Exploring Networking Barriers for Excavated Soil Management

A case study in the construction industry

En studie av nätverksbarriärer för utgrävd jordhantering
En fallstudie inom byggindustrin

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Abstract

The construction industry is today one of the greatest consumer of natural resources, and considering the current construction rate, the resource efficiency are to be a challenge. The complexity and uniqueness of the industry create barriers for managing resources efficiently. Construction entails excavation of soil, and from a resource perspective, the excavated soil can be managed more efficiently. The purpose of the study is to examine the network of excavated soil management and how different actors and their roles are intertwined with each other and how they are related to environmental aspects in construction projects. A qualitative case study with a systematic combining approach has been conducted, where semi-structured interviews, observations and secondary documentations were used to collect data. The collected data were further analysed using the ARA-model and the iron triangle. The results generated five main networking barriers for managing the excavated soil more efficiently; communication, co-operation and willingness to compromise/collaborate, unified vision, commitment and structure. However, the analysis resulted in two concluding barriers with the most substantial impact on the excavated soil management. First, the public procurement act which limits the opportunities for early involvement of the contractors, and second, the lack of unified vision regarding the responsibility of the excavated soil. Further, commitment among all actors is required for a joint long-term management. The findings are specific to the case, due to the complexity of the industry. Further research is required to make the results more generalizable.

Keywords: Networking, Construction Industry, Excavated soil, Systematic Combining Approach
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1. Introduction

The introduction chapter enables the reader to get an understanding of the content of the master thesis. The reader will be introduced to background information regarding the construction industry, followed by a problem description. The theoretical contribution and the research question will also be presented.

1.1. Background

To withstand global sustainable development there is a need for resource efficiency and reduction of climate impact from urban areas. The unsustainable way of using resources has caused the challenges we today stand in front of. Encouraging sustainable infrastructure and performing to a higher standard with less, to achieve sustainable management and efficient use of natural resources, is the twelfth goal of 2030 Agenda for Sustainable Development (United Nations 2018). The global population is increasing and are contributing to a significant urban expansion which makes the cities grow (d’Amour et al. 2017). Net sales in the construction industry in Sweden increased from 373 billion in 2007 to 639 billion in 2016, an increase about 71 % over a ten-year period. One of the largest percentages was in the region of Värmland with 91 % (Sveriges Byggindustrier 2017). In the region of Värmland five areas have been chosen to be prioritised to reduce the negative environmental impact until the year of 2020. However, as of today only one of these goals seems to be realised. To be able to achieve these goals, the communication and co-operation between actors in the region of Värmland need to be deepened (Länsstyrelsen 2017). In hasty growing cities, one of the major contributors of carbon dioxin emitters is the construction sector. Several scholars conclude the importance of reducing the climate impact construction stands for and the need for reuse of construction materials and improve efficiency (Ajayi et al. 2016; Chen et al. 2016; Magnusson et al. 2015). There is a wide supply of excavated soil, however today the demand is low due to the lack of strategic planning at an early stage how to manage the redundant soil if it cannot be reused on site. By reusing the excavated soil in construction, the savings are to be 14 kg CO₂ per tonnes (Magnusson et al. 2015).

Chen et al. (2016) argue that a trade-off exists between revenue and environmental care in construction business and the industry has long been criticised for its low level of innovation and efficiency. For every company profit maximization is the first priority (Afzal et al. 2017). In Sweden it is regulated by
law (SFS 2005:551) and this forces other aspects, like the environmental concern, to a secondary level (Isaksson & Linderoth 2018). During the past years the iron triangle, which stands for time, cost and quality (Atkinson 1999), has been used to measure project performance in the construction industry. Sustainability is an important criterion that should be added to the iron triangle (Toor & Ogunlana 2010), but to implement more sustainable considerations to the market, a long-term economic focus needs to be centralised (Isaksson & Linderoth 2018). To realise increased sustainability, holistic thinking is essential with regards to decision-making and innovative solutions, which is mutually favourable for all stakeholders (Yang 2012). Isaksson and Linderoth (2018) argue that one of the main barriers of adapting to environmental considerations is the lack of information and knowledge. The trade-off in the industry might constrain a holistic thinking, restrained by reasons of profit maximising firms. Thus, one might reason that the construction industry is profoundly institutionalised and rigid, due to its mode of business (Chen et al. 2016).

1.2. Problem

A construction project holds many actors, which all have different commitment, engagement, and operation method (Chen et al. 2016; Upstill-Goddard et al. 2016). Herazo and Lizarralde (2016) state that the alignment of stakeholders’ approaches does not always correlate, and they can change at different stages of a project. Their perception and position in terms of sustainability may differ significantly between parties. Thus, in the process of construction tensions can be created among actors. However, there is an increasing pressure from stakeholders to perform better environmentally and economically (Alrazi et al. 2015). Upstill-Goddard et al. (2016) state that implementation of sustainability standards will decrease in absence of stakeholder pressure, since companies strive towards business effectiveness and competitiveness and tend to exclusively fulfil what is required.

The construction industry is complex due to the involvement of multiple actors and that the daily operations are project based. Contractors have small incitement to drive questions regarding development and innovation, because they perform what is asked in the tenders. Thus, relationships among actors are in the industry singular. Project owners and contractors have different goals and often seek to limit their costs, at the expense of each other (Mallaoglu et al. 2015). The cultural differences create barriers to implement relationship partnering in the industry and hinders according to Mallaoglu et al. (2015) the
improvement of project performance. Crespin-Mazet et al. (2015) further states that it is important for partnering actors to have a relational agreement relating to resource efficiency, trust, commitment and values, to be able to improve project performance. While a construction company wants to find solutions that increase profit, the project owner wants on the other hand to lower the total cost of the project and decrease the earnings. In the area of partnering and relationships in the construction business, it is sought to further examine limitations in other geographical contexts than the United States. Børve et al. (2017) define project partnering, as a relationship strategy in business and the term is widely explored in research. However, there is still a lack of empirical research investigating the relationship challenges in partnering of construction business.

The construction business is said to exhibit low level of innovation. One explanation is that they remain successful regardless, by meeting local standards, governmental needs, and having new technology served by their network (Chen et al. 2016). Therefore, it can be questionable whether the construction industry would benefit from a proactive sustainability management, due to its conservatism and parsimonious innovation performance. Most studies in the field of construction business resort to sustainability indicators, or adopt classifications of green and conventional firms to measure their environmental performance (Tan et al. 2015). Further, Chen et al. (2016) state that the environmental information is dispersed across numerous of actors inside and outside the firm, making it difficult to improve efficiency. According to Aarseth et al. (2017) more qualitative case-based research regarding how sustainability is managed in complex projects need to be conducted, since they often have a political and institutional impact.

Excavated soil management is a problem that still has to be resolved in the construction industry. The redundant soil from road and infrastructure projects is left to be an economic and environmental problem, which parts the actors in the industry. To be able to improve resource efficiency in the construction industry, more research is essential to elucidate the environmental opportunities to reuse the excavated soil and the resulting economic outcome (Magnusson et al. 2015). Magnusson et al. (2015) also state that co-operation between the authorities and the construction companies are one factor to accomplish a more environmental beneficial management of the excavated soil. However, how this practically can be performed needs to be evaluated further.
In summary, there are many stakeholders in the construction industry with different levels of commitment and approaches, which can create tensions. There is a lack of research in the area of how different actors can co-operate to improve project performance. Ingemansson Havenvid et al. (2017) suggest that further research is required to examine how actors in the construction business interact with each other to accomplish long-term relationship goals. The construction industry is focusing on the economic performance but have little incentive to improve their environmental performance. According to Isaksson and Linderoth (2018) the low environmental focus is due to a lack of information and knowledge. The literature states that there is a need for a more environmental thinking in the decision-making process, but it is still questionable if sustainability management would benefit the construction industry due to its conservative attitude. This study will therefore investigate networking barriers among actors to improve economic and environmental performance.

1.3. Aim and research question

The purpose of the study is to examine the relationships and networks of different actors, related to the environmental aspects of project performance in construction business and in road and infrastructure projects. The aim of the study is to find barriers preventing an effective excavated soil management.

RQ: What networking/relationship barriers are there to implement a more economic and environmentally effective method when managing the excavated soil?

1.4. Case description

Necessary data to answer the research question will be collected from the case company Skanska Sweden AB and the public utility in Karlstad. Skanska is a worldwide company operating in the construction industry. The road and infrastructure departments in Karlstad have many years of experience in project management and completion. Further description of the case will be presented in chapter 4.

1.5. Delimitations

The case study will be conducted in the city of Karlstad. Data collection is delimited to public work projects within the road and infrastructure department.
The context of the study is delimited to pure excavated soil\(^1\) that cannot be reused on site. This thesis will focus on the dimensions of networking in terms of the ARA-model and its three layers; the actor layer, the resources layer and the activity layer. In order to complete the study in given time frame, the study is limited in content.

1.6. Report structure

The remaining report will be structured according to the following chapters. In the second chapter, the theoretical framework will be presented. In the third chapter the methods that have been used to collect and analyse data to answer the research question have been described. The fourth chapter presents the case description containing a calculation of the sustainability impact. In the fifth chapter the empirical results are presented which is further analysed in chapter six. Conclusion, references and appendices will be presented in the end of the report.

\(^1\) In this report, it primarily refers to clay unless otherwise stated.
2. Theoretical framework

The theoretical framework informs the reader of current research that is relevant to the master thesis. To answer the research question, previous studies about relationships, public-private partnering, the ARA-model, construction process, resource management and the iron triangle are presented.

2.1. Relationships and partnering in project business

2.1.1. Relationships in the construction industry

The importance of relationships in project business have for some time been emphasised in research. One of the first definitions of partnering comes from the Construction Industry Institute (CII) in 1991, where partnering was considered as;

A long-term commitment by two or more organizations for the purpose of achieving specific business objectives by maximising the effectiveness of each participant’s resources. This requires changing traditional relationships to a shared culture without regard to organization boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other’s individual expectations and values. Expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services. (CII 1991, p.6)

Numerous researches in literature referring to partnering have been provided, aiming to mature a widely accepted definition (Eriksson 2007; Nyström 2005). Larsson (1997) early defined partnering in specific elements of success, such as collaboration, trust, openness, and mutual respect. Newly, others have presented that there is a solid connection between what partnering is and how it is implemented. According to Bygballe et al. (2010), establishing long-term relationships in partnering are important, to guarantee the establishment of trust, common objectives, and commitment between participants. Further, they empathise on formal and informal aspects of partnering relationships to an effective development and thus a strategic and long-term relationship. However, Bygballe et al. (2010) state in their literature research that construction partnering do differ from the CII definition (1991). In addition, compared to other industries implementation of partnering, the normal way of thinking is the short-term thinking. Gadde and Dubois (2010) also claim that construction relationships are more likely to be irregular and intermittent. Buyers are thus likely to change suppliers from one project to the next, which creates uncertainties in future business expectations.
According to Ingemansson Havenvid et al. (2017) relationship continuity across projects occurs when a company encounters the same counterpart in more than one project. The projects can either be endured parallel, partly overlapping, or consecutive over time. Furthermore, Ingemansson Havenvid et al. (2017) distinguish a series of factors that determines the strength of relationships. The larger amount of projects a relationship holds, the larger percentage of the company’s total revenue these projects represent, and the longer the period of time the projects stretch over, the higher the intensity of collaboration among the company and the counterpart, decides the strength. This thesis will contribute to the current field of research by further investigating the relationship among actors and the way of thinking in the construction industry.

2.1.2. **Public-private partnering**

The idea of partnership has become common “as an ideal model for the design of interorganizational relationships in public sector management” (Friend 2006, p. 261) the world over.

