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The Role of Municipalities in Construction Logistics for Sustainable Cities

A study to research the prerequisites of effective construction logistics with a municipality perspective

Master's thesis in the Master's Programme Design and Construction Project Management

IDA JOHANSSON
SOFIA MELLGREN

DEPARTMENT OF ARCHITECTURE AND CIVIL ENGINEERING
CHALMERS UNIVERSITY OF TECHNOLOGY

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MASTER'S THESIS ACEX30

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Institutionen för arkitektur och samhällsbyggnadsteknik
Chalmers tekniska högskola, 2021

Department of Architecture and Civil Engineering
Division of Construction Management
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

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ABSTRACT

Cities are evolving with increased urbanisation and many construction projects are hence taking place in parallel in dense city areas. This means that accessibility in cities comes to the forefront when many projects need to share a limited space in the built environment. Thus, construction logistics to and from the sites becomes challenging. Previous studies have identified that the municipalities have an important role to play because they have a mandate to regulate how construction logistics solutions are designed and used to meet the demands of sustainability and the citizen's needs. Accordingly, the study that is conducted with AFRY, aims to investigate the municipalities' role, incentives, and responsibilities in achieving sustainable construction logistics. The case study covers the project Stockholm Royal Seaport and The City of Stockholm's implementation of a construction logistics solution as well as three other municipalities': City of Gothenburg, municipality of Uppsala and the municipalities of Södertörn, positions and perceptions of construction logistics.

The result of the study shows that the implementation of construction logistics solutions have varied in the studied municipalities. At the same time, all municipalities show an interest in construction logistics and see the benefits in an implementation. Construction logistics is considered important as it can reduce the climate impact and contributes to an attractive city. Construction logistics solutions thus contributes to the municipalities goals of reducing emission and is connected to the UN's Sustainability Development Goals.

The study concludes that to be able to implement a well-functioning construction logistics solution, the solution has to be developed by actors who possess the right knowledge and experience. Furthermore, the potentials with construction logistics have to be discussed at an early stage with affected stakeholders to create awareness and engagement among them. The result points out that an implementation of a construction logistic solution should be stated in the municipalities land allocation agreement in case of municipality-owned land or the land development agreement if the land is owned by a private actor.

Keywords: Construction logistics, Land allocation, Land development agreement, Land development department, Municipality, Sustainability.

Kommunernas roll inom bygglogistik för hållbara städer

En studie för att undersöka förutsättningarna för effektiv bygglogistik med ett kommunperspektiv

Examensarbete inom mastersprogrammet Organisering och ledning i bygg- och fastighetssektorn

IDA JOHANSSON

SOFIA MELLGREN

Institutionen för arkitektur och samhällsbyggnadsteknik
Avdelningen för Construction Management
Chalmers tekniska högskola

SAMMANFATTNING

När urbaniseringen och byggandet i tät stadsmiljö ökar är allt fler byggprojekt igång samtidigt och tillgängligheten i städer får stor betydelse. Då det byggs i flera projekt på mindre och svåråtkomliga ytor blir logistiken till och från byggarbetsplatserna en stor utmaning. Tidigare studier har identifierat att kommunen är en viktig aktör utifrån kommunens roll som självstyrande med möjlighet att reglera utformning av bygglogistiklösningar för att tillgodose invånarnas behov. Syftet med studien är att undersöka kommunens roll, incitament och skyldigheter för att uppnå hållbar bygglogistik. Studien är utförd tillsammans med AFRY och omfattar en undersökning av projektet Norra Djurgårdsstaden och Stockholms stads implementering av en bygglogistiklösning samt tre andra kommuners ställningstagande gällande bygglogistik: Göteborgs stad, Uppsala kommun och Södertörnskommunerna.

Resultatet visar att implementering av bygglogistiklösningar varierar i de utvalda kommunerna men samtliga har ett intresse av bygglogistik och ser fördelar med en implementering. Bygglogistik minskar klimatpåverkan och bidrar till en störningsfri och attraktiv stad och bygglogistik har en bidragande faktor i att uppnå kommunernas uppsatta utsläppsmål som kopplas till arbetet med FNs mål Agenda 2030.

För att kunna implementera en fungerande logistiklösning måste lösningen utformas av aktörer med rätt kompetens inom bygglogistik. Andra viktiga faktorer är att i ett tidigt skede diskutera bygglogistik för att skapa förståelse och engagemang hos alla inblandade aktörer, såsom representanter för olika förvaltningar, entreprenörer och byggherrar. Resultatet visar att om en bygglogistiklösning ska implementeras bör det ingå i kommunens markanvisningar när marken är kommunalt ägd eller i exploateringsavtal när marken ägs av privat aktör.

Nyckelord: Bygglogistik, Exploateringsavtal, Exploateringskontor, Hållbarhet, Kommun, Markanvisning

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Acknowledgements

This master's thesis marks the end of the master's programme Design and Construction Project Management and is our final project at Chalmers University of Technology. The thesis of 30 credits has been conducted during the spring of 2021 together with the consulting company AFRY and at the division Construction Management. We hope that this thesis will help and inspire municipalities to implement construction logistics and improve the urban environment for their citizens.

We would like to give our most sincere thank you to our supervisor at Chalmers University of Technology, Viktoria Sundquist. You have given us new insights and perspectives to continue the research to achieve its fullest potential. Thank you for supporting and believing in us and for showing your interest and knowledge in the field. We would also like to express our deepest gratitude to our supervisors at AFRY, Petter Wadmark and Jenny Olsson for your support and experiences within construction logistics. We have appreciated the time you have spent on this and will miss talking to you virtually every week.

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Gothenburg, May 2021

Ida Johansson & Sofia Mellgren

Glossary

Act on Guidelines for Municipal Land Allocation	Lag om riktlinjer för kommunala markanvisningar
Administration	Förvaltning
Area manager	Etappsamordnare
Building Committee	Byggnadsnämnd
Climate goal committee	Miljömålsberedning
Committee	Nämnder, Utskott
Comprehensive plan	Översiktsplan
the County Administrative Board	Länsstyrelsen
Detailed development plan	Detaljplan
Disposition plan	APD-plan
Environment Committee	Miljönämnden
Environment Administration	Miljöförvaltning
Implementation plan	Plangenomförande
Land allocation	Markanvisningar
Land allocation agreement	Markanvisningsavtal
Land development agreement	Exploateringsavtal
Land Development Committee	Expolateringsnämnden
Land Development Department	Exploateringskontoret
Municipal Assembly	Kommunfullmäktige
Municipal Executive Committee	Kommunstyrelse
Municipality Director	Kommunaldirektör
Officer	Tjänsteman
Plan- and building act (PBA)	Plan- och bygglagen (PBL)
Property Management Administration	Fastighetskontoret
Regional councils	Region
Stockholm Royal Seaport	Norra Djurgårdsstaden
the Swedish Environmental Code	Miljöbalken
the Swedish Transport Administration	Trafikverket
Traffic Committee	Trafiknämnd
Transfer Agreement	Överlåtelseavtal
Transfer of Land	Marköverlåtelse
Urban planning and construction issues	Plan- och byggfrågor
Urban Planning Administration	Stadsbyggnadskontoret
Urban Transport Administration	Trafikkontoret

Abbreviations

CLC – Construction Logistics Centre
CSCM – Construction Supply Chain Management
GBA – Gross building area
GUTA – Gothenburg Urban Transport Administration
ICT – Information Communication Technology
JIT – Just-in-time
PBA – Plan- and building act
PPA – Public Procurement ACT
SCM – Supply Chain Management
SDG – Sustainability development goals
SEC – Swedish Environmental Code
SRS – Stockholm Royal Seaport
SUTA – Stockholm Urban Transport Administration
ÄU – Älvstranden Utveckling

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1 Introduction

Urbanisation is causing increased construction in dense city areas with a lack of space around and at the construction site. Construction in dense areas imply that construction logistics is of high importance as it affects many actors. Chapter 1.1 describes the complexity of construction logistics in urban areas with arguments for the importance of the study and why the subject is necessary to research. Secondly, chapter 1.2 presents the aim of the study followed by chapter 1.3 with the research questions. Thereafter, delimitations are explained and finally, the structure of the thesis is presented to help the reader understand the structure of the report.

1.1 The complexity of construction logistics in urban areas

Urban areas attract and habitat more people than ever before, according to Lagerberg (2021) half of the world's population are living in a city and another 10 per cent will have moved to a city by 2030. Urbanisation requires cities to evolve which commonly entails producing new or renovating existing houses, offices, hospitals, and schools. The production occurs on the construction site and implies logistics challenges due to extensive deliveries of materials and equipment. Space limitations, accessibility, noise as well as environmental aspects such as pollution are causing problems and restraints on the urban transport flow in dense urban areas (Janné, 2018; Janné & Fredriksson, 2019).

The construction industry is one of Sweden's largest industries and accounts for around 11 per cent of Sweden's gross domestic product (Elmsäter-Svärd, 2020). A large amount of the CO_2 emissions in Sweden is generated from the construction industry, and 20 per cent of the total amount of heavy traffic in Sweden was distinguished to be going to and from construction sites (Sveriges Byggindustrier, 2010; Dubois, et al., 2019). Effective construction logistics can reduce transports by 60-80 per cent and well-planned deliveries result in less CO_2 emissions, shorter construction processes and fewer transports to and from construction sites (Abrahamsson, et al., 2019).

The construction industry is complex with many involved actors in temporary project-based organisations. Many small firms such as subcontractors and suppliers, along with contractors and clients need to be coordinated as to fulfil the project goals (Dubois & Gadde, 2002). Besides internal project actors, many external stakeholders, such as citizens, stores, pedestrians, etc. are affected by construction projects. All project actors have an impact on potential risks, opportunities, and solutions connected to the construction area. When discussing construction logistics, the external stakeholders' affections are important to consider (Szentes, 2019). The four most adverse impact categories from construction projects that affect the external stakeholders in the neighbouring area are the surrounding environment, pollution, traffic, and human society (Celik & Budayan, 2016). In governance decision-making, it is important to consider all stakeholders' interests in the early stages of projects. The goal of the construction logistics solution needs to be identified by the initiator on a strategic level and communicated to all stakeholders (Janné & Fredriksson, 2019). Furthermore, planning and coordination of logistics connected to construction projects and traffic also need alignment to improve infrastructural problems in cities (CIVIC, 2018). One of the biggest effects on urban goods transports is believed to be achieved by controlling means implemented by municipalities (Trafikanalys, 2016b). It could be assumed that

municipalities have a key role regarding the goods flow in urban areas stemming from construction traffic, especially in the cases where the municipalities are the developers.

The municipalities in Sweden have been self-governing since the 19th century and in 1974 municipalities self-governance was incorporated into one of the four fundamental laws in the Swedish constitution (Kullander & Langlet, 2020a; Sveriges riksdag, 2018). The Swedish municipalities are obligated to address urban planning and construction issues, housing as well as environmental and health protection (Sveriges Kommuner och Regioner, 2020). The Planning and Building Act (PBA) in Sweden stipulates that municipalities are responsible for the planning of land and water usage. The PBA aims to foster societal development towards adequate living conditions and a sustainable and long-term living environment for humans (Sveriges Riksdag, 2010).

