions and a platform to share experiences. Lack of structure. - Organizational members "post" what they want in different groups.	- Get insight in what type of information is posted in an informal manner. - Investigate how this is currently used as a platform to share knowledge.
Deviation System	- Digital platform (accessible through computers, mobile phones, iPads etc.) - Register deviations in different categories with pictures and descriptions of the deviations. - The deviations are sent to the person/profession responsible for closing the deviation.	- Identify how the organization register and handle deviations. - Compare what the interviewees say with the system itself.

Appendix 8 – Coding of Data

The mind map illustrates how we structured our data from the interviews and coded it in Nvivo. The table below gives an explanation of the mind map and our reasons for why we chose to categorize the data in the way we did.



Category	*Sub-category*	*Grounds*
Knowledge	Knowledge sharing	- Identify when the interviewees talk directly about knowledge sharing. - Easy to see this coding category in light of many other codes.
	Recognition of knowledge	- Identify when the interviewees talk about how they recognize knowledge (either from others or other projects , or their own knowledge).
	Repositories	- Identify what the interviewees view as repositories today. - Identify what repositories exist or what is in the interviewees desire.
	Reuse of knowledge	- Identify when the interviewees talk about the importance of other knowledge. - Relevant to see this in light of practices or other codes.

	Type of knowledge	- Identify when the interviewees directly talk about individual vs. organizational knowledge. - Interesting to draw attention to in the discussion.
Digitalization	Future thoughts	- Further divided into positive, negative and neutral thoughts. - Identify the interviewees thought about the future of digitalization, if they are optimistic or pessimistic, what they argue for or against.
	Perception of digitalization	- Further divided into barriers and possibilities. - Identify the interviewees understanding of digitalization. - Identify what they see as possibilities and barriers of digitalization.
	Digital tools	- Map out the digital tools the organization are currently using. - Draw lines between what the interviewees talk about digitalization, and how they use digital tools in their work.
Practices	Procedures	- General procedures are the working methods within the organization. - Further divided into procedures of beginning and closing of a project. - Identify working methods and procedures. - Link up to knowledge sharing and other relevant topics. o Identify how the organization perform knowledge sharing in the regular working procedures.
	Routines	- General routines the organization have. - Further divided into routines of the beginning and closing of a project. - Identify organizational routines and minimal requirements of the construction process. - Link up to knowledge sharing and other relevant topics. o Identify if knowledge sharing is embedded in

		the organizational routines.
	Interactions	- Identify how the organizational members are working together and interacting. - Draw lines between procedures of interaction and knowledge sharing. o Identify how the organization is working with knowledge sharing as a part of the routines.
Organizational structure	Managing Director	- Distinguish between the different positions and the responsibilities. - Not categorized as a mean to the analysis, but for our own understanding.
	Project Manager	
	Construction Site Manager	
	Project Planning Manager	
	Production Manager	

Appendix 9 – Overview of Quotes

Sub-research question	*Topic*	*The interviewee's position*	*Quote*
In what way is knowledge sharing valued in construction organizations?	Repetitive problems	Construction Site Manager	"Problems often occur along the way and are repeated in each project."
	Interaction	Construction site manager	"There are no barriers there, it is quite a free flow. So if you are wondering about something, you can pretty much call anybody."
	Recognition of knowledge sharing	Construction site manager	"I believe that we could learn a lot from each other, and perhaps be a bit more proactive and have better knowledge sharing."
		Production Manager	"There may be too few arenas to meet, and it may not be allocated enough time and resources to do the job, it requires a little extra."
	Nature of projects	Managing Director	"The projects are unique, that's what makes a project a project."
	Nature of projects	Project Chief	"... every construction project is, in fact, the same because you have to go through the same processes, solely the execution differs, but the process is exactly the same."
What types of knowledge repositories exist in construction organizations?	Individually held knowledge	Construction Site Manager	"It is often that some of the people that are going to be part of the project at a later point are occupied on other projects."
		Construction Site manager	"A great deal is based on what is kept in your head."
	Collectively held knowledge	Project Manager	"We have routines as a basis, but how it is carried out depends a lot on the resources or the people that are a part of that exact project."

	Reuse of knowledge	Project Manager	"Personally I write a journal and use Drop-Box … So I collect all the good experiences in a folder there which becomes my personal experience bank."
		Construction site manager	"Sometimes you wish you were better at taking notes as you go because you quickly forget."
		Project Manager	"You learn a lot from that. Mistakes you have made in earlier projects. Make sure you don't take these with you on to the next one."
		Project Planning Manager	".... we often start over again, instead of researching and searching for experiences."
	Manually handling of tasks	Construction Site Manger	"It should be followed up in the ---- system, but there we did not have the whole overview so we needed to do the additional work in an Excel-sheet. In theory, it should not be necessary, but I needed it in order to have control."
	Routines	Managing Director	"There is a routine in the total quality system, but it is not followed."
	Routines	Production Manager	"The different production managers do it generally in their own ways, even though there are routines in the total quality system, where it describes how we are going to do it, we solve it in our own way anyway."
	Experience bank	Managing Director	"The TQS is a collection of all bad experiences. So, if you follow the TQS, you will most likely succeed. ….. So, that is our experiences bank in regards to operating projects in a good way."

	Nature of projects	Construction Site Manager	"There is a great deal that is reinvented in each project."
	Handling of deviations	Project Planning Manager	"You take pictures when a mistake or deviation occurs on the phone etc., and then you write what it is and send it, both on HSE and quality deviations. Then you send it to the person responsible for closing the deviation."
	Evaluation of projects	Managing Director	".... it quickly becomes a report that is just written and to most pleasure for the person who wrote it, but it is placed in a drawer and disappears."
What barriers and opportunities for knowledge sharing exist within construction organizations?	Individually held knowledge	Project Planning Manager	"I have to use the experiences I have gained over these years, to solve it the best way possible."
	Collectively held knowledge	Project Planning Manager	"We become a small organization in a way, we who sit out on the barrack…."
	Lack of knowledge replications	Construction Site Manager	"You actually use more money and frustration on searching, then to just close your eyes and get it over with."
In what way can digitalization overcome barriers for knowledge sharing in construction organizations?	Barriers of digitalization	Managing Director	"I am not quite able to see what could have been, or how you can get a more digital flow."
		Managing Director	"We must not get a system that dehumanizes the sharing of experiences, where we sit in our office and search in a database to figure it out."
	Possibilities of digitalization	Construction Site Manager	"In my opinion, a great deal should have been digitized."
		Project Manager	"In the future, there may be more digital checklists, that you get help to check that all previous experiences are kept."

	Digital knowledge repository	Managing Director	"We do not have any systematic bank."
		Project Manager	"It could be possible to develop a system where everything is present when you open it."
		Construction Site Manger	"For all the things that appear, it would be an advantage to have it digitally, in some way, when you move on to the next similar project. Then you can use the previous experience to avoid some of the mistakes."
	Individually held knowledge	Construction Site Manager	"A great deal is based on experiences. The more we get digitally, the easier it is to retrieve it and use it for others."

Appendix 10 – Preliminary

See attachment.