Public work projects funded by the public are often structures used by or for the community, such as ports, highways, and institutions for education, airports and bridges. In order to offer better services and products, governmental organisations should, drawn from the conservative belief, co-operate with other governmental organisations, non-profit making organisations or business organisations. The public-private partnerships (PPP) is said to be of value when communities are to revitalise economic marketability and support social, housing, infrastructure and employment programs. The term PPP has found that a co-operative connection over sectors is to deliver increased efficiency. To create a successful partnership between private and public sector, conditions such as horizontal relationships between the parties, consensual decision-making, respect, and trust are of importance (Carol & Sang Ok 2008).

Literature implies that public work projects entails problems, which can cause difficulties of conflict, quality, time and budget. Also described in the empirical part of this study; traditionally plans of public work projects are completed before the public sector client selects the lowest bidding contractor. However, PPP is an alternative approach when to accomplish project effectiveness. Here a team can work towards a united vision, encourage communications, and trust. Carol and Sang Ok (2008) showed that a PPP surpasses public work projects in success factors of shared vision, commitment to vision and its potential for meeting realistic goals both in business and public ones. Further the PPP’s open
communication resolved problems and their willingness to co-operate was significantly higher. They also state that a public work project can through pre-planning move towards greater levels of success in construction. This study is limited to public-private projects, and will therefore contribute to current field of research. The success factors regarding PPP by Carol and Sang Ok (2008) will be further investigated in this thesis.

2.1.3. ARA-model

The ARA-model (Håkansson 1982; Håkansson & Snehota 1995) summarises the significance of long-term relationships and how they affect business development. A network of actors connecting with each other relates to firms that can admit, modify and combine resources, and tie different activities together to generate efficiency and innovation (Håkansson et al. 2009). However, engaging in relationship networks can demand high investments, due to their loss in control and their openness to be controlled (Håkansson & Ford 2002). Figure 1 contains the ARA-model and its three layers of business relationships, the actor layer, the resource layer, and the activity layer. The layers of actors refer to firms, organisations, and individuals, which separately control resources, to perform activities. The model can offer a framework to examine how relationships between actors are established and how they are accustomed, by connecting resources and activities across organisational boundaries. Through interplay, actor bonds, social bonds, as well as trust and commitment may ascend amongst the actors. Further, the resource layer associates to organisational or physical resources needed for business development. Ties can be created between the resources if they are regulated, united and utilised with other resources. Final, the activity layer defines the links between the actors and describes the activities among them. Hence, the bond between the actors can be stronger through increased interaction and shared adaption of resources and activities.
For this study the ARA-model is used to discuss the networking relationships and the barriers to manage excavated soil in the construction business between public and private actors. The ARA-model is connecting the barriers at each layer to each other, to create a greater understanding of underlying problems.

In summary, the relationship and partnering in project business describe current research regarding relationships in the construction industry. Trust, common vision, communication, respect and collaboration among the actors are recurring factors in several studies for achieving a successful partnership (Bygballe et al. 2010; Carol & Sang Ok 2008; Larsson 1997). The existing theories state that a short-term thinking reflects the construction industry, and the relationships are often discontinuous (Bygballe et al. 2010; Gadde & Dubois 2010). The study will investigate the relationships and networking barriers for creating a long-term relationship with excavated soil management as a context, and will therefore contribute to current field of research.

2.2. Construction process

2.2.1. How construction process functions

Figure 2. The four phases of a construction process.
The construction process is separated into four phases, demonstrated in Figure 2. The purpose of the project is determined in the pilot study, and economic, environmental, technical and other conditions for the project are being clarified. In the program phase, the project owner determines all demands and requirements. A construction program, describing how the project will be executed, is also conducted (Oberlender 2000; Révai 2012; Söderberg 2011). The third phase in the construction process is the projecting phase, where the final design, construction and method are determined. The purpose is to create construction documents and to specify the project further, which will be used as a basis for the production phase. In the production phase the construction of the project begins, and is managed by the contractor. When the project is finished, a final inspection is conducted before approval. The responsibility of the project is yet again handed over to the project owner (Révai 2012; Söderberg 2011). The project owner together with the contractor make sure that the demands and preferences of the end user are satisfied and that it is executed with respect to laws and regulations (see Appendix 9.3 for further description) (Lindahl & Ryd 2007).

The amount of interaction between the contractor and the project owner in the early stages of the construction process depends on the chosen design, due to uncertainty, complexity and stakes (Crespin-Mazet & Ghauri 2007). It is stated that prior interactions in a project process have a positive effect on the contractual co-ordination (Wang et al. 2017). Prior interactions among the team members can also contribute to an earlier trust development within the team (Pettersen Buvik & Rolfsen 2015). The contractor also desire to be involved in the earlier stages of the construction process, to be able to influence and contribute with their knowledge and expertise (Byggledarskap 2014). In Appendix 9.2, the long-term strategy for relationships from the case company is depict.

There are factors in collaboration between actors that have a significant effect on project performance. A previous study by Suprapto et al. (2015) conclude that team working and relational attitudes such as; trust, common vision and objectives, communication, social interaction and senior management commitment are the most important factors. Commitment, trust and collaboration are also central to improve the performance of the project according to Børve et al. (2017). A project with a positive outcome gives the contractor advantages in future negotiations and strengthens the relationship between the project owner and the contractor from a long-term perspective.
(Hadjikhani 1996). In contradiction to other studies, Suprapto et al. (2015) state that a long-term orientation does not have a significant importance in collaborative relationships, due to the non-realistic view of the practitioners.

Project partnering contributes to long-term relationships due to the high level of interaction and adaptation (Crespin-Mazet et al. 2015). Further, it can contribute to stronger commitment and trust among the actors. It is also important for both actors to nurture the relationship between projects, the sleeping relationship, to maintain the bond and create a stable long-term one (Skaates et al. 2002). The current field of research within the construction process contributes to an understanding of how the process functions. The construction process with regards to relationships between the actors and the excavated soil management will be further investigated in this thesis.

2.2.2. Resource management

A sustainable resource management can according to Bringezu and Bleischwitz (2009) be achieved by an efficient use of materials, energy and land resources. This can be accomplished by maintaining ecosystems, providing society with basic institution, decreasing risks of being dependent on resources, containing a fair global distribution of resource use, and if the resource productivity is higher than gross domestic product growth. However, when managing common resources, the tragedy of the common might occur i.e. individuals are taking actions which benefit the self-interest and deviate from the common good (Hardin 1968). The tragedy of the common is a well-mentioned economical problem in recent years. An example of the problem is the overfishing of cod in the region of Newfoundland. Occurring from an increased competition between fishermen to catch larger amount of codfish in the 1960s, resulting in a lower population of fish and in the 1990s the codfish industry broke down. The fishermen prioritised their own self-interest and neglected the common good in that case (Investopedia 2018). As of today, the construction industry lacks a holistic approach when managing the resources, which contributes to an inefficient utilisation of resources (Forsman et al. 2013). In order to manage the resources in construction projects more efficiently, there is a need for joint planning among the actors (Magnusson et al. 2015).

The environmental impact from earthwork projects in the construction industry is essential due to the high consumption of natural resources (Eras et al. 2013). To be able to shift the approaches within construction projects towards more resource efficient line of actions, the knowledge gaps of implementation are to
be fulfilled. The conservative attitudes and knowledge gaps are the main barriers for implementing resource efficient thinking in the construction industry. All stakeholders are required to commit to the resource efficient thinking to achieve a reform in perception (Sfakianaki 2015). According to Butera et al. (2015) the transportations of the material have the most impact to the environment, in particular the construction and demolition waste. To maintain a sustainable resource management, the waste can be used in landfilling, recycled on-site in construction projects or be transported and used in other projects. The material flows in construction projects are further demonstrated in Figure 3.

![Diagram of material flow in construction projects](image)

Figure 3. Material flow in construction projects (Adapted from Magnusson et al. 2015; 20).

The active stock in Figure 3 represents the material that is being used in construction and the inactive stock represents the materials that have been taken out of use, no longer serving any purpose (Magnusson et al. 2015). The most common strategies to manage the construction material are recycling off-site, incineration and landfill. To recycle and reuse construction and demolition waste on-site are however not that commonly applied (Bovea & Powell 2016). To determine the total environmental performance, a holistic approach is required before the decision-making process in waste management (Dahlbo et al. 2015). This also correlates with Magnusson et al. (2015) stating that decisions on all levels are compulsory for improving the opportunities to manage the construction material in a more efficient way. Strategic planning and regional management are required to construct an environmental performance. Construction and demolition waste consists of several materials resulting from construction activities (European Commission 2015). All the material, objects or substances that are required to be disposed of are defined as waste (see Appendix 9.3.2; 9.3.4). Excavated soil is one material included in construction
and demolition waste. However, according to the literature research conducted by Magnusson et al. (2015) previous research are mainly focusing on waste perspective, recycling potentials and environmental profits. More research regarding excavated soil management is required. This thesis will contribute to current field of research due to the focus of excavated soil management and resource efficiency.

2.2.3. The iron triangle

To reach project success, different criteria can be used as a measurement tool. Atkinson (1999) defines project performance as the iron triangle, using the criteria time, cost and quality. These three have during the past years been accepted terms to measure the success of a project in the construction industry. According to Lindhard and Kranker Larsen (2016) communication and sharing of knowledge are the main contributors to improve the time, cost and quality performance. The three criteria are equally important factors to reach project success. If one of the three pillars has a lower priority by the contractor, an optimal outcome will not be reached (Basu 2014).

Later studies indicate that other criteria need to be added to the iron triangle. Toor and Ogunlana (2010) showed that strategy, sustainability and safety are to become more important factors to measure the performance of projects, as a result of the new environmental guidelines and different demands of users. Studies show that the environmental management has a positive impact on the project success and should be used as a criterion (Carvalho & Rabechini 2017; Montabon et al. 2007). However, Demirkesen and Ozorhon (2017) state that environmental management does not affect the project success significantly, which is being explained by the contractors’ short-term focus on profits.

The study by Gilbert Silvius et al. (2017) indicated that the sustainability aspect is diminished in comparison to the iron triangle criteria in the decision-making process of project managers. In the few cases where sustainability was considered the environmental aspect was mostly focused on, but the social aspect of sustainability was neglected (Hueskes et al. 2017). According to Afzal et al. (2017) the financial performance is the most important factor for the contractors to reach project success in the construction industry today.
Ordinarily, a project owner asks for tenders from contractors, and the one with the lowest tender attains the contract. Thus, managers in firms have rather small reasons to choose methods that will make their tender more expensive. Therefore, practitioners are not making any rational decisions in business. Environmental practices acquire extra costs though the government and clients are not often acknowledging the matter (Ofori et al. 2000). Zhang et al. (2014) propose a shift in the environmental management due to conflicts between environmental performance, contract time and construction costs. Thus, it could only be resolved if the government authorises new policies and incentivises. Aarseth et al. (2017) state that sustainability is required to be considered by project organisations in earlier stages of projects. This implies that construction business and its project organisations should regard sustainability when constructing and establishing each actor role and responsibility.

In summary, the present literature state that the industry lacks a sustainability focus and is mainly focusing on the economy (Afzal et al. 2017; Gilbert Silvius et al. 2017). The need for a holistic approach for an efficient resource usage is also recurrent in the literature (Dahlbo et al. 2015; Forsman et al. 2013; Magnusson et al. 2015). The barriers for achieving a more efficient resource management regarding excavated soil, will be investigated and contribute to current field of research. The paper will contribute to a greater understanding of the underlying problematics of resource management and how to manage the excavated soil more efficiently.
2.3. Theoretical synthesis chapter

Previous researches contribute with an understanding of how the construction industry functions with regards to the construction process and the network. Relationships are included in the networking barriers that are going to be investigated, thereof the chapter of relationships in the construction industry. Due to the limitations of public-private projects, the public-private partnering chapter is highly relevant to this thesis. The ARA-model and the iron triangle will be used to evaluate the perceived barriers of the network with regards to resource management. The presented theories are being used for orienting the field study, and take part in the systematic combining approach, used for analysing the data.
3. Method

The section presents the approach and the scientific method used to answer the given purpose and the more specific issue. The data collection method and method of analysis that form the basis of the study’s conclusion will be presented.