Construction logistics consist of activities such as planning, organisation, coordination and control of material and resources to and from as well as on a construction site (Clausen, 1995). A wide range of different solutions can be implemented to improve logistics. For example, the usage of consolidation centres and checkpoints, Information and Communication Technology (ICT) tools and planning systems, or to a smaller extent, adapted work practices (Janné, 2018). The purposes and effects of the different solutions vary. To successfully implement efficient and effective logistics, planning is of the essence. The need for an initial plan and strategy for construction logistics in the early phases of a project is vital (Sullivan, et al., 2010). Actors working with production on-site and logistics personnel need to cooperate to assure that the logistics are adequate on-site (Sundquist, et al., 2018). The use of logistics solutions has become more apparent, several studies have shown that construction logistics is useful in the construction industry to increase efficiency (Vrijhoef & Koskela, 2000; Briscoe & Dainty, 2005; Gosling & Naim, 2009). The CIVIC handbook (2018) has proven that projects can become up to 30 per cent more productive due to successful construction logistics. However, construction logistics is a new novelty and is not frequently used for construction projects in urban areas (Janné & Fredriksson, 2019).

The thesis is conducted at the consulting company AFRY and their department within Supply Chain Management. AFRY offers logistic solutions to customers and is interested in investigating the municipalities' knowledge and motivation for pursuing implementations of construction logistics. It is also valuable to analyse how municipalities view their role and responsibility to achieve sustainable and successful construction logistics. The perspective of municipalities is interesting in terms of what they can affect and achieve, with their responsibilities, incentives, and driving forces in implementing construction logistics solutions. There have been several studies about construction logistics, both in Sweden and internationally, but few studies focus on the municipality's role.

1.2 Aim of the study

The thesis aims to investigate the municipality's role, incentives, and responsibilities in achieving sustainable construction logistics. The study covers three selected municipalities and one municipality committee in Sweden to scrutinize opportunities and hinders for the use of logistics solutions. The study thus contributes to an understanding of the contemporary challenges of construction in dense city areas.

1.3 Research questions

To fulfil the aim, four research questions have been identified:

1. How do municipalities currently work with existing construction logistics solutions?

2. What are the driving forces for municipalities when implementing construction logistics solutions?

3. What are the challenges for municipalities when planning to or implementing construction logistics solutions?

Based on the first three research questions that investigate current implementations of construction logistics, a fourth research question is identified to address how municipalities can affect the leap forward for further implementations of construction logistics solutions.

4. How can the municipality contribute to the implementation of construction logistics solutions among the actors involved in construction processes?

1.4 Delimitations

The study's main point of departure has been construction logistics and its effects on environmental sustainability in urban areas. Furthermore, the study is delimited to mainly consider and investigate the municipal aspect of an implementation of construction logistics. Out of the total number of municipalities in Sweden, the study was limited to study three municipalities and one committee formed of eight municipalities. The municipalities were selected due to a rather large number of citizens and to retrieve knowledge and insights from two municipalities that already have implemented successful construction logistics solutions and municipalities that are contemplating an implementation.

1.5 The structure of the thesis

Figure 1 below shows an overview of the various parts of the thesis and how those are connected as to analyse and reach a conclusion based on the results with regard to the four research questions. The first research question was answered solemnly through the empirical inquiry, while the second and third research question was analysed from both the theory framework and the empirical inquiry. The fourth and final research question was then answered simultaneously from the findings of the initial three research questions together with findings from the benchmarking project in the empirical inquiry. The result of the research questions did then collectively form the basis of the study and through discussion a conclusion was established.

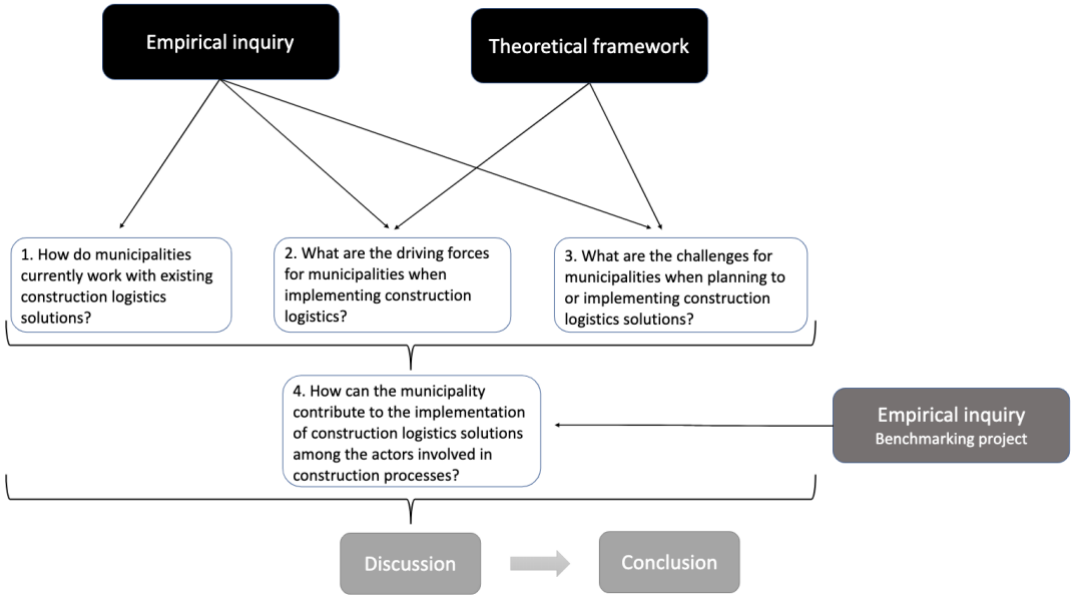

Figure 1 An illustration of the structure of the thesis.

2 Theoretical framework

The theoretical framework is the theory for the studied subject and sets a base for the discussion. The theoretical framework begins with 2.1 and studies the project-based nature of the construction industry and its characteristics. Secondly, chapter 2.2 Governance in municipalities is an investigation of municipalities perspective on organisations. To be further continued by 2.3 The building process with a municipality perspective and relations to the construction industry. In chapter 2.4, a deeper review is made of supply chain management in construction. Followed by 2.5 about organising construction logistics and 2.6 to get a better understanding of logistics solutions. Lastly, the theoretical framework states environmental aspects and environmental goals to relate environmental issues to the construction industry and is stated in chapter 2.7 Construction logistics contribution to sustainability.

2.1 The project-based nature of the construction industry

A construction process contains a combination of many activities, that takes place at the same time, involving many different actors and all these activities lead to the final outcome, i.e. a building (Janné, 2018). The synergy between the activities is limited and rarely repeated which limits improvements and quality (Vrijhoef & Koskela, 2000). The crucial activities in the implementation of new solutions in a project-based industry are planning, change and adaptation.

2.1.1 Characteristics in the construction industry

The characteristics of the construction industry and its organisations are that the projects are complex, involves many stakeholders and temporary organisations with new condition, for each new project (Dubois & Gadde, 2002; Ekeskär & Rudberg, 2016). The industry is project-based and Vrijhoef and Koskela (2000) state that new supply chains are created with each new project. The construction industry excels from other industries and has its own characteristics, Vrijhoef and Koskela (2000) state several aspects that relate to the industry and its uniqueness. Firstly, one of the characteristics that is strongly connected with logistics practices is that the production occurs on the construction site. For each new site, the location is temporary and located where the product will be. Secondly, Vrijhoef and Koskela (2000) state that on-site production entails temporary supply chains and reconfigurations for each new project. Solutions that have worked on previous similar projects do not necessarily work in new projects, Vrijhoef and Koskela (2000) state that similar projects can have similar processes but the circumstances, contextual factors and achievements that can be accomplished differ. Furthermore, the industry is known to be fragmented, and resistant to change due to cultural aspects in the industry. The cultural aspects in construction consider the organisation culture about trust, values, respect, and relationships. The industry is resistant to change because it is often associated with unrealistic expectations and requirements (Lines, et al., 2015). Lastly, the design phase and the production are separated, and the solutions are based on a make-to-order supply chain (Vrijhoef & Koskela, 2000; Fadiya, et al., 2015).

In Sweden, each construction project involves many deliveries and transports with heavy vehicles. Out of the 79 000 heavy vehicles on the roads in Sweden every day, one third is going to or from a construction site (Dubois, et al., 2019). Statistics have

shown that more than 40 per cent of all deliveries connected to construction suffer in quality in terms of delivery time, amount, location, and/or has been damaged (Thunberg & Persson, 2014). Better planned transports and effective logistics can reduce the total costs by up to 20 per cent (Sundquist, et al., 2018; Dubois, et al., 2019). The logistic activities in a construction project are highly important and are divided into off-site and on-site logistics. The off-site logistics concern and relates to stipulations, procurements as well as transports and deliveries to and from the construction site. While the logistics performed on-site is planning of the flow and material handling process on-site (Sundquist, et al., 2018). The two are, however, strongly integrated and the material delivery on-site is what connects the two (Sundquist, et al., 2018; Dubois, et al., 2019). The integration between on-site and off-site logistics is of great relevance to attire a high level of productivity and effectiveness in a construction project (Sundquist, et al., 2018).

Each project has many suppliers and subcontractors in their supply chain, about 60-80 per cent of all gross work is connected to purchasing of materials and the services suppliers and subcontractors perform (Ekeskär & Rudberg, 2016). The performance and efficiency are strongly connected to suppliers and subcontractors, and the synergy between them. In a single project, many different actors are involved during the construction process and new actors continuously interact during the process, the network becomes complex and hard to manage (Ekeskär & Rudberg, 2016). Vrijhoef and Koskela (2000) state that the complex network is the reason why the construction industry is known to suffer from low productivity and rising costs in production. The characteristics of the industry are aspects that need to be considered in how a change process can be implemented and how logistics activities can enhance construction production.

Implementation of new solutions in the construction industry requires a change in working methodologies. As previously mentioned, the construction industry is resistant to change and to implement new methodologies and renew organisations direction, change and adaptation are necessary (Moran & Brightman, 2001). Change management is important to implement new practices and approaches to disengage the traditional work methodologies, that sometimes have been used for decades in the construction industry (Lines, et al., 2015).

Moran and Brightman (2001) explain change management as a process of continuous improvements of an organisations structure to meet new demands. Further, Lines et al. (2015) explain change management on different levels, in construction change is explained as a long-term process with strategic thinking. Change processes are not easy and as the construction industry is resistant to change it is also necessary with good structure management. Cameron and Green (2020) describe different perspectives of change and focus on the importance of a change agent. A change agent is a person who can lead change, it means operating and supporting an organisational change. A change agent can both be a consultant, as an external actor, or an in-house employee, an internal actor. The advantage of an internal change agent is that the employee already knows and understands the root causes of the change. The change agent already has an established relationship with the organisation’s employees and knows the company jargon, which is essential in a construction company. However, when the change is complex, external help, without conflict of interest might be necessary (Cameron & Green, 2020). Further, Battilana and Casciaro, (2013) emphasize that the informal

network position of the internal change agents is essential for successful change implementation. In any organisation, there are both formal and informal structures. The formal ones define the hierarchy position within the organisation while the informal ones define the communication, trust, and influence the employee has inside the organisation. Studies show that an employee with a central role in the informal network is a much more successful change agent than a high-ranking boss (Battliana & Casciaro, 2013).

2.1.2 Relationships between stakeholders in the construction industry

The informal and formal structure inside an organisation is affected by the relationships among the actors. Gadde and Dubois (2010) state that relationships between stakeholders in the construction industry have a varied level of involvement. High involvement relationships are described to last for a long time if both ends of the relationship make adaptations to enhance the shared performance. Adaptation leads to opportunities as well as interdependencies among the stakeholders. Both interdependency and adaptation are developed through continuous interaction between the stakeholders. The interactions are, however affected by previous experiences between the stakeholders which in turn affect for example loyalty and the prospect of potential future involvement among the stakeholders. Interaction is also argued to help with the relationship atmosphere when an agreement is reached in conflicting issues leading to a mutual orientation (Gadde & Dubois, 2010).