3.1. Research design

The main purpose of the study is to verify and partly complete current research by using the theoretical framework together with empirical data to answer the research question. In order to examine barriers of excavated soil management within existing construction business network and the dynamics of the participating actors, as well as the activity links related to excavated soil management, we selected a case study methodology. According to Yin (2013), case study approach is an appropriate method to explore an empirical phenomenon that is within its context considered complex. The research methodology used to answer the research question has been qualitative, in forms of interviews, observations and documentations. Qualitative research is often associated with case studies, due to the generation of multiple perspectives through data collecting methods. In addition, it is highly contextual and it allows the researcher to have a holistic overview. The qualitative approach makes it possible for reflection and analysis of underlying causes (Gray 2017).

Within the framework of the case study approach the researchers operated a systematic combining approach (Dubois & Gadde, 2002, 2014). Dubois and Gadde (2002, p. 556) describe systematic combining as “a nonlinear, path-dependent process of combining efforts with the ultimate objective of matching theory and reality”. Research in industrial network is often using case studies as their approach. When performing systematic combining approach, theoretical framework, empirical data, and case analysis are evolving and are being adapted to connect with each other, backward and forward, when moving through the research process. The method is seen as very iterative because of the movement between theory, empirics, and analysis, making it a preferable method for development of theory. This implies that the research design is an abductive approach (Dubois & Gadde 2002).

To answer the purpose of the research, the network of the construction business in Karlstad has been charted. The present situation was thereafter analysed and projected against theory, which was conducted iteratively to identify actors, resources, activities performed and the activity bonds.
3.2. Data collection method

To collect data a combination of methods was carried out to answer the research purpose and question. There are two kinds of categories one can collect data from, primary and secondary data. Which one to choose depends on different factors for example, intentions of the study, purpose of the research, available resources, and current knowledge of the researcher (Kumar 2011).

3.2.1. Primary and secondary data

According to Hox and Boeije (2005) primary data is being collected during the research with the purpose of answering the current research problem, using appropriate methods. When primary data is gathered, new information is added to existing data. Two of the most common primary data collection methods in a qualitative research are interviews and observations. In qualitative research several data collection methods are usually being combined to control the trustworthiness of the data (Moser & Korstjens 2018; Bryman & Bell 2013).

Secondary data, also called raw data, have been collected in earlier stages for a different purpose (Hox & Boeije 2005; Bryman & Bell 2013). An example of secondary data is corporate documentation. The advantages of using secondary data sources are that it could save time and money, and does often contain high quality data (Bryman & Bell 2013).

3.3. Interviews

There are three types of interviews; structured, semi-structured and unstructured (Gill et al. 2008). In this study both semi-structured and unstructured interviews have been conducted.

3.3.1. Unstructured interviews

Unstructured interviews often occur spontaneously and could begin with an opening question followed by a discussion about the topic. Unstructured interviews are not prepared in advance and do not reflect preconceived theories (Gill et al. 2008).

Unstructured interviews were conducted with nine industry experts at the case company to create a deeper understanding of how the construction industry operates. The unstructured interviews contained an in-depth discussion of different topics regarding the industry. The purpose of these unstructured interviews was to gain more information of different actors, their responsibilities
regarding resources and the activities they conduct. The purpose was also to find perceived problems and development areas. These were not recorded, but notes were taken. An interview guide was then created, using the long interview approach by McCracken (1988).

3.3.2. Semi-structured interviews

Semi-structured interviews are flexible but still structured. The interviewer has usually prepared an interview guide with key questions before the interview, but the approach still allows the interviewer to deviate if for example new ideas occur or to ask follow up questions. The approach permits new findings of data that have not been thought about by the researcher but is important to the respondent (Gill et al. 2008).

Each semi-structured interview was executed at the participants chosen location, to create a safe environment for the respondent. To make the respondent feel comfortable each interview started with an open conversation (McCracken 1988) before they were asked if the interview could be recorded. All of the semi-structured interviews were recorded to ease the transcription and to avoid misunderstandings. By recording the interviews less distraction towards the interviewer is made, compared to only taking notes. Notes were taken to document interesting thoughts from the researcher and important comments, key terms, topic avoidance, misunderstandings, deliberate distortion and other behaviours from the participant (McCracken 1988).

To increase the participants trust towards the interviewer they were told that the interview were anonymous. Altogether nine participants were interviewed, listed in Table 1, which holds people from different actors in the construction industry. The participants were carefully selected based on their role and experience to be able to give answers to the research problem. The participants were chosen with help of recommendations from the case company and supervisors from Karlstad University.

An interview should be transcribed in written words to be used as a basis for the analysis (Bryman & Bell 2013). In this study all interviews were fully transcribed. According to McCracken (1988) the transcription should be done by a professional typist, since the interviewers recognise the data from the interviews which could affect the later process of analysis. However, due to limited resources it was not possible to use an external typist. An advantage
when the researcher does the transcription is that the researcher has more control of the outcome of the transcription.

<table>
<thead>
<tr>
<th>Organisation type</th>
<th>Date and length</th>
<th>Position of interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22.03.2018 (1 h)</td>
<td>Project Manager</td>
</tr>
<tr>
<td>B</td>
<td>04.04.2018 (45 min)</td>
<td>Project Manager</td>
</tr>
<tr>
<td>C</td>
<td>21.03.2018 (1 h)</td>
<td>Production Manager</td>
</tr>
<tr>
<td>D</td>
<td>20.03.2018 (50 min)</td>
<td>Project Leader</td>
</tr>
<tr>
<td>E</td>
<td>21.03.2018 (30 min)</td>
<td>Project Leader</td>
</tr>
<tr>
<td>F</td>
<td>03.04.2018 (50 min)</td>
<td>Project Leader</td>
</tr>
<tr>
<td>G</td>
<td>02.04.2018 (30 min)</td>
<td>Environmental Specialist</td>
</tr>
<tr>
<td>H</td>
<td>04.04.2018 (30 min)</td>
<td>Local Government Commissioner</td>
</tr>
<tr>
<td>I</td>
<td>22.03.2018 (25 min)</td>
<td>Environmental Specialist</td>
</tr>
</tbody>
</table>

3.4. Observations

The observational method studies people in their natural settings in a systematic way, and records, analyses and interprets their behaviour. The advantages of observations are that they can emphasise the meaning that one gives to their action as well as focus on the frequency of their actions. To collect observational data, researchers commonly write field notes or use structured observation methods (Gray 2017). As a first step to obtain data, unstructured observations were performed at the case company to gain a deeper understanding of a network within the context of construction industry.

During observations the observer can choose to participate actively or not, by asking questions or just being passive taking notes (Bryman & Bell 2013). In this study the observers have been practicing both, by being active asking questions about on-going events, as well as being passive only taking notes at project sites during production meetings. Notes were documented in direct connection to the observations or during. Observations have been helpful in creating a greater understanding of the network.

3.5. Documentation

Documentation is a secondary data source that is not affected by the values and perceptions of research, which increases the trustworthiness due to less actuating effects (Bryman & Bell 2013). Meeting minutes and other forms of
documentations from the case company were reviewed. The main purpose of using documentation as a data collection method is triangulation, to verify findings (Gray 2017).

3.6. Sustainability calculations

Calculations of the carbon dioxide emissions for different alternatives in managing the excavated soil have been conducted to determine the sustainability impact. Six completed projects was chosen (Project A-E), and data were collected from stored documentations which were calculated using excel sheets. These projects have from consultation with the case company been selected.

The projects are together corresponding to an annual production of redundant soil in the city of Karlstad. Due to the lack of documented data, several assumptions have been made, which are together with a project description, being presented in Appendix 9.5. The first case of managing the excavated soil is to transport the masses and use them as cover material at closing landfills (see Equation 1). The second case is when the contractors find their own solutions to managing the redundant material, in this case by finding farmers in need of masses for example filling pits (see Equation 2). The third case is to transport the excavated material to build a sound wall (see Equation 3). For the three cases, the calculations include carbon dioxide emissions arising when excavating the material due to the excavator and carbon dioxide emissions due to transportations. Project A-E are completed by the case company, and project F was calculated but not executed by the case company. The data are being collected from secondary tendering documentations.

To calculate the sustainability impact with regards to the carbon dioxide emissions, the following equations have been used:

\[ \text{Total emissions} = \text{Fuel consumption} \times \text{Emissions transport} \times \frac{\text{Ex situ}}{\text{Volume per truck}} \times \text{Length to landfill} \]

(1)

\[ \text{Total emissions} = \text{Fuel consumption} \times \text{Emissions transport} \times \frac{\text{Ex situ}}{\text{Volume per truck}} \times \text{Length to farmer} \]

(2)

\[ \text{Total emissions} = \text{Fuel consumption} \times \text{Emissions transport} \times \frac{\text{Ex situ}}{\text{Volume per truck}} \times \text{Length to sound wall} + \frac{\text{CO}_2}{\text{m}^3} \times \text{Ex situ} \]

(3)
Table 2. Units used in equations.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption</td>
<td>l/km</td>
</tr>
<tr>
<td>Emissions transport</td>
<td>kg CO₂/l</td>
</tr>
<tr>
<td>Emissions</td>
<td>kg CO₂-eq</td>
</tr>
<tr>
<td>Length</td>
<td>km</td>
</tr>
<tr>
<td>Ex situ</td>
<td>m³</td>
</tr>
<tr>
<td>Volume per truck</td>
<td>m³</td>
</tr>
</tbody>
</table>

3.7. Data analysis method

In qualitative research the amount of collected data can grow quite fast. When unstructured materials consist of interviews, field notes and different documentations it can be hard to handle. Data analysis can therefore become difficult to enter according to Bryman and Bell (2013). One of the most commonly used ways to approach qualitative data is thematic analysis. A methodology that aims to detect and analyse patterns, called themes, in collected data. Here a theme sets the data in relation to the research question to describe what is essential, further it also represents a degree of sense within the data (Gray 2017).

Six steps are to be followed when performing the thematic analysis (Braun & Clarke 2006): data transcribing, initial coding, collate codes into themes, theme reviewing, theme definition, and provide sufficient evidence for the themes. A thematic analysis might be easy to perform, however according to Braun and Clarke (2006) it is easy to not develop an analytic narrative, which could result in a scant analysis.

In this case study thematic analysis process was performed. To connect the case analysis with data sources and the framework, systematic combining approach was performed. In other words, parallel development of the theoretical part, delimitations, the case, the findings and the analysis have been carried out. The original framework has been successively modified, as a result of empirical findings and of theoretical insights during the process, making new concepts derive from reality (see Figure 5).
3.8. Transparency and trustworthiness

To assess the quality in qualitative research Bryman and Bell (2013) have suggested trustworthiness as an alternative to reliability and validity. The four following criteria of trustworthiness are being used in the study to evaluate the quality of the research.

3.8.1. Credibility

Credibility determines the trustworthiness of the study, meaning if the society can accept the results. To create credibility in the results, it is required to ensure that the performance of the study is conducted correctly. Respondent validation is one way to create credibility, to confirm the collected data with the respondent to decrease the risk of misinterpretations. In this study, validation is reached when the conducted interviews were recorded. There is a small chance of distorted interpretations when the interviews are translated, although this risk is considered to be very small. Another recommended and used technique is triangulation, to ascertain the collected data is valid. In this case, interviews, observations and documentations are used to collect data.
3.8.2. Transferability

Qualitative research is often focusing on the depth of the research instead of the width, which entails the result to be focusing on the unique in the contexts. Qualitative research is often limited to one specific case and context, which makes it questionable if the results can be generalised. The transferability determines how transferable the results are to another context. To increase the transferability, thick descriptions can and will be used. The methodology needs to be described in detail to ease the process of other researchers to transfer the results into another environment.

3.8.3. Dependability

Dependability can be created by ensuring that a complete description of all the phases in the process are available, in which external examiners can determine the quality of the chosen procedures. However, in those cases where the respondent is said to be anonymous, the transcriptions of their interviews cannot be available for external parties. Sensitive internal information collected from the case company, such as long-term strategies, cannot be written in the report due to confidentiality.

3.8.4. Confirmability

It should be evident that the execution of the study has not been influenced by the researchers’ personal values or theoretical alignment. The purpose of confirmability is to ensure and determine that the researchers have an objective approach. In this case, one of the researchers is currently working at the case company. However, both researchers have conducted the study with an objective approach and therefore the risk of affecting the result is considered to be low by.
4. Description of the case

This chapter of the thesis presents the technical findings of the excavated soil, sustainability calculations and a description of the case company and its operations.

4.1. Construction Industry in Karlstad

In cities with a high pressure of mass material flow there are few places to store the excavated soil. If the material contains sand or rock, the masses can be reused in future projects and have a value on the market. However, in Karlstad some of the material consists of softer materials, for example silt and clay that cannot be used as a building material because the quality is considerably low. This creates problems for the construction companies, to accomplish and complete projects, due to the lack of demand of the excavated soil.

In most cases, the municipality imposes all responsibility and ownership of the masses to the contractors to find suitable places to dispose it, often due to limited human resources at the municipality. It is strictly controlled by the Swedish environmental code (see Appendix 9.3.2) where to tip the excavated masses and permission by the municipality is required. Today the amount of production within the construction sector is high and the entrepreneurs have limited amount of time to search for places for landfill. The consequence is that the excavated soil is being used as filling at non-optimal places where there is no great need or in worst-case scenario, where it is forbidden.

4.2. Technical theory

The technical theory is used to create an understanding of the excavated soil by a comparison of different construction materials. The section is first described by a general description of construction materials, followed by a deeper description of excavated soil and its field of application. The technical theory enables the reader to understand the problematics of silt and clay as a material, which is one of the delimitations of the study.

4.2.1. Construction material

To build a house for a household, it is estimated to require 40 tonnes of ballast material, and about 64,000 tonnes to build a kilometre of highway. When construction is carried out, earthmoving is often performed and the masses that arise consist of sand, gravel, earth material, rock and crushed mountains. For the most part the materials are transported to landfill or storage elsewhere. However, it is most sought to reuse the masses where they have been created,
because of the high costs and consumption of time to transport the masses. Modification of land and heights are the main solutions to take care of the masses. Some parts of the masses have such qualities that they can be used directly or after modification for building purposes. Different types of ballast material are used for construction of houses and infrastructure (SGU 2018). However, some excavated soils are of such poor quality that they cannot be reused in many various ways because they are too soft. Masses with a lower degree of technical requirement may be suitable for sound barriers or terrain formatting (Respondent A; B; C).

In Sweden, ballast materials are produced in extractions and are divided into different types; natural gravel, moraine, crushed mountains and other. The category other, mainly consist of crushed rock from separate crushers, scrap stone, surplus stone from industrial and natural gas decay, but also some "miscellaneous" such as demolition and crushed asphalt (SGU 2018). Ballast is the largest raw material that is extracted in Sweden, except water. Sweden’s metropolitan regions are one of Europe’s fastest growing areas. A social transformation risks becoming a huge challenge for the environment when all building materials are to be broken, loaded, stored, and transported to and from construction sites (SGU 2018).

4.2.2. General about excavated soil

In a construction project excavated soil arises that has to be landfilled if there is no other disposal. Examples of different construction projects in the section of road and facility that can create excavated masses are earthmoving for foundation of buildings, maintenance work in a road, or excavation of pipes. However, when projecting a construction project with virgin soil, one is striving towards a mass balance that creates as little surplus as possible. In road construction refilling sinks and cutting of tops to create balance can avoid unnecessary surplus. Where there are urban lands, the possibilities to reach mass balance are scarce. It is therefore more common with larger volumes of excavated masses when working in developed areas with previous construction (Respondent A; C; F).

There can be several factors that confine the reuse of the excavated masses where they arise. The technical quality may not be sufficient for its purpose, or the masses can be polluted. Further, practical problems with intermediate storage are common when there is no disposal in a near future timeframe and the storage space is not enough. Landfilling is often not seen as an option due
to the high charge, therefore a construction project can end up with big expenses in landfilling and transportation (Respondent A; C).

4.2.3. Classification of soils

Several classification systems are used based on the soils formation, its composition, or technical properties in different context. Examples of earth’s name that refer to the formation are moraine, mud clay, shifting sand, etc. These names present valuable information about the soils construction and therefore its geotechnical properties. The earth deposits are divided into detailed elements of mineral and humus soil. Particle size and distribution are the foremost important factors for mineral soil and its mechanical properties. Since 2004 there is a common European and international standard for geotechnical classification of soil, SS-EN ISO 14668 (SGU 2018).

Earth deposit with regards to block and stone content as well as fine earth content are the mineral soils divided into four main categories (Larsson 2008):

- Very rough soil - Soil mainly consist of block and stone
- Rough soil - Gravel and sand
- Mixed grainy soil - Silt, or muddy gravel and sand soil
- Fine soil - Silt and mud

4.2.4. Silt and clay

Silt is common all over Sweden as earth deposit and as a fraction in mixed grainy soils. Geological maps usually indicate the fine-grained sediments silt and clay together, and the two are more or less interbedded. Silt is a soil that is in between regarding particle size clay and sand, which causes special problems in many cases (Knutsson et al. 1998).

Cohesive soil (clay) is a clay mineral that consists of very small particles with a diameter less than 0,002 mm. In a short-term perspective the clay is considered a compact material. However, the structure is usually quite open in which the material is strongly compressible in a longer perspective, because the pore pressure can equalise despite the low permeability. In addition, clay has very high capillarity and is usually completely water saturated. From the point of view of building engineering, clay is difficult due to its high compressible characteristics and can give rise to major subsidence if no ground reinforcement measures are taken (Knutsson et al. 1998).
Unsaturated soil (sand and coarse soil) consists of a larger grain of rock mineral. Above the free groundwater the capillarity and the degree of saturation are low and it is only naturally moist. One can assume that no pore pressure differences will arise for most cases with changes in tension because the soil is very permeable. Its structure varies with density, but the compressibility is low in comparison with clay (Knutsson et al. 1998).

Silt can be seen as earth deposit between unsaturated soil and cohesive soil with respect to particle size, capillarity, permeability, compressibility, and mineral composition (see Figure 6). Its permeability is low, which often results in a significant delay before pore pressure is equalised and subsidence has developed. However, the delay is considerably smaller than the corresponding delay for clay. Silt is said to have special problems due to its extreme material. One main factor is its high sensitivity to water. Silt is partly erosion prone, and partly very sensitive of the water content and the pore pressure occurring in the soil profile, these are factors that can change fast. Moreover, soils with silt are very sensitive for the water ratio, which can with rather small changes, as for example precipitation change hastily from a material which can be packed to a compact filling to a material which behaves as a floating dough (Knutsson et al. 1998).

<table>
<thead>
<tr>
<th>Clay</th>
<th>Silt</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle size</td>
<td>(Logarithmic scale)</td>
<td></td>
</tr>
<tr>
<td>Permeability</td>
<td>(Logarithmic scale)</td>
<td></td>
</tr>
<tr>
<td>Capillarity</td>
<td>(Logarithmic scale)</td>
<td></td>
</tr>
<tr>
<td>Compressibility</td>
<td>(Logarithmic scale)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Silt as soil between clay and sand (Adapted from Knutsson et al. 1998; 8).

4.2.5. Possibilities for excavated soil

Projects with water and drainpipes and road construction works produce large quantities of excavated soil, which are possible to reuse in semi-parallel projects. However, there are strict requirements regarding material types that are allowed for road and filling of lines. This implies that a great amount of the material has to be bought and the excavated soil is to be transported for deposing. Nevertheless, maintenance work is occasionally required and new material (virgin soil) need to replace the excavated soil. These kinds of projects are
therefore restricted in use of excavated soil (silt and clay) and are more sought to use crushed rocks from extractions sites (Respondent A).

4.3. Sustainability impact

The results of the sustainability impact are presented in this chapter. Three possible cases to manage the excavated soil are compared with each other. The first case is to use the material as a cover for closing landfills, the second is to find farmers willing to receive the material and the third case is to build a sound wall.

Figure 7. Calculated carbon dioxide emissions as a result of six projects in three possible cases.

Figure 8. A comparison of the total amount of carbon dioxide emissions from each case.
The calculations demonstrate the problematics of the management of excavated soil. The transportations contribute to considerably greater impact on the environment compared to the excavation process. The first and third case results in approximately the same total amount of carbon dioxide emissions (see Figure 8). The first alternative serves for a greater good for the society, but is not an option in Karlstad as for today. By managing the excavated soil as a cover material for closing landfills, it serves the purpose of social utility by managing the resources in an effective way. The third case contains shorter transportations than the first case, but emissions due to the construction of the sound wall are added. However, the sound wall fulfils a purpose gaining the society and contributes to the execution of two projects in one. If these projects can be synchronised, intermediate storage of the excavated soil can be avoided. To manage the redundant soil by constructing sound walls is however probably not an alternative due to the limitation of space. If a sound barrier should be constructed, it is required to fulfil a social benefit, and not for the purpose of disposal. The third case is also time-limited for the contractors due to the length of the application process. The second case entails the least amount of emissions, due to shorter transportations. However, the limited time for the contractors to contact and find farmers willing to receive the material together with the large amount of excavated soil makes this alternative unreasonable. Several alternatives are required for this size of projects.

4.4. Description of Case Company

The case company that has been a part of this study is Skanska Sweden AB, operating in the construction industry. The data collection is limited to Skanska’s office in Karlstad, within road and infrastructure projects. Figure 9 describes a general organisational structure in construction projects, further described in Appendix 9.4. The actors are continuously working towards streamline construction processes regarding time, cost and quality. The department perceive development opportunities when managing the clean excavated soil that cannot be reused on site at construction projects. When Skanska get hold of the tendering documents from project owners, they calculate the total production cost using an internal calculation program. The program also enables them to calculate the amount of emissions from transportations of the masses. The case company wants help to analyse and investigate the barriers and possibilities within management of excavated soil further, which in turn could contribute to a more effective process.
Figure 9. General organisational structure of actors in a construction project.
5. Findings

The empirical findings are presented in this chapter. A compilation of the observations and conducted interviews regarding barriers are presented in the form of emerging themes.

5.1. Barriers

Table 3 and 4 depicts and summarises the perceived barriers for achieving an effective excavated soil management in the construction industry that have been identified in observations and interviews. A total of five themes have been found; communication, co-operation and willingness to collaborate, unified vision, commitment, and structure. In upcoming subsections these themes will be explained further in detail.

Table 3. Observational findings.