Gadde and Dubois (2010) state that relationships between stakeholders in the construction industry usually have been established for a long time, but they are irregular and of low involvement. The main reasons for the low involvement are that relationships in the construction industry avoid dependencies, have limited interactions, and lack a common orientation between stakeholders. Dependency is avoided to enable stakeholders to use different suppliers with different solutions and to make use of the competition among suppliers, especially in terms of price (Gadde & Dubois, 2010). Janné and Fredriksson (2019) emphasize the importance of identifying the different concerns of all stakeholders, which sometimes are conflicting, including common established goals and concerns are to be reached.

Interaction and communication are argued to be limited and poor since construction projects are unique and have different prerequisites (Gadde & Dubois, 2010; Gamil & Rahman, 2017). Janné and Fredriksson (2019) acknowledge good communication as well as clearly stated roles and responsibilities are important to achieve the project's greatest potential. A construction project is by Dubois and Gadde (2002) discussed to be loosely coupled while the network system within construction is tightly coupled. A tightly coupled system can efficiently deal with complexity and uncertainties due to decentralized authority, interaction, and interdependency. This is beneficial for projects since they have the possibility to explore new ideas and initiatives without much adaptation to others. However, since the network system is loosely coupled the information and knowledge from a specific project do not spread and hampers the possibilities for innovative ideas to evolve norm and culture in the construction industry (Dubois & Gadde, 2002).

A common orientation is on the other hand hindered since different stakeholders have different drivers, for example, private stakeholders can have a strong focus on monetary

aspects and public stakeholders might be driven by attaining a public value (Janné & Fredriksson, 2019). Gadde and Dubois (2010) argue that what is hindering the common orientation is the fact that tenders are competitive and the relationship between contractors and subcontractors is usually cost-driven. Addressing the different concerns of all stakeholders is preferably done early on through on a local project level with both high and low involvement relationships (Janné & Fredriksson, 2019; Gadde & Dubois, 2010).

2.2 Governance in municipalities

High involvement relationships and interaction among stakeholders enhanced in more tightly coupled relationships can affect and improve governance. Janné and Fredriksson (2019) describe governance as coordinating and aligning concerns and establishing a common understanding through incentives, decisions, control, and interactions between the involved stakeholders. In the handbook, CIVIC (2018), governance is defined as: *"The art of overcoming barriers through organising collective action"* (CIVIC, 2018, p. 13).

Governance can be divided into three levels, strategical, tactical, and organisational. The strategic level is focused on a long-term perspective where goals and concerns are identified. Concerning construction logistics, the aim for implementation should on the long-term level be determined by the initial stakeholder, stakeholders such as a municipality, developer, or main contractor. The tactical level is instead focused on how and with what means the established goals and concerns are reached. While the organisational level is focused on the short-term perspective and the daily activities and operations needed to attain and move toward the sought outcome on a daily basis. (Janné & Fredriksson, 2019)

2.2.1 The Swedish system of governance

The Swedish governance is founded as a democracy where power is exercised on four levels; the European level, the national level, the regional level and the local level (Sveriges Kommuner och Regioner, 2019). The power in Sweden is exercised to be as near the citizens as possible which is enabled by self-governing regional councils and municipalities. There are 21 regional councils in Sweden, and the councils' primary focus is on healthcare and regional development (Sveriges Kommuner och Regioner, 2019). On the local level, there are in total 290 municipalities (Sveriges Kommuner och Regioner, u.d.). The municipalities main responsibilities are community services such as education, childcare, elderly care, and social services (Sveriges Kommuner och Regioner, 2019). The municipalities and regions, therefore, have a focus on the tactical and operational level while the national level is more strategic oriented.

The national level constituting of the Swedish government and parliament that through preposition and authorization of laws regulate the actions of the self-governing municipalities and the regional councils. Laws, including the laws of the constitution, are in Sweden stipulated by the government, the parliament can constitute ordinance, which is legally binding but subordinate to laws and cannot conflict with established laws. Authorities can either stipulate legally binding regulations or propose recommendations within their area of expertise, which however are not legally binding (Boverket, 2020).

In Sweden contracting authorities which are municipalities, state authorities, and regional councils, need to follow the Public Procurement Act (PPA) when procuring (Swedish Competition Authority, 2011). PPA includes the procurement of supplies, services, and award of contracts to construction contractors (Sveriges riksdag, 2016). The municipalities are self-governing and have the right to regulate the taxes and use tax means to finance their business (Sveriges Kommuner och Regioner, 2021). However, additional financial funding can be applied for environmental innovative initiative and can for example apply for funding from the Swedish Energy Agency (Energimyndigheten, 2021).

2.2.2 The structure of municipalities

The Swedish municipalities are governed by a Municipal Assembly. Figure 2 is an example of how a municipality, in general, is organised.

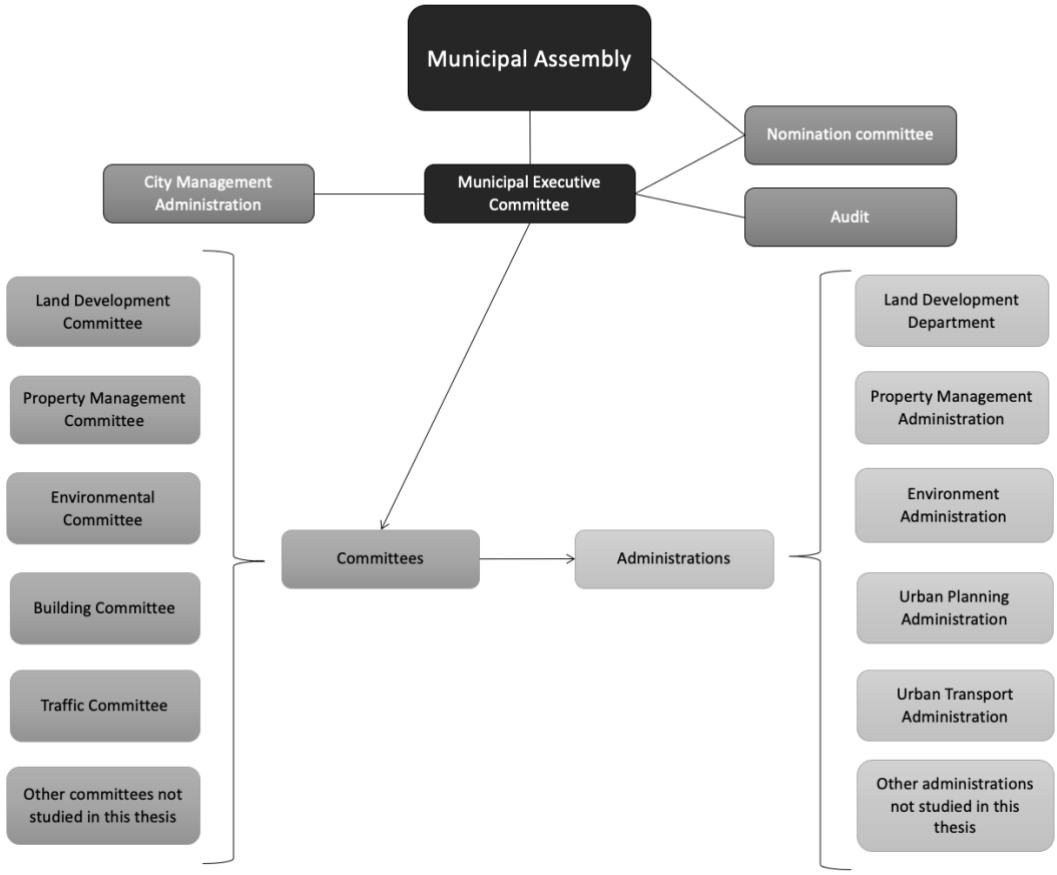

Figure 2 An illustration of an organisation of a municipality.

It is up to each Municipality Assembly to organise the municipality with its committees and administrations and therefore the organisations look different depending on the municipality. In addition to the Municipal Assembly, the organisation consists of a Municipal Executive Committee and consists of several committees that manage and handle different political missions. The committees consist of elected politicians that are to represent the citizens and the politicians assign work to administrations. The officers in respective administration have both knowledge and experience to work with

the assignments. The officers practically realize and implement the business and proposals established by the politicians and report back to the politicians since they have the greater responsibility. (Kullander & Langlet, 2020b; Göteborgs stad, n.d.; Stockholms stad, 2020a). In Figure 2 the most common committees and administrations connected to the building process are presented, and accordingly, they can also relate to construction logistics.

2.2.3 Municipalities responsibilities in urban planning

Municipalities are obligated to address urban planning and construction issues, as well as environmental and health protection (Sveriges Kommuner och Regioner, 2020). In Sweden, the Planning and Building Act (PBA) stipulates that municipalities are responsible for the planning of land and water usage. PBA aims to foster societal development towards adequate living conditions and a sustainable and long-term living environment for humans (Sveriges Riksdag, 2010). The current PBA was introduced in 2011 to simplify the building process and to restrict the building control process. The PBA is generated and developed as a result of previous laws regarding construction (Boverket, 2020d; Regeringen, 2009).

One of the first Swedish legislation concerning building plans and consequently, the beginning of the municipal plan monopoly was established in 1907. The legislation stipulated that municipalities were obligated to redeem land that was to be used as a street and public space. Later in 1960 the municipal plan monopoly had evolved and was more or less established with a new enforced building statute. The building statute stipulated that each municipality had to form a building committee to reduce the influence of local building regulation. With this new statute, the responsibility for building plans shifted from private landowners and developers to the municipality (Boverket, 2020d). With their established plan monopoly and responsibility in urban planning the municipalities have an influence on the building process.

2.3 The building process with a municipality perspective

The building process and the municipalities role in the process are different from municipality to municipality, though, in general, the process has its similarities (Göteborgs Stad, n.d.; Stadsbyggnadskontoret Stockholms stad, 2020; Isacsson, 2020). Urban development includes several steps and approvements from the municipality and it is important to consider everyone’s interest and regulate it to the requirements in PBA. The building process has an important role in the implementation of construction logistics and at what stage the solution needs to be presented. Below, in Figure 3 the important plans and agreements the municipality is involved in concerning the building process are presented.

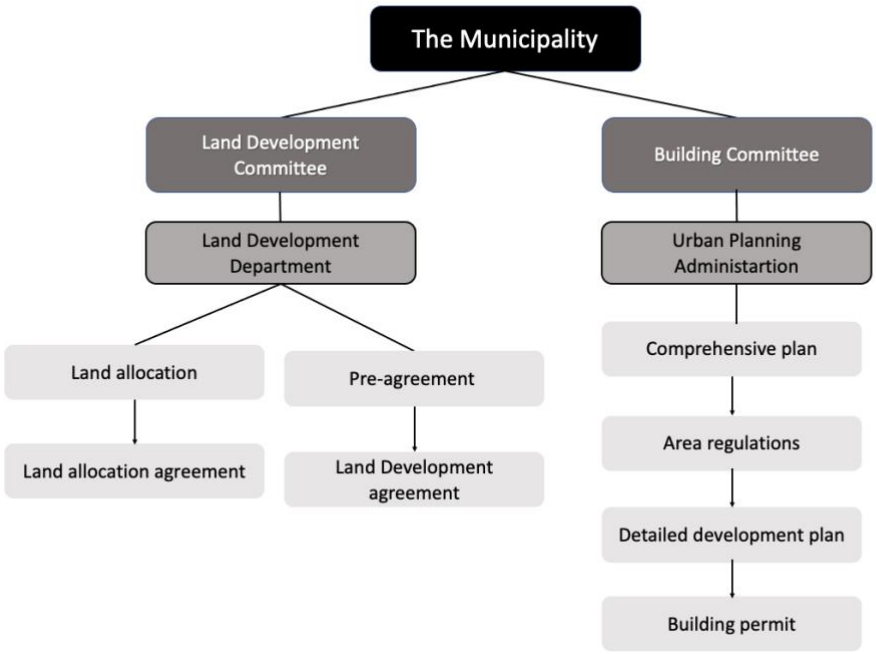

Figure 3 An illustration of which municipal committee and administration is responsible for providing certain documents in the construction process.

2.3.1 Comprehensive plan

A comprehensive plan is a plan for a larger area and states the long-term goals and strategies for an urban area. It is the municipality's responsibility to review the risks and potential damages in case of a new construction or renovation of an area. The comprehensive plan states the risks with a focus on environmental issues. In some cases, construction logistics can be a part of a solution to achieve the goals and strategy in the comprehensive plan. The government along with the County Administrative Board shall assist with financial means to include climate adaptation in the comprehensive plan. (Sveriges Kommuner och Regioner, 2020)

The municipality is responsible for reviewing all ideas and evaluate comprehensiveness with the strategy and goals in the comprehensive plan. The politicians can accept or reject the pilot study and decide if it should be further developed or accepted without any changes. (Stadsbyggnadskontoret Stockholms stad, 2020; Göteborgs Stad, n.d.)

2.3.2 Municipality owned land regulated in land allocation

In Sweden, much of the land is owned by municipalities and the municipality has a key role in deciding how the land will be used and allocated. The municipality can sell or lease the land they own to a developer. The municipality and developer have an interdependent collaboration and decides the development rights and creation of plans and permissions for the land, in Sweden called detailed development plan. (Caesar, 2016)

It is up to every municipality to decide upon the guidelines and facilitate the land allocation process. The municipality can put requirements about the construction phase in a land allocation agreement (Boverket, 2020b). If a municipality wants to put requirements that are out of the legislation, Bröchner (2021) states that it is possible to do it in a land allocation agreement and then it becomes a civil law agreement. Civil

law is jurisdiction concerning the relationship between two private actors and is the opposite of public law (Nationalencyklopedin, n.d.). Public law concerns the relationships between authorities and between society and the individual, it is where municipalities organisation, work approach and relationships with individuals are considered (Nationalencyklopedin, n.d.).

Depending on when the land allocation occurs in the plan process different agreements can be constituted. If the developer is appointed at an early phase the land allocation agreement is decided before the plan process begins and later before the detailed development plan is accepted (Boverket, n.d.). In 2015 a new regulation came into force; the Act on Guidelines for Municipal Land Allocations that regulates the municipalities rights in land allocation in terms of procedures, prerequisites, and pricing (Sveriges riksdag, 2014). Not all municipalities have adopted this regulation and it is only the municipalities that have adopted it that need to follow the regulations (Boverket, 2020b). To paragraph the law 2014:899, (Sveriges riksdag, 2014):

1§

"Land allocation refers to an agreement between a municipality and a client that gives the client the exclusive right to negotiate with the municipality for a limited period of time and under given conditions on the transfer or lease of a certain land owned by the municipality for development."

2§

"The guidelines shall contain the municipality's points of departure and goals for transfers or leases of land areas for development, management routines and basic conditions for land allocations as well as principles for land pricing."

Figure 4 below shows the process of land allocation and how it relates to the detailed development plan.

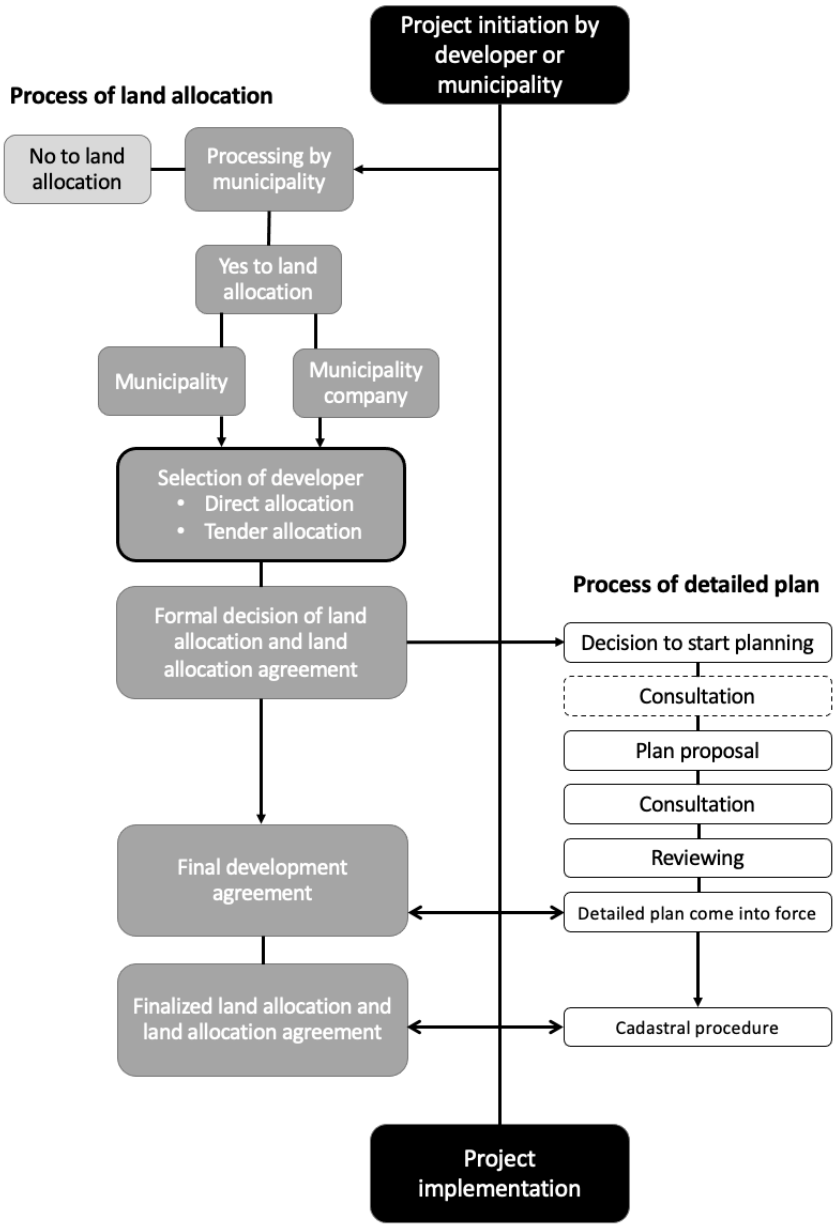

Figure 4 The process of land allocation and development of the detailed plan, illustration based on Caesar (2016).

2.3.3 Detailed development plan

The detailed development plan is more specific than the comprehensive plan and describes in detail what is going to be built. It includes descriptions of how the land will be used, how it comprehends the environment and how it will affect the already built environment. It must follow the regulations in PBA along with the general and private stakeholders' interests. PBA states what responsibility the municipality has and the regulation they can do (Boverket, 2020c). Some important aspects to include are noise disturbances, surrounding traffic, risks, and environmental affections. There are many aspects and decisions to take into consideration and the detailed development plan is continuously decided together with the politicians at the Urban Planning Committee (Stadsbyggnadskontoret Stockholms stad, 2020). A detailed development plan according to Bröchner (2021) a detailed development plan does not regulate the

construction process and only constitutes the building and its impact when the construction is finalized.

The detailed development plan is decided when all stakeholders have had the opportunity to review it and state their opinions. When this is done, the plan is once again presented for the politicians and the Building Committee decides if the detailed development plan is accepted, and if so, the contractor can apply for a building permit. (Stadsbyggnadskontoret Stockholms stad, 2020)

To build on land included in a detailed development plan a building permit is needed, with a few exceptions connected to the planned building's gross building area (GBA) and usage. The building permit is to be approved by the Building Committee and the building process is not allowed to begin before permission to start has been granted from the Building Committee. If the Building Committee rejects the building permit the contractor can get it reconsidered by the politicians, if it is once again rejected, the contractor can appeal the decision and then it is up to the County Administration Board to take a final decision (Stadsbyggnadskontoret Stockholms stad, 2020).

2.3.4 Privately owned land regulated in land development agreement

A land development agreement is signed between a developer and municipality, or a property owner, if the agreement does not regard municipal land. The land development agreement considers how the implementation of the detailed development plan will be performed and clearly states under what circumstances and requirements the municipality enters the agreement (Berggren & Ingelstam, 2018). Prior to a land development agreement, a pre-agreement can be signed to establish the points of departure the land development agreement can be developed from (Stockholm stad, 2018). It consists of principles regarding how the responsibility and cost are allocated, which later on is regulated in the land development agreement (Stadsbyggnadsförvaltningen, 2018). The detailed development plan and the land development agreement are connected since the detailed development plan legally regulates what is stipulated in the land development agreement. Therefore, it is beneficial if the land development agreement is considered and developed in parallel with the detailed development plan process, but this is no requirement (Agerberg, et al., 2019). The detailed development plan process is connected to both land allocation and land development agreement and is visualised in Figure 5.

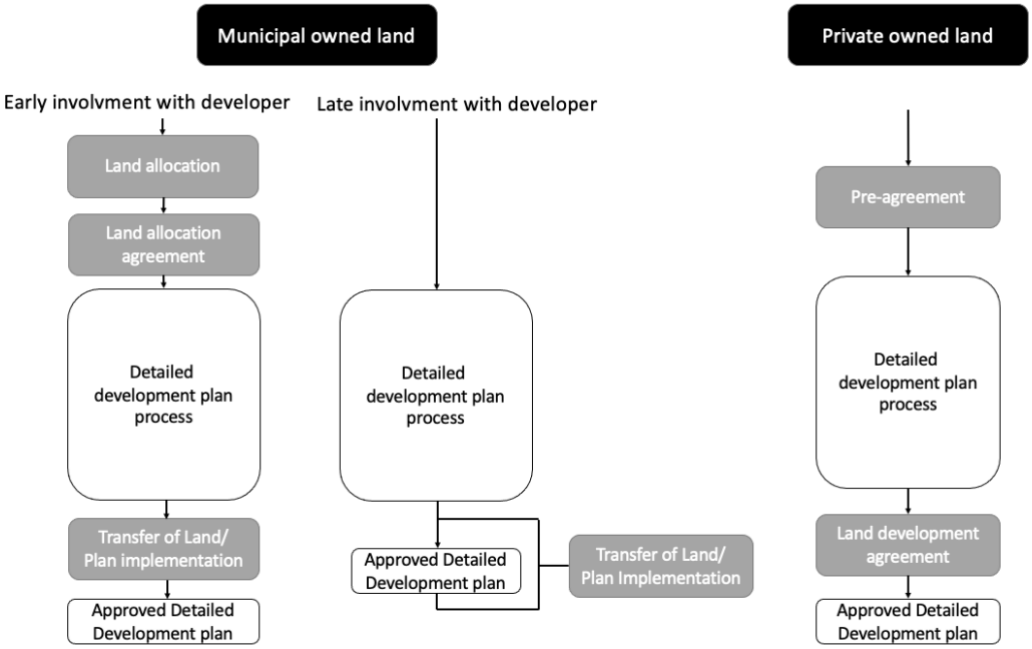

Figure 5 An overview of the land allocation process and the land development agreement process, illustration based on Kalbro & Lindgren (2018) and Caesar, et al. (2013).