<table>
<thead>
<tr>
<th>Communication</th>
<th>Co-operation and willingness to collaborate</th>
<th>Unified vision</th>
<th>Commitment</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous site meetings.</td>
<td>Important to resolve problems at site. Take responsibility for actions. Reasoning and discussion are standards.</td>
<td>Scarce or no discussion regarding excavated soil management between parties. Late entry in projects. Economy parts representatives.</td>
<td>Commitment bound to person.</td>
<td>Limitations due to human resources. Undefined roles. People changing chairs.</td>
</tr>
<tr>
<td>Open, truthful and direct contact.</td>
<td>It is preferable to communicate over phone; mail does not get the process forward.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4. Perceived barriers for achieving an effective excavated soil management.

<table>
<thead>
<tr>
<th>Communication</th>
<th>Co-operation and willingness to collaborate</th>
<th>Unified vision</th>
<th>Commitment</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationships are bound to person (A,B,C,F)</td>
<td>Public Procurement Act prevent early co-operation (A,B,E)</td>
<td>Lack of commitment contribute to a lower quality in project (A,C,E)</td>
<td>Commitment is bound to person (A,B,C)</td>
<td>Earlier involvement of the contractor (A,B,F)</td>
</tr>
<tr>
<td>Public Procurement Act prevents early communication (A,B,E)</td>
<td>Open and honest communication (A,B,F)</td>
<td>Lack of co-operation during production regarding excavated soil (A,B,C,D,E)</td>
<td>Active representative on site contribute to higher commitment (A,B,C)</td>
<td>Lack of political commitment (H)</td>
</tr>
<tr>
<td>High level of trust for the contractor (D,E,F)</td>
<td>Earlier involvement of the contractor (A,B,F)</td>
<td>Unclear responsibility distribution (A,B,C,E,I)</td>
<td>Public Procurement Act (A,B,E)</td>
<td>Public Procurement Act (A,B,E)</td>
</tr>
<tr>
<td>Economy contribute to bad atmosphere (A,B,C,D,F)</td>
<td>Some actors are reluctant to change (A,B,C,E)</td>
<td></td>
<td>Limitation of human resources (D,E)</td>
<td>Limitation of human resources (D,E)</td>
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<td></td>
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<td>Excavated soil management is perceived as a problem (A,B,C,D,E,F,G,I)</td>
<td></td>
</tr>
</tbody>
</table>
5.1.1. Communication

Communication between actors during production phase is most often continuous. The amount of communication between the actors during the production phase varies on the level of interest in the project from the representatives. However, the level of interest is bound to person and not the organisation. A stronger personal relationship among the representatives may also contribute to more frequent communication regarding the management of excavated soil between the actors. In general, the communication among the actors is reflected by honesty and openness.

It is very bound to person, so to speak, if you are open and social and nice and knowledgeable and honest, all the conditions exist. (Respondent F)

It is common that the same representatives from different actors are working together in several projects and are thereby maintaining the personal relationship, which also develops the communication. The project owner holds a high level of trust for the contractors, “we have not been out and followed up directly on site, but we have got to trust their words” (Respondent E), contributing to less communication and less verifying how the contractors manage the excavated soil.

Communication is one of the most important tools to avoid and resolve conflicts. The communication is important to discuss and find solutions to problems, in particular regarding economy due to its contribution to a tense atmosphere.

Towards the end of a project [...] when the economy is going to be discussed, it is not as good atmosphere as in the beginning. (Respondent D)

However, one of the main barriers for an open communication before the production phase is the public procurement act (see Appendix 9.3.1). There is a lack of communication during the tendering phase, to avoid conflict of interest and to maintain the same conditions for all tenderers. Project owners are willing to increase communication with the contractors earlier in the process, but are unable to do so due to the public procurement act.

We cannot do it with individual firms, then we have to do it with everyone. And it is also according to LOU [public procurement act], that we have to give the same conditions in the tendering phase. We can never benefit the individual. (Respondent E)
A consequence of the late involvement of the contractor in the construction process is a limitation in ability to contribute with their knowledge and effective solutions in the project design phase. The contractor is also time-limited in terms of planning how to manage the excavated soil. In most cases the time restrictions generate ineffective management of excavated soil concerning the economy and environment.

The times are very hard-set, [...] so even if the materials are getting better with time, they might have a lay time at six months before they are usable, and by that time the project will be completed, implying that the materials are transported from the project site anyway. (Respondent C)

5.1.2. Co-operation and willingness to collaborate

Co-operation and compromise in public work projects are restricted due to regulations and laws. A willingness to compromise is however essential to attain mutual project objectives and keep open and honest communication. There is a strong willingness to incorporate competence, innovation and vision in early stages of planning and projection. However, because of the constrained form of the public procurement and the worry of creating conflict of interest between actors, it is difficult for a contractor to enter at an early stage. Some actors are reluctant to change and compromise when handling resources and activities in the process, and strictly follows the recipe in lack of freedom in decision-making. Others may venture or challenge laws and regulations to make something more suitable as stated by Respondent F, “I use to think to myself that now I am going to challenge the system of rules and stress test it”. This is bound to person and whether one can see and is willing to create value in projects and therefore regulate the economic.

Depending on who is the project owner representative, the LOU can be maneuverer and do something good out of it. (Respondent B)

The ability to compromise and change public work projects is also problematic because public projects lock contractors into cost. Lowest price restricts the opportunity to succeed in quality due to lack of competence in contractor. By involving production personnel early, one will create something buildable and good from the beginning without departing from the vision and changes in production cost.

I think that the legislation should be pointed towards competence procurement instead of price procurement. [...] they are not buying a price, they buy competence. (Respondent A)
5.1.3. Unified vision

Public work projects are often time pressured due to the fast process transitions between the procurement phase and production phase. This creates stress on contractors to start production, which entails lack of time to discuss upcoming project. A factor that is valuable for the involved parties’ relationship, where actors can discuss the project as a whole and their expectations. Further, if the specification of project procurement is poor restraints are often caused on conversation throughout the remaining process, which makes it more difficult to uphold a shared objective. Respondents also state that commitment is significant to unify actors and organisations during process. By engaging in the process and making time as a manager one will be appreciated by the workers and becoming a team member, working towards common goals. A project is likely to halt if it lacks a solid foundation in terms of an absent project manager or owner.

You become a team with a common goal based on procurement documents […]. The project owner is the owner of the product no matter what, and if he is not interested and involved […], then it feels safer to have a product owner who turns up rather too much than too little. (Respondent C)

A unified vision is missing when managing excavated soil in the construction business. There are different views on who should be responsible for the organisation of the masses. Every actor is picturing the masses as an opportunity and a valuable resource for the society and has a common understanding of the problem. However, there is an absence of collective dialogues to find social benefits, primarily because of the workload the actors perceive but also due to the strict regulations, which respondent C states “There is a lack of a good strategy for it”.

If they do not have use for it or can manage it, and is required to transport it to landfill, well then they have to regulate their price setting after that. (Respondent E)

5.1.4. Commitment

Commitment is highly relevant for all the involved actors in construction projects. The level of commitment is personal for the representatives and not the organisation. If the person representing the project owner is more committed to the project, they are more active on project site and show their interest in the project. It is necessary for the project owner to be fully committed to the project at all times. The project owners do not contain detailed knowledge
about the project, which is the contractors’ responsibility. However, as Respondent F states, “I am committed but I try not to ask in detail” do they sought to be more involved. Project owners hold high level of trust for the contractors, which enable them to leave the details towards the contractors.

The public procurement act requires the project owner to communicate equally with the different contractors and be equally committed to each organisation. These regulations restrict the opportunities to have long-term commitments and therefore each project is executed, as it would be the last. Time and human resource limitations restrict project owners to be more committed to the projects. Due to these limitations, the project owners are not very committed to the management of excavated soil, and often leave the management to the contractors.

I have approximately 30 projects, which limits the commitment, but it would be more fun to be [...] more committed. (Respondent D)

5.1.5. Structure

The organisational structure of public private projects is restricted by the public procurement act in the tendering and project design phase. The public procurement act contributes to a fair competition by the contractors, and all contractors are to have the same conditions for tendering. These regulations limit the opportunities for the contractors to be involved in the earlier stages of a project. To be involved earlier in the process is desired by the contractors to enable prior resource planning.

I would like to be involved from when the idea occurs. To be involved in the planning phase, then you can control quite a lot as an entrepreneur [...], and when you have the right resources. (Respondent A)

The municipality is a grand organisation with many faculties and responsibilities in different areas. Due to the extensive construction rate and the limitation of human resources, the representative of the project owner has limited participation in each project. The representatives are most often involved in several construction projects at the same time.

The high workload also restricts the project owners’ ability to co-operate regarding management of excavated soil, and therefore the responsibility often lies with the contractor. There are some contradictions regarding what actors are responsible for managing the excavated soil. Some of the respondents state that the main responsibility lies with the contractor, some respondents consider
the responsibility to be shared among the actors, and other respondents think that the main responsibility lies with the project owner. From a political point of view, the excavated soil management in the construction industry is not talked about. Politicians are not aware of the perceived problem regarding the management of excavated soil among the contractors and project owners.

The structure of today’s excavated soil management is outlined as a problem that the project owner displaces and where the resulting consequence is an ineffective mode of operation.

Today, we go around like vacuum cleaner salesmen and sells to, or sells, we ask if they are interested in receiving. (Respondent A)

Today management of excavated soil is a pressured question among the involved actors. However, in a market economy the whole purpose is to utilise the competition and generate the best possible solution. With a free, respectable and healthy competition society should benefit from rivalry, and effective optimisation should be feasible when the responsibility lies on the private market to handle. Though, without environmental laws and regulations that correlate with the competition and what the public sector intends for the development of the infrastructure, the system is stumbling because of long office turnaround time, tight schedules and masses that are not of the right quality.

Resources are scarce in the business and the focus on sustainability in terms of resource efficiency is not prioritised in the extent as economy. However, the actors see possibilities for effective use but are limited by their projects and wish for some control to promote sustainability. The actors request co-operation for social benefit and development, by clarifying the legislations and propose for consideration to utilise structural poorer masses. It is seen as a struggle for the actors to individually be able to resolve the problem, but no one seems to be willing to take the first step and co-ordinate the network. The legislation is perceived as limited and is set out to focus on preventing mistakes rather than supporting opportunities for reuse. Further, the legislation is seen as out-dated in relation to the industry’s development.
6. Analysis and discussion of findings

The analysis is including a discussion of the empirical findings with the ARA-model and the iron triangle in relation to the theoretical part, to answer the research question.

6.1. ARA-model

6.1.1. The actor layer

The actor layer refers to firms, organisations and individuals controlling the resources and performing activities. The construction relationships are according to Gadde and Dubois (2010) often irregular and intermittent. In this case, several actors in the construction industry have been studied to find out about the relationships within the network. The relationships between the project owner and the contractor are most intense during the production-phase, with a short-term perspective on the relationships. The intensity of the relationships fades out when projects are completed. Relationships are bound to person, meaning that relationships between actors could be irregular depending on the representatives of the actors. Ingemansson Havenvid et al. (2017) state that relationship continuity occurs when a company encounters the same counterpart in more than one project. This also correlates with the result of the case, since it is common that the same representatives from different actors are working together in several projects, which might result in a positively developed personal relationship. However, as Mallaoglu et al. (2015) state, that developing relationships in the construction industry have a barrier in terms of cultural differences. This can correlate with the barrier of the public procurement act and how they are capable of creating relationships within the act. Apart from this, cultural differences have not been of any outcome in the findings. The commitment of actors is also bound to person, which could be seen as a barrier for creating long-term relationships if the level of commitment is low. Bygballe et al. (2010) state that commitment between participants is an important factor for establishing long-term relationships. If one representative is not committed, it might result in weaker actor bonds and network.