2.4 Supply chain management in construction

The municipality have an important mandate when it comes to plans and agreements in the building process and is one of many important stakeholders in the network of stakeholders regarding construction. Supply chain management (SCM) is the integration and coordination of different networks and how the different functions in an organisation interrelate (Behera, et al., 2015; London & Kenley, 2001). The Global Supply Chain Forum (GSCF) define SCM as: *"Supply Chain Management is the integration of key business processes from end-user through original suppliers that provides products, services, and information that add value for customers and other stakeholders."* (Lambert & Cooper, 2000, p. 66)

SCM is a network of many stakeholders with a business-to-business approach, where the network consists of service, information, and product flows (Lambert & Cooper, 2000). SCM gives a comprehensive overview of all parts of a production line and ephasizes trust and transparency in the coordination and configuration between stakeholders (Cooper & Ellram, 1993). When businesses has high-involvement and are relationship-based, Lambert and Cooper (2000) state that it leads to strong relationships that have competitive advantages compared to single business management. SCM has existed before the term *Supply Chain Management* was a known phrase, it became a known concept when Toyota applied it in their manufacturing and production systems (Behera, et al., 2015; Vrijhoef & Koskela, 2000; Shingo, 1988). Just-in-time (JIT) deliveries was at the same time introduced which meant that every supplier would deliver in small amounts right when the material was needed to decrease the inventory. SCM and JIT enable long-term relationships and increase the quality because of regular contact with the suppliers. Deming (1982) described the benefits of JIT deliveries in an SCM network as increased quality and decreased costs in production (Vrijhoef & Koskela, 2000). SCM is well known in manufacturing, in process-based organisations and much research has been done in the field. Vrijhoef and Koskela (2000) have

identified four roles in construction that relate to SCM and the significant "flow view". Figure 6 visualizes the four roles.

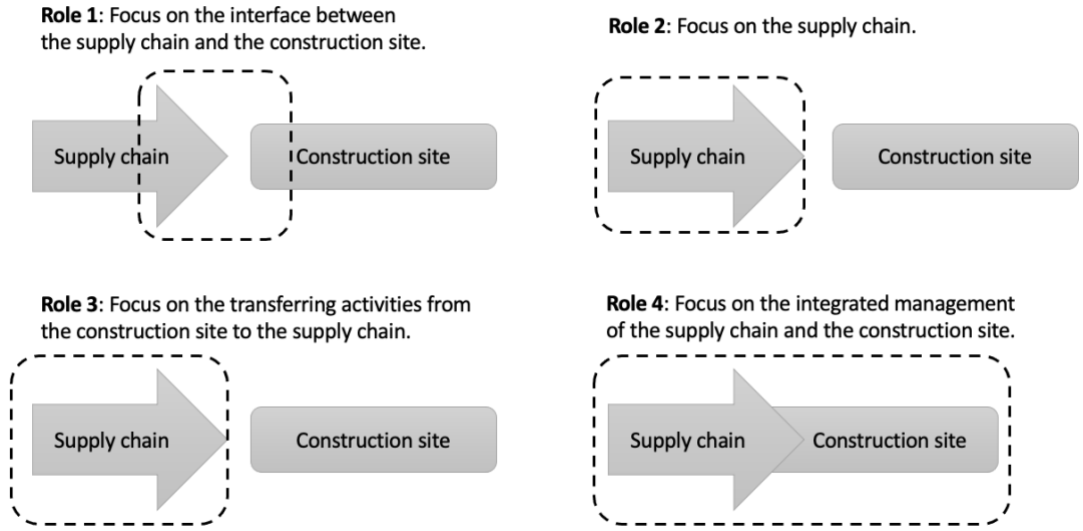

Figure 6 The four roles of CSCM, illustration based on Vrijhoef and Koskela (2000).

Logistics management is a part of SCM that consists of the flows of goods, services, and information and making the processes effective and efficient. (Lambert & Cooper, 2000; Vrijhoef & Koskela, 2000). In connection to construction logistics the first role (see Figure 6) focuses on the interface between the construction site and the supply chain and how the supply chain affects the on-site logistics. A focus is on reducing both the time and cost of activities on site. The main contractor is influential when applying this focus and making sure that the workflow on site is not hindered. The second role focuses solemnly on the supply chain to reduce the cost that is, for example, related to logistics as well as lead-time and inventory. Suppliers of material and components may see the relevance of adapting this focus. The third role focuses on transferring activities to the earlier stages in the supply chain from the construction site. The main purpose is to reduce the costs and time of activities on site. This focus is mainly useful to adapt by suppliers and contractors. The fourth, and last, role is an overall focus on both the supply chain and the construction site. It involves improvements and integrating management within the supply chain and production on site. Identified as the initiators of the fourth overarching focus are suppliers, contractors, and clients. An important note is that even if a division and separation between the four roles have been made, they often overlap and are combined. (Vrijhoef & Koskela, 2000)

The supply chain in construction is often temporary, and project based. Behera et al (2015) describe construction supply chain management (CSCM) as a specific supply chain and for a specific product. The processes in construction can be seen as a traditional way of managing the supply chain and about a transformation in production. The processes in CSCM are centralized to each stage rather than an overview of the whole project (Vrijhoef & Koskela, 2000). CSCM consist of several leaps and can be organised with different construction logistics activities.

2.5 Organising construction logistics

Construction logistics can be analysed in several ways and with help of different logistics activities to organise the CSCM. The term of logistics activities and objectives in construction is stated by Benton and McHenry (2010, p. 28) *"The purpose of the supply sourcing function for construction organization is to buy materials and services of the right quality, in the right quantity, and at the right price from the right source at the right time."*

Construction logistics is a part of logistics related to the construction industry, Agapiou, et al. (1998, p.132) describes construction logistics as follows: *"For the construction industry, logistics compromise planning, organization, coordination, and control of the materials flow from the extraction of raw materials to the incorporation into the finished building."*

The transports and logistics activities related to construction can be divided into three configurations: Figure 7 shows the de-centralised coordinated configuration, Figure 8 the on-site coordinated configuration, and Figure 9 the supply network coordinated configuration (Dubois, et al., 2019). The most common coordination of configuration is the de-centralised, which is stated as the traditional one where every contractor handles its activities, both on-site and off-site, independently. The traditional, de-centralized configuration lacks coordination among contractors' supply chains and all logistics activities are performed separately. The on-site coordinated configuration is when all logistics activities on-site are coordinated among contractors and subcontractors. Though, the transports and logistics activities to the site are handled separately. Lastly, the supply network coordination has similar on-site logistics coordination as the on-site coordinated configuration but includes coordination of transports to the site and decreases the total amount of trucks in dense areas and at the site (Dubois, et al., 2019).

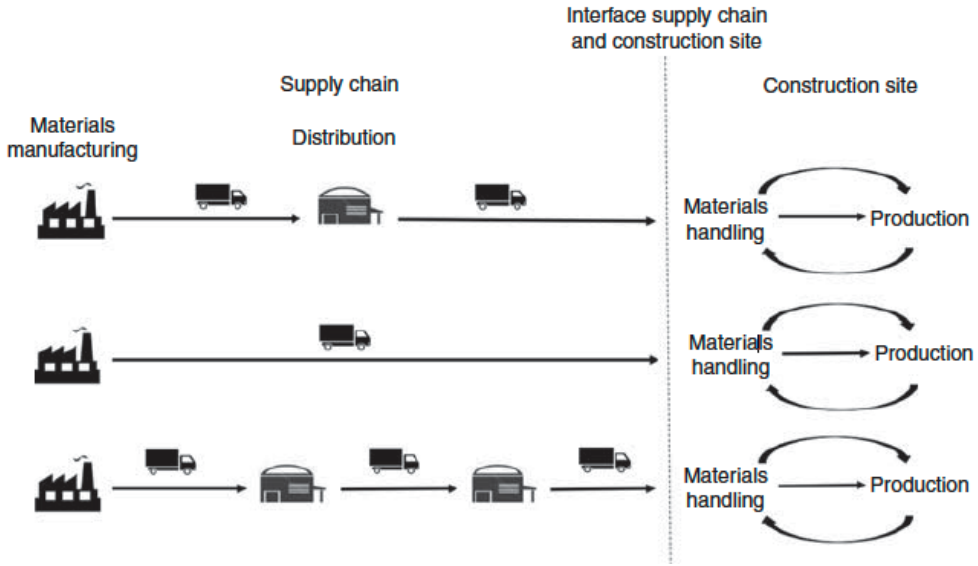

Figure 7 The de-centralised coordinated configuration (Dubois, et al., 2019)

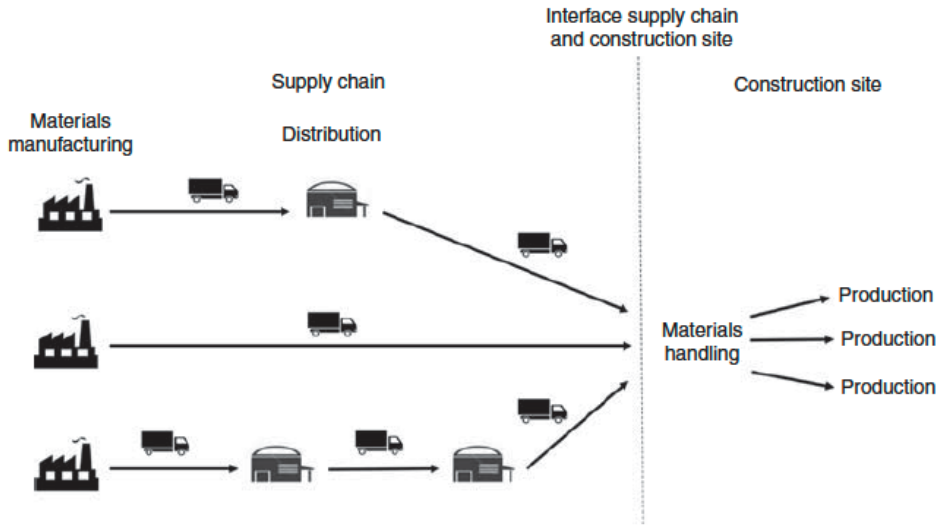

Figure 8 The on-site coordinated configuration (Dubois, et al., 2019)

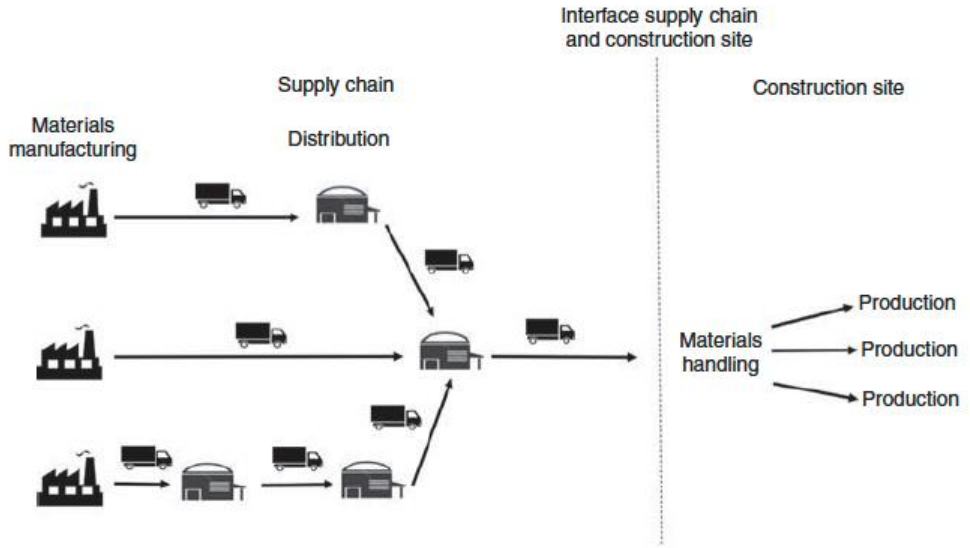

Figure 9 The supply network coordinated configuration (Dubois, et al., 2019)

Construction logistics is of importance when discussing transports in dense urban areas, since the production occurs on-site it contributes to logistic problems with increased traffic flows due to deliveries of material and resources. Other driving forces for an implementation of construction logistics are space limitations, accessibility, noise as well as environmental aspects such as pollution (Janné & Fredriksson, 2019; Janné, 2018). The amount of traffic can be reduced in several ways with the usage of construction logistics solutions, either due to the type of coordinated configuration is applied or by alternative transport modes. The supply network coordination configuration reduces the number of transports to the site due to joint coordination (Dubois, et al., 2019). To investigate which coordinated configuration that is best fitted to specific solutions a logistics analysis can be performed to analyse the alternatives.

2.5.1 Logistics analysis

An analysis of construction logistics is to research the opportunities of implementing different solutions in a construction project and analyse the outcomes the solutions entail. Logistics analysis can be performed in several ways to analyse the effects of

different logistics solutions in an early phase of projects. Analyses of the logistics can be general with an overview of the material and resource flows or detailed with complete responsibility of the logistics in the entire project (Sundquist, et al., 2018). Logistics analysis is performed both externally and internally and is connected to the on-site and off-site logistics. The logistics analysis is performed early in the process of construction projects to calculate the effects of different solutions (Lindholm & Browne, 2015). Further, when an analysis of potential solutions and the effects they entail are shown, a logistics plan is developed and specified for the project.

A logistics plan is produced to set a framework based on the logistics analysis and how the logistics will be managed. Much of the off-site logistics planning is about transport movements to and from the site and to optimise the routes with consideration of safety, emissions, reliability of deliveries, and to achieve a reduction in congestion (Lindholm & Browne, 2015). Lindholm and Browne (2015) state several advantages of a logistics plan from a sustainable perspective. Firstly, it enables the precision of deliveries and the possibility of planned deliveries. This enables the deliveries to become more time reliable and to decrease noise and intrusion when being scheduled properly. Secondly, the security and safety improve when the deliveries decrease, and the loading areas are carefully selected. Further, a reduction in costs is achieved when deliveries are co-loaded, because of fuel savings and time is saved as unnecessary deliveries are identified.

The logistics analysis can be seen as a pre-study if construction logistics is usable and can achieve the desired outcomes and goals for the project. The analysis can be performed internally by the company that wants to apply the logistics solution or externally by a Third-party logistics (TPL) provider.

2.5.2 Third-party logistics

The TPL provider can handle both on-site and off-site logistics and all flows connected to and at the construction site (Janne & Rudberg, 2020). A TPL can perform different logistics solutions such as logistics analysis to identify the best-fitted logistics solution. Janné and Rudberg (2020) state that by hiring a TPL all costs connected to the logistics flows become visible, that most often, without a TPL is difficult to identify. A TPL provider can be seen as a part of the supply chain and the TPL's role is to manage all stakeholders in the network. However, the role of the TPL can differ depending on the project. One important responsibility for the TPL is to have an overview of everyone involved and the relationship arrangements between stakeholders (Lambert & Cooper, 2000). The TPL often has a specialised logistics manager responsible for the logistics in the project, and the logistics manager schedules coordination meetings and achieve good collaboration to have a well-functioning logistics solution (Ekeskär, et al., 2019). Some activities a TPL can be responsible for are, transports and alternative transport modes, storage and inventory of goods and materials, information-related activities such as planning and tracking of the materials and goods among others (Ekeskär & Rudberg, 2016).

2.5.3 Alternative transport modes

Construction logistics activities involve many transports, which are one of the biggest challenges from a sustainability perspective. The construction industry stands for up to

20 per cent of all heavy goods vehicles within a city, which can be reduced with well-planned logistics (Abrahamsson, et al., 2019). The transport mode is selected in the procurement process and is a part of the planning of a project (Ahmadian, et al., 2014). The alternatives of transport modes are by rail, road, water, or air and the benefits can vary depending on location and several other aspects. The most common transport mode in Sweden is by road and stands for up to 90 per cent of all transports (European Comission, 2005; Fredriksson, et al., n.d.). According to Ahmadian, et al. (2014) 20 per cent of all the costs in a construction project are transport expenditures.

Some of the major city development districts in Sweden are located near water and Fredriksson et al (n.d.) discuss the transition of transport modes from road transport to transports by water. Water transports have a lower impact on the environment but the issue and challenges about costs are remaining and it is more expensive than road transports. The major barrier is that someone must be the initiator for the costlier solution and that environmental gains and related costs shall be allocated to specific actors. The pros and cons differ depending on the actor but for the municipality, water transports entail less traffic congestion in the city. On the other hand, the materials handling is noisy, and it increases administrative work in the land allocation process, environmental legislations are necessary to drive change and temporary permits may be necessary. The city or municipality needs to support on a government level to make the transition happen (Fredriksson, et al., n.d.). Other industries, such as manufacturing and transports of goods within a city, use different modes of transports and the construction industry can learn from their experiences.

2.5.4 City logistics and the connection to construction logistics

City logistics is a term for urban freight transports within a city, the last mile transports and can use different transport modes. City logistics have been used to increase the urban sustainable mobility within a city to decrease the total transports by coordinating transports of different goods (Gammelgaard, 2015; Guerlain, et al., 2019). An example of an implementation of city logistics is in the municipalities of Södertörn. They have jointly coordinated the distribution of goods (Södertörnskommunerna, 2021). The city logistics in Södertörn have achieved a safer environment because of fewer transports in the areas and fewer deliveries close to schools and childcare.

Construction logistics and city logistics have the need to decrease the amount of traffic in urban areas in common. However, city logistics as a developed field of solutions has existed for a longer time and consists of the constitution of private stakeholders and commercial enterprises (Janné, 2018). The supply chain of city logistics includes stakeholders such as haulages, retailers, and logistics companies and is governed by municipalities regulations (Gammelgaard, 2015). The outcome of successful city logistics is the decrease of CO_2 emissions by coordination of transports among the stakeholders. Implementation of city logistics and the coordination of stakeholders include the complexity of a change process and the management of urban logistics innovation (Gammelgaard, 2015). Regarding construction logistics, the solutions of city logistics can apply to the construction industry and the learnings of a change process among many stakeholders (Janné, 2018; Ekeskär, 2016). In construction, many stakeholders are involved and often the contractors collaborate for the first time, and framework agreements allow the main contractor to decide upon terms about services and goods. Local authorities work closely in a city logistics arrangement to meet the

legislations and restrictions on roads and request to do temporary changes (Guerlain, et al., 2019). A comparison is made by Guerlain et al (2019) between city logistics and construction sites and the learnings possible to take into the construction industry. In construction, the loading unit is often pallets while in urban freight transports it is boxes, which are of a smaller size than a pallet. The characteristics of the construction industry and the supply chains are different in comparison with urban freight transport and are therefore challenging to compare. However, both have in common the logistics patterns of transports and the possibility to decrease transports by coordination of goods, although, in different aspects (Guerlain, et al., 2019).

2.6 Construction logistics solutions

To organise construction logistics different stakeholders can initiate implementations of construction logistic solutions, where the stakeholders can be a municipality, developer, or main contractor (Janné, 2018). There are many different construction logistics solutions that can be implemented. The solutions can be used separately or in combination and organised and decided upon with help of logistics analysis, by a TPL provider and/or by learnings from other logistics contexts. The most common logistics solutions are a Construction Logistics Centre (CLC), checkpoints, Information Communication Technologies (ICT), and materials handling.

2.6.1 CLC - Construction Logistics Centre

A CLC is a warehouse located in close proximity to the construction site where materials and equipment can be temporarily stored before arriving at the construction site (Sullivan, et al., 2010). There are some exceptions of deliveries that can go directly to the site without passing the CLC, for example when the transports are fully loaded or deliveries with large goods (Janné, 2018; Lundesjö, 2011). A CLC is a solution to adapt in order to enable JIT deliveries and can be managed by a TPL. By using a CLC some of the material handling performed on-site will instead occur off-site (Sullivan, et al., 2010). The goods that are delivered to the CLC are quality controlled and registered before stored. When the contractor calls off the needed goods the personal at the CLC load the collected goods on a truck and delivers them to the site. Vehicles can be co-loaded with deliveries to multiple sites to increase the filling rate of the load, and delivering to multiple sites is sometimes referred to as going on *milk rounds* (Janné, 2018). The delivering transports returning to the CLC can be reloaded on site with waste, excess material, recyclable, and reusable items to further reduce the traffic to and from the site (Lundesjö, 2011). The usage of a CLC has been shown to reduce the number of vehicles to the construction site and therefore reducing traffic congestion, noise, emissions and facilitate more accessibility on-site (Guerlain, et al., 2019; Lundesjö, 2011; Janné, 2018). Further, studies have shown that the productivity level of labour on site increased by 6 per cent, waste has decreased by 7-15 per cent and that 70 per cent of the delivering traffic has been reduced when a CLC is used (Lundesjö, 2011).

2.6.2 Checkpoints

Checkpoints is another solution that focuses on establishing JIT deliveries and can be used as a construction solution on its own or together with a CLC. A difference between a CLC and a checkpoint is that CLCs focus more on consolidating the goods (Janné,

2018). A checkpoint can be run by a TPL provider and is located at a strategic position for deliveries at the construction site. Deliveries are obligated to go through the checkpoint and are organised by being assigned a specific time slot for when to deliver. This enables the checkpoint operator to be prepared for the incoming deliveries and reduce the effects on the surrounding environment and traffic. Deliveries can either be delivered directly to the installation area on site after being checked at the checkpoint or be delivered, checked, and unloaded at the checkpoint. Unloaded deliveries at the checkpoint will at a later stage be delivered to the installation area by the operator of the checkpoint (Ekeskär & Rudberg, 2016). The coordination and scheduling of activities in both a CLC and checkpoints can be organised with the help of ICTs.

2.6.3 ICT – Information Communication Technology

ICT tools is a collective name for digital solutions for information and communication and is a part of the operation management in construction. ICT tools can be used together or separately and enable information and knowledge sharing in the supply chain (Pero, et al., 2017). ICT can be used in varying situations, it can be used for productivity assessment for improvement in delivery, scheduling and planning, prevention in the aspect of safety, theft and accident or a tool to help measure waste reduction (Fadiya, et al., 2015). ICT tools are systems that facilitate collaboration and communication in the supply chain at different phases of the project; in procurement, design, production and governance processes. Tools such as file sharing, building information modelling (BIM), and project management tools are useful to increase transparency and trust between stakeholders (Pero, et al., 2017).