According to Carol and Sang Ok (2008) the relationships within public-private projects are successfully achieved if equal relationships, mutual decision-making, respect and trust are accomplished. The result of the study demonstrates that horizontal relationships, respect and trust are most often achieved. However, according to the contractors, the decision-making regarding
excavated soil management is not achieved by consultation with the project owner. There are also diverse opinions of which actor is responsible for managing the excavated soil. Forsman et al. (2013) state that the construction industry lacks a holistic approach, a necessity for an efficient utilisation of resources. This corresponds with the result of the case, due to the unclear responsibility regarding excavated soil management. These responsibility contradictions affect the society, since no actor takes full responsibility for managing the excavated soil with a focus of benefiting the society. The management of excavated soil can be seen as having similarities to the tragedy of the common good (Hardin 1968). There is a lack of unified vision regarding excavated soil, which in turn contributes to an individual organisational focus and not managing the material towards what is best for society. The lack of commitment from the project owner regarding excavated soil together with the economic focus of the contractor and their limited time contribute to non-optimal solutions.

6.1.2. The resource layer

The resource layer concentrates on the resources necessary for business development (Håkansson 1982). In this case barriers that obstruct management of excavated soil. The case study shows that personal commitment corresponds to resource efficiency; time and human resources are two factors, which limit the level of commitment to bear a sustainable thinking in the process of construction. Because time is scarce in the fast-moving process, one is not able to individually commit to the problem solving. By taking advantage of competence within a network through time management, resource efficiency can be attained when people involved in several projects at once can co-operate. It is among the actors essential to manage the excavated soil collectively, which is mutually to Sfakianaki (2015), that to accomplish a reform in perception all actors are required to commit to resource efficiency mind-set. Further, to develop the prospects of sustainable management Magnusson et al. (2015) indicate that strategically planning is vital for environmental performance. Relationships are therefore an important resource to conduct and it is significant to have the ability to see beyond the end of a project and not see it as the last one.

The modifications and interplay of several resources can create ties between the resources. However, the resource collection within organisations and the resource constellation in this case do not correlate due to the absence of the
ties. By creating actor bonds in terms of unified vision, actors have to engage in project constellations and actively become team members, this might result in a more unified group where the team has the same vision and goal. Once a team has the same objectives resources are more likely to correlate and be used effectively within and between different projects. This correlates with Crespin-Mazet et al. (2015), that relational agreements relating to resource efficiency are vital for project performance improvement. Another outcome of unified interplay and vision is the probability that a team can see beyond one project and reuse resources and competence in future projects. This correlates with Ingemansson Havenvid et al. (2017) and not Gadde and Dubois (2010) who claim that construction relationships are more likely to be discontinuous making the interplay of the common resources difficult.

6.1.3. The activity layer

The third layer, the activity layer depicts the activities which are connected between the actors (Håkansson 1982). Accordingly, by augmented interplay and mutual integration of resources and activities, stronger bonds between the actors can be developed. In this case the communication between the actors are highly developed as well as their knowledge of the advantages good communication brings and how essential it is for project success. Relationships are in the business developed and maintained by efficient co-ordination of activities in ways actors are able to handle uncertainty. Showed in Chapter 4 and the sustainability impact calculations, transportations contribute to the greatest carbon dioxide emissions. However, to practically create an efficient management of larger volumes of excavated soil, co-ordination of activities is required. Further, Magnusson et al. (2015) also conclude that co-operation is a factor to accomplish environmental successful management. Certain meetings are essential to manage and drive towards projects success such as; the first meeting after the procurement phase were all uncertainties and differences are discussed. Further, at this meeting and at all the other building meetings the attitude going in among the actors is highly important for further relationship and network development. The central relationship between the actors affects how the network of actors develops and their ways of managing activities and obstacles such as the excavated soil.

In the case the importance of unified vision strongly correlates with the activity layer. There are obvious advantages in planning and co-ordinating activities in early stages as well as discussing expectations and possibilities concerning
projects beforehand. By overlapping planning and production activities of projects, a synergy effect may occur within the network and result in the preservation of resources. Further, Carol and Sang Ok (2008) state in their research that a public work project can obtain a higher level of success if pre-planning has been implemented correctly. In this case a higher efficient way of managing excavated soil when in a greater extent focus on long-term strategies or linking specific activities across projects in advance. However, the lack of engagement in ways of improve and co-ordinate excavated soil management is an essential problem. An explanation might be the perception of responsibility and ownership of the masses, the problem that the clay and silt lack demand and value on the market. For the contractor and the project owner the soil mainly contains problems in terms of long process without positive economic result. In contrast to clay and silt, the value and aspiration of rocks are much higher. The rock material has a clear and useful purpose which the clay does not hold. However, Isaksson and Linderoth (2018) stated in their report that scarce sustainable focus is due to knowledge and information, which in this case has not been an outcome of the results. Further, there is a need for a more economic and environmental disposal of the excavated soil, but to achieve this, activities have to be co-ordinated long before a single project starts.

6.2. Iron triangle

The construction industry and its mode of business are well defined by the iron triangle with the three constraints of time, cost and quality (Atkinson 1999). These constraints have impregnated this study and are well acknowledged by the actors. However, the public work and the dynamics between public and private actors have, as the literature indicates, issues regarding dissension cost, quality and time. Further, the question where and whether sustainability should be a measure of performance, since it has been diminished in previous research (Hueskes et al. 2017).

The idea of incorporating the act of sustainability management in project management and the business of construction could have a positive impact on project success (Toor & Ogunlana 2010). However, the amount of focus that is set on the financial performance is a barrier where the rigours bureaucracy and authority control, and management over the process create low incentive of change and opportunities within the network. Most activities in the web of actors are based on official laws or regulations. On the contrary the public procurement discussion of the excavated soil is out of discussion in comparison
with other collaboration decisions in the process. Joint agreement and discussion over the product completion are considered upon all aspects such as, structure, configuration, manufacturing, etc. The lack of unified vision within the network creates inefficiency throughout the construction processes, a problem that in other nodes would denote high communication and efforts of resolution amongst the actors.

Implications emerge in absence of a unified visioning process when managing excavated soil. First, team vision and goals disconnect from the project vision and structure. Because, the importance for unified strategy is essential for project success and for the constraints in the iron triangle to come through even in terms of time and resources efficiency, budget limitations and the quality output. The question if sustainability could be incorporated in the controlled triangle is to be achieved by an in-depth relationship between the actors where planning, production and standardisation are established. Another implication is the opportunities to reach economy of scale due to the iteration of cost transactions to society when managing the excavated soil, transporting it around until decent deposition is found. There is as Chen et al. (2016) stated a trade-off in the industry. Another implication connected to asymmetry regarding the excavated soil management, is the perception of who actually owns the soil. This implies that the material has no economic value and is redundant.

There is a need for a clearer systematic overview of the management, where it is possible to analyse current state and its sustainable consequences and what future actions regarding effective and conscious management require. Which correlates with Herazo and Lizarralde (2016) who claim that the alignment of stakeholders’ approaches does not always correlate and their perception of sustainability. By the results of the research it is of importance to plan and create not only one-way to success but instead several parallel processes in which sustainability is stated. Sustainable solutions have to be encouraged to sustain development of resource efficiency. The network has to be formed in a way that actors can make active strategic choices in their mode of business. Which is in line with Carol and Sang Ok (2008) who state that there is a need in public-private projects to meet realistic goals for both parties. Working methods within the network lack support that contributes to see the whole picture. Further, opportunities and conditions for the actors and their bonds would benefit from an evaluation to reach the common objectives between the network stages.

To summarise the analysis and the discussion of findings, two main barriers can be recognised; the public procurement act and the lack of unified vision. While
the co-operation is hindered by the rigid public procurement act and its structure. It can also be seen that the lack of unified vision is missing structure in how to manage the excavated soil as well as who actually has the responsibility and ownership.
7. Conclusion

In the following chapter, the findings and contributions are concluded. Further, the managerial implications, limitations and suggested future research are also presented.

This research has been investigating the network in construction business and their project performance. The purpose of the study is to understand the excavated soil management and how different actors and their roles are intertwined with each other and how they are related to environmental aspects in construction projects. In the following concluding discussion, a further discussion will take place of the findings and answer the study’s research question:

RQ: What networking/relationship barriers are there to implement a more economic and environmentally effective method when managing the excavated soil?

Existing literature of the construction industry focus and state that the relationship characteristics among the actors are much coloured by adversarial and intermittent relationships. These relationships tend to lead to problems concerning productivity, time management, budget overruns as well as innovation loss. Further, this leads to trade-offs in decision-making between revenue and environmental considerations (Chen et al. 2016, Isaksson & Linderoth 2018). Based on this case study the existing relationship among project owner and contractor is highly developed and does not reflect a sector in which are fragmented in their working relationships. However, this study has evolved in findings of dynamics related to structure and flexibility in the network concerning problems in efficiency and reuse of resources.

The public procurement act in Sweden is rigorous when to manage excavated soil and is affecting the actors in the construction network. Problems resulting in terms of the public procurement act are possibilities to interact with other parties to conduct a well-planned and successful project. This barrier is difficult to overcome and manoeuvre, due to the quick and fast processes when a project has landed on the contractor’s table. Possibilities to interplay and influence project development is therefore hard to realise for the involved players. Chen et al. (2016) also concluded that the industry is profoundly institutionalised in its mode of business, in which holistic thinking and approaches are difficult to establish. The public procurement act also stands for the barrier for low innovation in sustainability due to its complexity, unique structure and the involvement of multiple actors. Upstill-Goddard et al. (2016) state in their
research that sustainability standards can be implemented, but if no pressure is perceived the decrease is a fact. This correlates well with this research due to the public procurement act and the possibilities to actually perform better is no option because the game plan and the environmental prospects do not correlate with the act.

The results presented a second dilemma regarding how unified vision between the actors along projects relates to a lack in structure. This can be explained by the unwillingness of taking care of the excavated soil because the material is seen as useless due to its material compound. A widespread term in resource management is the tragedy of the common (Hardin 1968), which can be related to this network problem. There is a reluctance to manage redundant soil, because it has no economic value on the market. However, the soil is a natural resource which can be useful if structures in the network are strategically pre-planned and there is a common objective for disposal. Though, today the called “problem” is pushed to last minute removal, in which its usefulness is lost. There is a need for strategic planning at an early stage to foresee and evaluate the demand and availability of the excavated soil on the market.

Commitment is required from both project owners and contractors to realise a system overview of the excavated soil management. A committed leadership from one or several combined parties to motivate and clarify processes, roles and operations. This may require a regional node to develop joint human efforts and effective work structure. Furthermore, work towards efforts to get decision makers both private and public to understand their role and responsibility to implement and develop management in a sustainable direction. To accomplish an effective management, actors in the network have to be stimulated to act for collaborative solutions over the public private boundary. As stated by Carol and Sang Ok (2008), that public work projects can move towards success through preparations and that a co-operative bond over sectors results in increased efficiency. Further, a collective effort that drives is needed to realise resource efficiency that is flexible to support the network.

In summary, it can be concluded that the construction industry is a complex and unique business and that relationships amongst actors are vital for project completion and success. The barriers to overcome are the possibilities to manage excavated soil in a more economic and environmentally effective way is first, the ability to manoeuvre the public procurement act and its structure before and during the process. Second, there is a lack of unified vision among the actors, with regards to the perception on who is responsible and have the
ownership of the soil that is not seen as useful or valuable. To then accomplish or move towards a more effective way of operations, there is a need for commitment amongst all actors where a node could unify the parties and jointly strive for collaborative problem solving and long-term visioning.