2.6.4 Materials handling

Materials handling involves activities connected to on-site logistics and consist of transporting material from where it has been unloaded to the place of installation (Dubois, et al., 2019). Material handling also occurs in a CLC or at a checkpoint where the quality is controlled before arriving to the construction site (Sullivan, et al., 2010). If material is purchased at short notice, there is a lack of time to plan the delivery which can cause problems both on-site but also at the CLC. The delivery might not make it on time and therefore delay the construction process or/and the number of material purchases might not comply with the quantity of material needed, resulting in an excess of material handled (Agapiou, et al., 1998). The latter will sometimes result in the material being exposed, moved on several occasions, and even damaged. The main logistic solution for this is to make sure that the material is delivered on a JIT basis by using, for example, a CLC (Sullivan, et al., 2010). In a study of four different construction sites, 30-40 per cent of the construction cost was material related (Guerlain, et al., 2019). Studies have also proven that with less material stored and handled on-site, the productivity of the on-site work has improved, tasks have been more completed, more efficient, and fewer accidents have occurred due to better accessibility (Lundesjö, 2011).

2.7 Construction logistics contribution to sustainability

Well planned construction logistics contributes to sustainability in the urban environment. It can be by the perspective of ecology to lower emissions, the social aspect of increasing well-being for citizens, or with the economic perspective of using

the tax means and invest in construction logistics solutions. The importance of focusing on reducing environmental impact is in early stages. The building phase of new buildings produces more CO_2 emissions than what will be produced during 50 years of using the building (Kvint, 2021). Improved construction logistics can reduce emission by at least 30 per cent (Fredriksson, 2021). There are many goals that need to be met and with help of construction logistics the construction industry can contribute to achieve these goals.

2.7.1 Sustainable Development Goals

In 2015 the United Nations' Sustainable Development Goals (SDG) were established by the General Assembly of the United Nations (UN) that consist of 17 SDGs illustrated in Figure 10 with 169 targets. With an aim toward achieving the 17 goals, developing as well as developed countries are striving for a more sustainable world (United Nations, u.d.). To achieve this the countries, Sweden included, will take action to reduce their greenhouse gas emissions and are obligated by agreements to communicate their actions towards establishing resilience towards global warming (United Nations Climate Change, n.d.).The Swedish municipalities have a responsibility in doing what they can to achieve the SDGs.

Figure 10 The 17 SGD formulated by the UN in 2015 (Unicef, u.d.).

2.7.2 The Swedish focus on reducing climate change

In 2010 a Swedish goal was set to reduce greenhouse gas emissions by 70 per cent, mainly produced by fossil fuels, until 2030 at the latest (Lundblad, 2020; Björsell, 2021). Only 20 per cent of the greenhouse gas emission had been reduced in 2020 and during 2018 an increase in emissions was identified. The progress rate is therefore in need to expedite to reach the goal by 2030. One-third of the greenhouse emissions in Sweden is from transports, where the heavy vehicle traffic and passenger cars have been identified as main producers of greenhouse gas emission (Lundblad, 2020; Sveriges Miljömål, u.d.).

By setting requirements on environmental classified and renewable fuels the municipalities can help in reducing the emissions. In 2009 the EU directive put requirements on renewable fuels, this led to demands on the effectiveness of transport fuels to reduce emissions. Based on the EU directive the local authorities, such as municipalities, can set local conditions for environmental criteria of fuels (Upphandlingsmyndigheten, 2016). Further, the transports can increase filling rates and according to the national strategy about goods the filling rates can increase the effectiveness (Regeringskansliet, 2018). Currently, the filling rate is low, only 50 per cent and sometimes 20-30 per cent of the space in the vehicles are filled, this can be increased with a coordinated distribution of goods (Regeringskansliet, 2018). Filling rates are defined by the size or weight of the goods and the limit for the vehicle.

Lundblad (2020) states that in order to reach the envisioned goals a focus on improving logistics and utilizing the possibilities to transport goods over water and railways together with greater usage of biogas needs to be established. Another goal, that also connects to construction logistics, is a well-built environment. Challenges that need to be overcome to achieve this goal is urban planning and a better adaptation of stipulated regulations such as the PBA. If the municipal allocation of land planning is developed further, it is stated to be a great tool to target several aspects of the goal of a well-built environment. A need for collaborative and basic planning of construction and infrastructure is also identified to be of great value (Swedish Environmental Protection Agency, u.d.).

2.7.3 Environmental laws and regulations in Sweden

In 1999 the Swedish Environmental Code (SEC) was enforced to facilitate the sustainable development and the SEC abrogated the previous environmental protection law in forced in 1969 (Sveriges riksdag, 1969). The SEC, which consists of several ordinances and regulations stipulated by the government, applies to all actions taken by individuals as well as businesses. The SEC developed previous environmental legislations and today the legislations compliment the code and refer to provisions within the SEC (Hofset, 2020). In the aspects of construction, the environmental code is connected to what is stipulated within the PBA (Boverket, 2020e). In 2018 a new legislation was enforced with an ambition to stipulate new long-term goals towards reducing the negative impact on the climate with a set timeframe and sub-goals. The legislation stipulates that the government must establish a political plan of actions to improve the environmental work every fourth year. The current action plan has defined specific goals for both transports and construction (Miljödepartementet, 2019).

For the transport sector, the political plan of action aims to reduce greenhouse gas emissions by 70 per cent before 2030 and to reach a total net zero emission by 2045. In the political plan of action, the climate goal committee is assigned to establish climate goals for air transports and enable goals for water transports. Lastly, appropriate authorities are stipulated to be assigned work and collaborative work to reduce the environmental impact from transports (Miljödepartementet, 2019).

For construction, the political plan of action states that declarations and demands are to be forced to establish life cycle perspectives together with demands for a reduction of climate impact. The usage of wood is to be increased and the environmental risk assessment connected to recycling will be developed as well as the usage of residual

masses will be simplified (Miljödepartementet, 2019). The declaration is to be enforced on the first of January in 2022 and stipulates that the developer needs to declare how much emissions the construction of a new building will generate. This must be presented to the responsible authority before a final clearance will be given by the Building Committee. Transports to the construction site will be included in the total emissions and has to be accounted for (Regeringskansliet, 2020).

Connected to construction some recommendations regarding noise for construction sites also exist to minimize the effect on the surrounding environment. These recommendations are suggested by the Swedish Environmental Protection Agency and align with the environmental code. The recommendations differ depending on the time of the day, day in the week and the surrounding environment. The highest level of noise that is acceptable is 70 dBA, with few expectations. Transports to a construction site is regarded as transports sound and have different recommendations (Larsson, 2020a). A new ordinance was enforced in 2015 that regulate the noise from traffic passing residential buildings (Sveriges riksdag, 2015). Since noise from rail traffic reaches a higher frequency, it is easier to reduce, and a higher dBA can be acceptable compared to road traffic (Larrson, 2020b).

2.7.4 The construction industry environmental effects

The environmental aspects need to be targeted to reach the goals and according to the International Energy Agency (2019), 39 per cent of the emission in 2018 was connected to the building and construction industry. Kvint (2021) similarly states that 40 per cent of the emissions are connected to the construction industry worldwide, which shows that there are possibilities to reduce the climate impact from the construction industry. Out of the total CO_2 emissions from transports in Sweden, the construction industry is responsible for 10 per cent (Fredriksson, 2021). To achieve a positive impact on the climate and reduce emissions a direction was established in Sweden by several stakeholders within the construction industry. The initiative set out to reduce the emission to zero by 2045 and formulated 26 encouragements to politicians, stakeholders, and authorities on how to achieve this. For the developer it is, for example, suggested to include climate issues early in the planning and construction process as well as primarily consider tendering requirements with innovative solutions to reduce climate impact (Fossilfritt Sverige, 2018). The aim of the initiative aligns with the result of a study on how to reduce the number of emissions to low or even zero with construction logistics, within a Norwegian context. The study concludes that to succeed it is vital to have a close and transparent collaboration between involved actors, well thought out plan and established ambitious requirements (Venås, et al., 2020). To know what is required to achieve a reduction of emissions Fredriksson (2021) states that data is required, for example, regarding handling of residual material. The data that is missing is the amount of material used, where the material is stored, what traffic routes, vehicles and fuels are used as well as how storage areas are localized. Access to data regarding these issues will enable research to assist the construction industry with calculations of how logistics can reduce emissions (Fredriksson, 2021).

3 Methodology

Methodology is a research tool to help researchers find solutions and attain more knowledge about a subject. This chapter describes how the study was conducted in 3.1 research process and 3.2 research approach and what methodologies were used in researching the topic. Followed by chapter 3.3 collection of data and how the empirical inquiry was conducted. Lastly, 3.4 presents the ethical and sustainable conduct in the study.

3.1 Research process

The study consists of a theoretical framework based on mainly scientific articles, reports, and books. Search engines such as Google Scholar, Scopus, Chalmers library, and AFRY´s own projects were used. When searching for information keywords such as *construction logistics*, *municipality*, *sustainability in construction, municipalities' role, land allocation, building process, logistics governance,* etc. were of relevance. The literature study helped in gaining knowledge of construction logistics and the role of municipalities related to construction logistics. The literature formed the theoretical framework of the study and contributed to the formulation of interview questions used in the data collection.

Further, when the authors had gained some initial knowledge about the topic the data collection began. The empirical part consists of interviews with different actors from the municipalities. The study used semi-structured interviews as data collection method. Valuable information and new perspectives were gained from the interviewees; therefore, the theoretical framework was continuously developed during the empirical phase.

The empirical gathering of data was conducted with interviews and a single benchmarking project. The chosen project to benchmark of a CLC located in Stockholm is referred to as SRS. Together with the supervisors, the SRS project was chosen because research has been conducted about the project and it is an extensive construction logistics solution in Sweden, and possibly one of the most comprehensive in Europe (Bergman, 2016). There have been limited cases about construction logistics in larger contexts and in SRS the City of Stockholm had an important role and is interesting in the matter of what role the City of Stockholm had. The benchmarking of the SRS project is based on reports and articles about the project and interviews with key persons of the project. The benchmarking project is researched to get a practical example of how logistics solutions can be implemented and further researched if it could be developed in other municipalities and areas.

3.2 Research approach

The study follows abductive reasoning with a qualitative research method. The theoretical framework together with the empirical findings was run in parallel and both parts continuously fed each other and contributed to the development of the study during the entire process.

Abductive reasoning is a combination of deductive and inductive study, where empirical and theoretical data are interpreted together to a result and explained in the

best possible way. Bell, Bryman, and Harley (2019) describe it as an understanding of the gained knowledge from both perspectives that later was matched together to a result. As this study was a combination of the reviewed literature and empirical data collected from both interviews and benchmarking of the SRS project that was run in parallel, abductive reasoning was preferred.

A qualitative study explains in detail the information to create an understanding and to contextualize the information. It is about gaining more knowledge and interpreting social and human phenomena, which could be researched in several ways (Holme & Solvang, 1997). Data could be gathered through interviews or observations and be based on experiences, values, behaviours, and social movements (Denzin & Lincoln, 2000). Qualitative research is often an iterative process where the authors synthesize the empirical data and continuously questioning the outcome to get a deep understanding of the research (Bell, et al., 2019).