7.1. Managerial implications

Hopefully this study will lead to a raised awareness in this field and contribute to development of further work. Our findings (see Table 4) can be summarised in a number of managerial implications;

- Actors have to prioritise and develop actions of how to implement a strategic plan to manage the part of a project where excavated soil is in focus. By focusing on a more long-term strategic plan and maintaining as well as expanding their relationships opportunities, mobilisation of other actors for support the excavated soil can be handled in a more efficient way during process.
- Commitment is required among all actors, to accomplish collaborative solutions regarding the excavated soil.
- Continue to preserve the resource perspective within the network and strive to challenge the legislations.
- Evolve the awareness of the development in which possible solutions can be obtained that leads to decreased negative effects which contributes to social, economic and sustainable welfare by a greater management of excavated soil.

7.2. Limitations

One limitation with the study is that it is conducted at one specific case company and in one single municipality, which can make it difficult to draw a general conclusion. Due to the time limitation of a time plan of the research, any possibility to conduct the research with more than the participating public-private actors has not been feasible. Another limitation due to the timeframe is that other actors that would have been of interest for interviewing purpose were not possible to contact and schedule.

Another limitation of this research is that the construction industry is a complex and unique in every new project in terms of operations and execution and therefore it might be problematic to generalise to other industries. However, because it is project based it could be generalizable to similar modes of business. Furthermore, in other contexts the outcome could be different depending on organisational size and how large the urban development projects may be.
7.3. Future research

It would be beneficial to conduct more interviews at other and several organisations, to obtain a more widespread and reliable result concerning management of excavated soil. This means to conduct the same research but at both larger or smaller municipalities and entrepreneurs, to compare the results in this case. It is therefore of interest to see whether contractors and customers display the same strategy patterns and how they interact to achieve long-term visionary goals. It could also be of interest to investigate the possibilities for a more assembled solution when managing the excavated soil on a higher level of authorisation. Studying a project at a regional level where municipalities or organisations interplay over regional boundaries or how collaboration between competitive organisations would play out when orchestrating a solution for a collaborative management.
8. List of references


9. Appendix

9.1. Glossary and definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Excavated masses</td>
<td>Masses that are excavated from the ground. Contains gravel, sand, clay, organic material and water, and other that have been laying in the ground. Its composition is graphically dependent and varies between geology and history.</td>
</tr>
<tr>
<td>Ballast</td>
<td>Grain material used for construction. Natural: ballast of rock material, only subjected to mechanical processing. Manufactured industrially: ballast of mineral origin, obtained by industrial process involving thermal or other modification. Recycled: ballast, obtained by processing inorganic material previously used for construction.</td>
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<tr>
<td>Landfill</td>
<td>A waste disposal site located on or in the ground. A landfill is not a place where waste are: Reloaded to prepare it for future transportation to another place where it is being processed, Stored before it is recycled, if storage is for a shorter period than three years, or Stored before disposal, if storage is for shorter period than one year.</td>
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<tr>
<td>Floating soil</td>
<td>Soil that becomes liquid if exposed to motion and vibration.</td>
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<tr>
<td>Friction soil</td>
<td>Soil whose shear strength is largely due to friction between the grains. Gravel and sand are examples of friction soil.</td>
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<tr>
<td>Humus</td>
<td>Organic material, yellow or dark brown to black in colour. Consist of coal, oxygen, hydrogen and nitrogen and is formed of natural organic materials by decomposition or repositioning.</td>
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<tr>
<td>Mineral soil</td>
<td>Soil containing less than 20 % of organic material by weight.</td>
</tr>
<tr>
<td>Organic soil</td>
<td>Soil containing more than 20 % of organic material by weight.</td>
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<tr>
<td>Pore water pressure</td>
<td>The pressure of water in soils pores. It affects the stability and bearing of the soil, for example deformation at different loads.</td>
</tr>
<tr>
<td>Pore volume</td>
<td>Total volume of pores in a soil. Together with the pore size, it is important for capillarity and permeability.</td>
</tr>
<tr>
<td>Subsidence</td>
<td>Soil, land surface, buildings or roads vertical deformation.</td>
</tr>
<tr>
<td>Capillarity</td>
<td>The ability of a liquid to rise in a pipe or porous material as a result of surface tension.</td>
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9.2. Relationship Strategy - Case Company

At larger organisations, it is common that internal strategies are documented and are used as guidance for the employees. A relationship strategy has been conducted by the case company to maintain competitive on the market, and to create long-term cooperation with project owners. The contractor’s process of creating relationships with the customer during early and later stages of the construction process is described using four phases. The first phase is focusing on understanding, referring to early marketing efforts in the sales process. Understanding and knowledge about the market, business models and offers are created. This gives the opportunity to prioritise the customers that the contractors want to build long-term relationships with. Early meetings with the customer are often performed, to implement a first contact and create prerequisites for a good relationship amongst the actors.

In the requirement phase, the focus is on listening to the customer and building relationships as well as establishing trust. The purpose is to create prerequisite for getting to know the customers and understanding what factors driving them, both personally and professionally. The customer manager ensures that the sales work is done through value-added advice and decision-making. The earlier that the contractor become a part of the customers knowledge gathering, the greater is the ability to understand and influence what the customer will value as important. With a deep customer understanding as a base, the next step in the sales process is to submit and perform a customised professional business proposal. In the tendering phase, the project owner will feel confident that the contractor has understood and can realise the needs – both the early ones and those identified through value-added dialogue and counselling. The customer should be convinced that the suppliers’ offers create added value for their business and help to achieve their goals. The tender will meet the customer’s needs and highlight areas that are unique in the co-operation with the contractor.

The processing phase strives to develop and improve the relationship and business with the customer by taking advantage of the opportunities offered by an ongoing business. Continuous meetings create long-term relationships and ensure the right delivery and satisfied and loyal customer, providing the best prerequisites for new business opportunities. This relationship strategy provided by the case company is in this thesis used for the purpose of triangulation (Gray 2017), to verify the results and determine the trustworthiness of the collected data from the semi-structured interviews.
9.3. Rules and Regulations

9.3.1. The Swedish Public Procurement Act

The Swedish Public Procurement Act only applies to procurement undertaken by a contracting authority. There are six principles controlling the public procurement act. The first principle is non-discrimination which implies a prohibition of discrimination due to their nationality. The contracting authority need to set requirements that all organisations can meet, regardless of nationality. All the tenderers are required to be treated the same way and have the same prerequisites, which is also the second principle. Equality between the tenderers is required, where all the tenderers need to get access to the same amount of information at the same time. The contracting authority cannot for example accept a delayed tender due to the time regulations. The third principle is proportionality, which implies that the requirements and terms of the procurement shall be proportionate to what is tendered. The fourth principle is the transparency principle, which implies openness and predictability in the procurements. Important information regarding the procurements is prohibited to be withheld. The procurement should be published in public and the participating organisations are required to be informed of the result. The fifth principle is focusing on mutual recognition, which implies all the foreign suppliers to have the same conditions and opportunities as the Swedish actors. Certificates that are approved in the Swedish public procurement act are based on regulations issued at European Union (EU) level and therefore all the approved certificates within EU are permitted, and cannot be rejected. The sixth principle entails that procurement cannot be formed in order to limit the competition by giving advantage to certain tenderers. (SFS 2016:1145)

9.3.2. The Swedish Environmental Code

The Swedish Environmental Code is intended to support a sustainable development so that present and future generations ensure a healthy and good environment. A sustainable development is based on the insight that the nature has a protection value and that the human right to change and use the natural resources is associated with a responsibility of a good management. Some of the most important regulations and limitations in the field of excavated soil are described in the Swedish Environmental Code.
**General considerations, 2nd chapter**

In the second chapter of the Swedish Environmental Code some general considerations are described. It is required to obtain the knowledge that is necessary to conduct an activity to protect the health of humans and avoid environmental damage. If there is reason to assume that an activity or action can cause damage or inconvenience to human health or the environment, precautions should be taken. It is also required to limit the use of raw materials and energy, and to exploit the possibilities of reuse and recycling. The location of the activity should be chosen with regard to achieving the least possible impact on human health and the environment. These regulations should be taken into account and the benefits from these actions should be compared with the execution cost to determine the plausibility.

**Environmentally hazardous activities and health protection, 9th chapter**

The ninth chapter of the Swedish environmental code is highly relevant regarding the management of excavated soil. Environmentally hazardous activities are referred to the use of land, buildings or facilities in a manner that might cause inconvenience to human health or to the environment. According to the Swedish environmental code the government can prescribe that a permission or notification is needed to construct or operate certain types of factories, other establishments or other environmentally hazardous activities, and releasing or depositing solid waste or other solids, if there is a risk of land, water or groundwater being contaminated. Furthermore, it is stated that an initiation of a notificationable activity is allowed at the earliest six weeks after the notifications has been made, unless the regulatory authority decides something else.

**Water operations, 11th chapter**

Water operations refers to construction, modifications, repairs and extraction of dams or other facilities in water areas, filling and piling in water areas, drainage of water from excavation, blasting and cleaning in water areas as well as other measures in water areas if the measure is aimed at changing the depth or position of the water. A water operation is only allowed if the benefits outweigh the costs and the damages of the activity. Normally permission is required for water operations. The environmental court is examining applications for permission.
Consultation obligations, 12th chapter

According to 12th chapter in the Swedish environmental code a notification for consultation is required to the county administrative board if a measure, which does not require notification or permission, is significantly changing the natural environment. Examples of activities that require notification are individual roads, landfill, and dredging, and mud mass storage. Excess of excavated soil masses which will be stored for later use requires consultation, even if the masses are completely clean.

Waste and producer responsibility, 15th chapter

Waste is according to the Swedish environmental code defined as every object, material or substance included in a waste category and which the holder discards or intends or is required to get rid of. The holder of the waste is required to ensure that the waste is managed in an acceptable manner with regards to the human health and the environment. It is not allowed to litter at locations where the public has access to (SFS 1998:808).

Planning and Building Act

According to the planning and building act, each municipality is required to have an up-to-date sketch plan, which displays how land and water areas will be used in the future. The sketch plan is not binding. The regulation of the use of the land and the development within the municipality take place through local plans. A local plan is binding until it changes. For limited areas not covered by the local plans, area regulations can be adopted, if necessary for the purpose of the sketch plan to be achieved or to ensure that national interests are met (SFS 2010:900). According to the Swedish environmental code, permission or dispensation is not allowed to contradict the local plans or area regulations (SFS 1998:808). Some actions require building permits, for example when forming heaps and storage places. Within areas with local plans a land permit is required, unless otherwise agreed in the local plan, for excavating or filling that causes changes in the elevation of plots or land for public places. According to the planning and building act, land and water areas are required to be used for the purpose they are most suitable for, with regard to the nature and location as well as the present needs. Priority should be given to such use which results in good utilisation from a general point of view (SFS 2010:900).
Waste Ordinance

Waste is defined as all the objects, materials or substances that the holder wishes to dispose of or is obliged to dispose of, and which is included in any of the waste categories in the waste ordinance. The lack of clear environmental risks from an activity is not a relevant criterion to determine whether it is a waste or not. If a decay product constitutes waste or not depends on the holder’s purpose or interest regarding how to use the decay product. The actual intention of the holder’s disposal of the decay product is required to be tested to determine whether the intention is to utilize it or to only get rid of it. If the material is being classified as waste and used for construction purposes, and the use involves risk for human health and the environment, a notification is required (SFS 2001:1063).

9.4. Organisational structure during a construction project

Figure 9 displays the general structure of the organisation at a construction project. However, the structure can differ depending on the type of project, project owner and contractor. The project owner is together with consultants creating a basis for tendering. Depending on the type of procurement, the consultants are more or less involved. When the tendering documents are formed, they are sent to interested contractors, which in turn calculate a price to complete the project. If the project design are be decided by the contractor, they have in some cases a project design manager who is in charge of that process. The construction manager and the project leader from the project owner are sometimes the same person, depending on the project size, and is the representative of the project owner. The representatives of the contractor are the project manager and the production manager, and are the ones with the most frequent contact with the project owner. Supporting functions have different tasks, they are for example responsible for the economy and questions regarding quality, environment and the working environment. The measuring engineer is responsible for measuring and doing co-ordinate calculations of the construction project. Depending on the project type, the contractor also contains a project design manager responsible for developing the project design, if it is not done in previous stages by the project owner or a consultant.
9.5. Project description and Calculations

**Assumptions**

- Worst case scenario where all the material being transported from the project site are assumed to be clay.
- The transportations from case 1-3 are starting from the same location.
- The transportations from case 4-6 are starting from the same location.
- The trucks are transporting the material one way and go empty on the way back.
- Due to lack of information regarding kg CO₂-eq emissions for project A and D-F, the calculated kg CO₂-eq for the excavator per cubic excavated material for project C have been used for those cases as well.
- The type of truck used in the calculations is a 4-axis truck, with the maximum load weigh of 17 tons. The fuel being used for transportations are diesel, which is the most common fuel to use for trucks. The fuel consumption has been assumed to be 0,3 litres per kilometre. These assumptions have been made with consultation with the case company.
- For the second case, an assumption has been made that each farmer can receive 5 loads of excavated soil. In average, the farmers are located 8 kilometres from the starting point.
- For the third case, the height and width of the sound wall have been assumed to 3 and 2 meters. Further, the execution time to excavate the material per cubic and the time to construct the sound wall per cubic has been assumed to be the same. Therefore, the amount of CO₂ emissions from the excavator during the excavation process in project C is being used for constructing the sound wall at case 3.

**Project description**

Project A was the first stage out of three, where water and drainage pipes have been installed. Project B and C are the second and the third stage and all together 6-7 kilometres of pipelines have been constructed. In total, 150-250 properties have been connected to the pipes. The project owner of project A-C was Hammarö municipality and the type of procurement was turnkey contract. Project A-C have been jointly designed of both actors. Project A-C involved the installation of two pipelines, one for wastewater and one for fresh water, as well as the construction of several major and smaller pumping stations. In the first and second project, the construction of walk- and bicycle roads with associated lightning was prepared for. The time for completion for the first project was between February 2016 and June 2016, the second project was constructed between June 2016 and July 2017. The third project overlapped the second, and had a completion time between February 2017 and November 2017.

Project D was part of the expansion of Karlstad, and comprised the installation of approximately 2600 meters of water and drainage pipes with associated
approximately 2000 meters of road and walk- and bicycle path containing lightning. The project owner of project A was Karlstad municipality. The project was executed between October 2015 and the end of August 2016. The type of contract in project D-F was pure construction contract. Project E was continuing on project D, and comprised the installation of approximately 500 meters of water and drainage pipes. 500 meters of road and walk- and bicycle path, including lightning, have also been constructed. The execution time lied between August 2016 and November 2016. The project owner was Karlstad municipality in this project as well. Project F was also owned by Karlstad municipality and was executed by a competing organisation to the case company. The project comprised 1800 meters of roads with associated walk- and bicycle paths, five bus stops, lightning and approximately 2200 meters of water and drainage pipes. The time for completion was between June 2017 and June 2018.

Table 5. The amount of excavated soil from each project, both the amount that will be used on site (in situ) and transported from the project site (ex situ)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>In situ (m³)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12320</td>
<td>350</td>
<td>9093</td>
</tr>
<tr>
<td>Ex situ (m³)</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>8270</td>
<td>8590</td>
<td>2500</td>
</tr>
<tr>
<td>In situ (m³)</td>
<td>0</td>
<td>881</td>
<td>1205</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ex situ (m³)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>In situ (m³)</td>
<td>2771</td>
<td>16613</td>
<td>11403</td>
<td>2100</td>
<td>4460</td>
<td>2450</td>
</tr>
<tr>
<td>Ex situ (m³)</td>
<td>0</td>
<td>6336</td>
<td>6581</td>
<td>12500</td>
<td>1440</td>
<td>910</td>
</tr>
<tr>
<td>In situ total (m³)</td>
<td>2771</td>
<td>17494</td>
<td>12608</td>
<td>16420</td>
<td>4810</td>
<td>11543</td>
</tr>
<tr>
<td>Ex situ total (m³)</td>
<td>75</td>
<td>6336</td>
<td>6581</td>
<td>20770</td>
<td>10030</td>
<td>3410</td>
</tr>
<tr>
<td>% of ex situ</td>
<td>3%</td>
<td>27%</td>
<td>34%</td>
<td>56%</td>
<td>68%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Table 6. Information regarding the three cases used in calculations

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (tonnes/m³)</td>
<td>2.7</td>
</tr>
<tr>
<td>Volume/truck (m³)</td>
<td>6.3</td>
</tr>
<tr>
<td>Maximum weight per truck (tonnes)</td>
<td>17</td>
</tr>
<tr>
<td>Fuel consumption (l/km)</td>
<td>0.3</td>
</tr>
<tr>
<td>Emissions (kg CO₂-eq/l)</td>
<td>2.56</td>
</tr>
<tr>
<td>Lengths project A-C to landfill (km)</td>
<td>38.6</td>
</tr>
<tr>
<td>Lengths project D-F to landfill (km)</td>
<td>16.4</td>
</tr>
<tr>
<td>Loads per farmer</td>
<td>5</td>
</tr>
<tr>
<td>Length to farmer (km)</td>
<td>16</td>
</tr>
<tr>
<td>Sound wall height (m)</td>
<td>3</td>
</tr>
<tr>
<td>Sound wall width (m)</td>
<td>2</td>
</tr>
<tr>
<td>Sound wall distance (km)</td>
<td>20</td>
</tr>
</tbody>
</table>
Table 7. Data collected from stored documentations at the case company

<table>
<thead>
<tr>
<th>Project</th>
<th>Sustainability impact (kg CO₂-eq)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Project A</td>
<td>223536</td>
</tr>
<tr>
<td>Project B</td>
<td>1405837</td>
</tr>
</tbody>
</table>

Table 8. Calculated kg CO₂- equivalents per excavated cubic soil for each project

<table>
<thead>
<tr>
<th>Project</th>
<th>Total kg CO₂-eq</th>
<th>CO₂/m³</th>
<th>Excavation kg CO₂-eq</th>
<th>In-situ (m³)</th>
<th>Ex-situ (m³)</th>
<th>Ex-situ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0,25</td>
<td>19</td>
<td>2771</td>
<td>75</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0,03</td>
<td>178</td>
<td>17494</td>
<td>6336</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0,25</td>
<td>1635</td>
<td>12608</td>
<td>6581</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>0,25</td>
<td>5160</td>
<td>16420</td>
<td>20770</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>0,25</td>
<td>2492</td>
<td>4810</td>
<td>10030</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>0,25</td>
<td>847</td>
<td>11543</td>
<td>3410</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>
Table 9. The amount of transportations is calculated from the maximum allowed volume per truck and the amount of excavated soil transported from the project site (ex situ).

<table>
<thead>
<tr>
<th>Project</th>
<th>Sustainability impact Ex-situ</th>
<th>Amount of transports</th>
<th>kg CO₂-eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1006</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1045</td>
<td>1635</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3299</td>
<td>5160</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1593</td>
<td>2492</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>542</td>
<td>847</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7497</td>
<td>10331</td>
<td></td>
</tr>
</tbody>
</table>

Table 10. The final results regarding the kg CO₂-equivalents from Case 1.

<table>
<thead>
<tr>
<th>Project</th>
<th>Landfilling cover material</th>
<th>kg CO₂-eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>353</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>29832</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>30985</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>41549</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>20064</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>6821</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>129604</td>
</tr>
</tbody>
</table>

Table 11. The final results regarding the kg CO₂-equivalents from Case 2

<table>
<thead>
<tr>
<th>Project</th>
<th>Farmers Amount of farmers</th>
<th>kg CO₂-eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>12844</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>12365</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>146</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>40535</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>19575</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>6655</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>92120</td>
</tr>
</tbody>
</table>
Table 12. The final results regarding the kg CO\textsubscript{2}-equivalents from Case 3

<table>
<thead>
<tr>
<th>Sound wall Project</th>
<th>Length total (m)</th>
<th>kg CO\textsubscript{2}-eq transport</th>
<th>kg CO\textsubscript{2}-eq excavator</th>
<th>Total kg CO\textsubscript{2}-eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12</td>
<td>183</td>
<td>19</td>
<td>202</td>
</tr>
<tr>
<td>B</td>
<td>1056</td>
<td>15457</td>
<td>1547</td>
<td>17031</td>
</tr>
<tr>
<td>C</td>
<td>1097</td>
<td>16055</td>
<td>1635</td>
<td>17690</td>
</tr>
<tr>
<td>D</td>
<td>3462</td>
<td>50669</td>
<td>5160</td>
<td>55829</td>
</tr>
<tr>
<td>E</td>
<td>1672</td>
<td>24468</td>
<td>2492</td>
<td>26960</td>
</tr>
<tr>
<td>F</td>
<td>568</td>
<td>8319</td>
<td>847</td>
<td>9166</td>
</tr>
<tr>
<td>Total</td>
<td>7868</td>
<td>114968</td>
<td>11727</td>
<td>126878</td>
</tr>
</tbody>
</table>
9.6. Interview guide

Follow-up questions: Why? What do you mean? Tell me more? Can you develop your answer? How?

Interviewer's Name:

Date:

Place:

Time:

Organisation:

Respondent Name:

Position:

The interview will be anonymous.

Is it okay if we record the interview?

How long have you been in this position?

How long have you worked for the organisation?

Relationship Questions

Can you tell me briefly about your role in the construction process within road and facility (VA)?

How does the cooperation with the VA contractors/project owners work?

- Before construction start?
- During the construction process?
- Afterwards when the project is complete?

What are your relationships with VA entrepreneurs/ project owners?

Do you see any difference in the relationship during the different phases? Does it shift? Why?
How and in what way are the project owners involved in projects?  
- Does it differ between projects and project owners?  
When and in what way do you want to be involved in projects?  
Does it differ between project owners in the region of Värmland?  
What does the relationship look like with the contract project managers? Does it differ between companies?  
How have you worked with relationships with project managers / entrepreneurs before?  
How do you want to work with relationships in the future?  
How do you work to develop your relationships with the entrepreneurs/project owner?  
What do you do to create a long-term relationship with the entrepreneurs/project owner? Is it something you strive for?  
What development opportunities do you see for with your relationships with the entrepreneurs/project owner?  
What obstacles are there to create a long-term relationship with the entrepreneurs/project owner?  
How do you handle conflicts with the entrepreneurs/project owner?  

**Excavated Soil Questions**  
How do you look at the management of clean masses that cannot be used on site?  
Do you think that there are problems with mass management today?  
Are you planning for the management of clean masses in construction projects before the project is transferred to the contractor?  
How do you/ the contractors take care of the clean masses (case B) today?  
Who has the responsibility to manage the masses?  
What advantages is there when the responsibility to handle the masses lays on the contractors/ project owner?
What are the disadvantages?

How does it benefit society?

What do you think that the contractors want from the municipality in terms of excavated soil management?

Do you know how other regions handle the masses?

What do you see for development opportunities with the management of clean masses?

What obstacles exist to create an efficient management of clean masses?

If you were to help entrepreneurs to manage excavated masses, how would you do that?

**Other**

Do you have anything more you would like to add?

Can we contact you again if we have further questions or if we need to clarify your statements?