Interview is a method of collecting qualitative information such as opinions, behaviours, attitudes, and processes. Collecting empirical data from interviews can give less quantity of responses but is instead more likely to reach the key actors with valuable and in-depth insights. Interviews can be structured on different levels, this study used a semi-structural approach where questions were written down beforehand but allowed some flexibility in adapting the preformulated questions to the interview (Rowler, 2012).

A case study is a research methodology about a tested example and gives an in-depth understanding of a real-life context (Flyvjberg, 2006). The thesis consists of a case study of municipalities' role in construction logistics and contributed to an understanding of a specific phenomenon in the empirical world (Dubois & Arajou, 2007). Further, Dubois and Arajou (2007) explain that the methodology for a case study can vary according to what is being studied and if it should be built on theory testing or theory building. The case has been studied qualitatively and in detail described the situations and choices by researching articles and reports about the SRS project along with interviews with key persons within the different municipalities. The case was studied with a qualitative method with an analytical approach to enable theoretical notations and studied assumptions (Dubois & Arajou, 2007). Throughout the study, an abductive approach has been used and the case was studied through reviewing existing literature along with empirical gathering. The boundary of the case study was not fixed until the completion of empirical data because the focus during the iterative theoretical and empirical choices could reconsider the focus and what parts were of most importance (Dubois & Arajou, 2007).

3.3 Collection of data

A part of the study was to identify the responsible actors in the municipality and how they perceive their role in the implementation of construction logistics. The City of Stockholm, the City of Gothenburg, the municipality of Uppsala, and the municipalities of Södertörn were chosen to investigate based on their different level of implementation regarding construction logistics. Another reason these municipalities were chosen was that they are among the municipalities with the most citizens in Sweden and are of relevance since construction logistics is of importance in dense urban areas. Table 1 presents the citizens for each municipality.

Table 1 Citizens of each municipality (SCB, 2020).

Municipality	**Citizens**
Stockholm	975 000
Gothenburg	580 000
Uppsala	231 000
Södertörn	505 000

Both the municipality of Uppsala and the City of Stockholm have implemented construction logistics solutions. While the City of Gothenburg and the municipalities of Södertörn have not implemented construction logistics solutions and were chosen based on understanding why implementation has not taken place and to understand if one will in the future since both municipalities have plans on expanding the cities in the urban areas.

The chosen municipalities and their organisations were studied to get an overview of the municipalities administrations that could be of relevance for the study. The first interviews were recommendations from supervisors and experts in construction logistics field. During the interviews the interviewees were asked if they know other people working within the area and could be of relevance for the study, a so called snowball strategy (Bell, et al., 2019). Relevant interviewees were also contacted through emails listed on the municipalities' websites. Among the people asked for an interview approximately 20 per cent felt they had knowledge, time, and was interested to be part of the study. However, the others that was contacted were helpful in refereeing to the right person and if they did not have knowledge in the matter that was in itself also regarded as a result. To attain the high quality of the study interviewees with similar position within the municipalities were contacted to enable comparability between the municipalities and the roles. The *Logistics Specialists* were chosen based on their knowledge in the field and that they have experience from several of the studied municipalities.

All the interviews were semi-structured and performed remotely due to the restrictions and limitations of the Public Health Authority. The virtual environment facilitated interviews with municipalities located far away from the authors. Virtual interviews limit the opportunity to informal meetings and observations of the interviewee's reactions, feelings, and non-verbal expressions, though, all the interviews were performed under the same conditions. Sometimes due to lack of time or knowledge, interviewees communicated and responded in a written text through email. Table 2 to Table 6 presents the performed interviews and for what municipality the interviewees work. Some interviews were with experts in the field and since the role and knowledge about the topic vary the interview questions were adopted according to whom was interviewed. The questions were sent in advance so the interviewee could prepare and enable comprehensive answers. The questionnaires are provided for in the appendix. All interviews and communication were performed in Swedish to reduce language barriers and the data collected was at a later stage transcribed into English.

Table 2 Interviewees with Logistic Specialists

Role	Company	Length	Date	Type
Logistics Researcher	University of Linköping	1 hour	2021-02-22	Remote Teams
Logistics Consultant	Land Development Department	1.5 hour	2021-03-26	Remote Teams

Table 3 The City of Stockholm interviewees

Role	Company	Length	Date	Type
Traffic Strategist *Traffic Planner*	Urban Transport Administration	1 hour	2021-03-05	Remote Teams
Project Manager CLC in SRS	Land Development Department	1.5 hour	2021-03-11	Remote Teams
Environmental Specialist	Environmental department		2021-03-05	Written communication

Table 4 The City of Gothenburg interviewees

Role	Company	Length	Date	Type
Goods Planner *Mobility Manager*	Urban Transport Administration	1 hour	2021-02-17	Remote Teams
Project Manager A ÄU	Älvstranden Utveckling AB	1 hour	2021-03-09	Remote Teams
Land Development Manager A	Property Management Administration	45 min	2021-04-22	Remote Teams
Project Manager B ÄU	Älvstranden Utveckling AB	45 min	2021-04-23	Remote Teams
Land Development Manager B	Property Management Administration	30 min	2021-04-27	Remote Teams
Construction Manager *Strategic Manager* *Planning Manager*	Urban Planning Department		2021-02-15	Written communication
Environmental Director	Environmental Department		2021-04-26	Written communication
Urban Planning Director	Urban Planning Department		2021-04-22	Written communication

Table 5 Interviewees at municipality of Uppsala

Role	Company	Length	Date	Type

Operating Manager CLC	Land Development Department	1 hour	2021-03-25	Remote Teams, Written communication

Table 6 Interviewees at municipalities of Södertörn

Role	Company	Length	Date	Type
Project Manager Tyresö	Land Development Department Tyresö	1 hour	2021-02-24	Remote Teams
Coordinated Distribution Manager	Procurement Södertörn	1.5 hour	2021-03-12	Remote Teams
Sustainability Strategist	Environmental Department Nynäshamn		2021-02-18	Written communication

3.3.1 Evaluation of data

The data collected was evaluated by the usage of two different approaches and one of them is shown in Figure 11. The qualitative data retrieved from interviews were thematically analysed from notes and transcripts. The data within the notes and transcripts were reviewed and under the evaluation process divided based on relation to each other and divided into different themes before the data was interpreted. The data collected from interviews and the theoretical framework of the municipality's organisations and interrelationships in Sweden was additionally mapped out and analysed visually for easier interpretation. (Creswell, 2009)

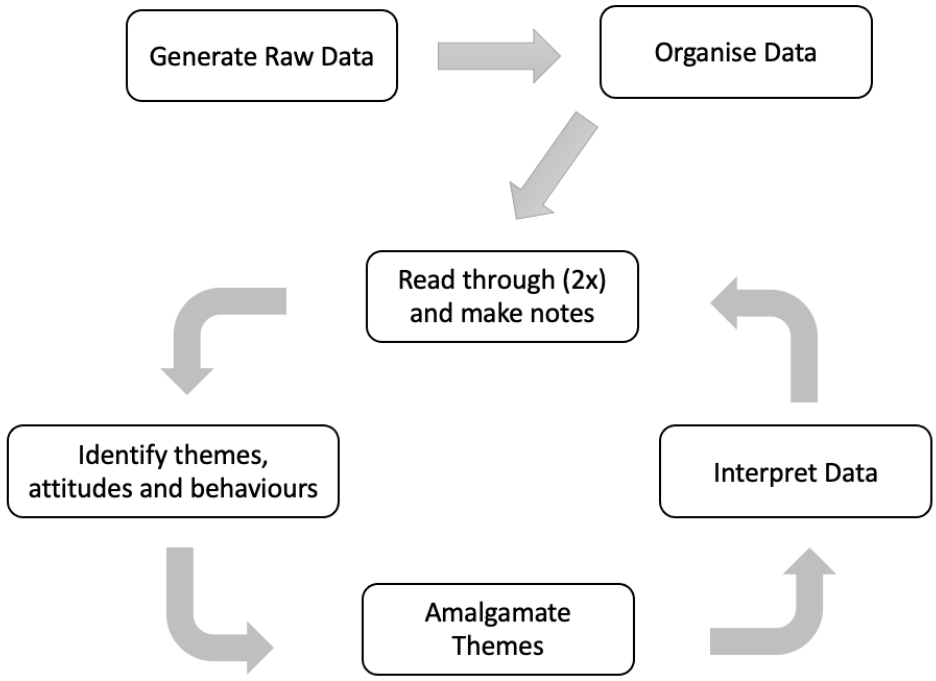

Figure 11 An analysis spiral, illustration based on Creswell (2009).

Once the data collected was divided into themes and mapped out it was presented to the three supervisors during two remote virtual meetings between the authors and supervisors. The two meetings that were recorded enabled discussions about the collected data among the participants and was used as a foundation for the written discussion in this study.

To attain a study of high quality, aspects such as validity, reliability and transparency have been considered. There exist multiple ways of obtaining validity in a qualitative study (Creswell & Miller, 2000). The number of municipalities selected to investigate was purposely chosen to obtain insights in different municipalities and at the same time enable more in-depth research. All interviewees were kept anonymous in the study to create an atmosphere where interviewees felt comfortable sharing their honest opinions to enhance truthfulness which however possibly could reduce the transparency. The questions for the interview are in the appendix of the report to increase reliability and transparency. Interviews were recorded to enable the authors to go back and review the material once more to reassure the data has been interpreted correctly. Notes on the transcribed interviews from the interviewees were reviewed to make sure the information is understood and conveyed accurately. This is by Creswell and Miller (2000) referred to as member checking and identified as a technique to reassure credibility.

3.4 Ethical and sustainable aspects

During the process of this study, four ethical aspects identified by Bell and Bryman (2006) were considered. The first aspect is to protect the identity of the participants in the study. This was considered by offering anonymity and confidentiality to the interviewees. The second is connected to enabling consent from the participant. This was considered when recordings of the interview were made only if consent was obtained from the interviewee. The third was to assure that participants in the study did not fall victim to any wrongdoing nor harm in any way. The fourth and final aspect considers the conflict of interest, which was reduced by performing data collection in parallel with discussions and analysis together with the three supervisors of this study. The supervisors also, throughout the project continuously contributed with valuable feedback and insights, to limit the authors' subjective impact on the study. The two authors contributed to an equal extent to the study which limited the influence of one's personal values.

The research aim was to evaluate the responsibility and role of municipalities and had a strong connection to sustainability within the city. Some benefits of construction logistic is a reduction of negative impact on the environment as well as society (Janné, 2018; Janné & Fredriksson, 2019). In order to investigate the municipalities interest in construction logistics, the municipalities own sustainable goals, as well as national and UN targets on ecological and social perspective, were considered and discussed.

4 Empirical inquiry

The empirical inquiry chapter presents the results from the interviews and the collected empirical data. It starts with 4.1 a benchmarking project of Stockholm Royal Seaport (SRS) to provide a better understanding of how a construction logistics solution can be implemented and used. Further, in 4.2 the construction logistics specialists are presented with their knowledge and experience. The chapter continues with an investigation of the municipalities' perspectives on construction logistics. In 4.3 The City of Stockholm, 4.4 The City of Gothenburg, 4.5 Municipality of Uppsala and lastly, 4.6 Municipalities of Södertörn.

4.1 Benchmarking project - Stockholm Royal Seaport

The Stockholm Royal Seaport (SRS) is one of the largest city developments in Europe. The construction of the new area started in 2001 and is still in progress and will be finished between the years 2035 and 2040. The new area will consist of around 35 000 offices and 15 000 residents and is located in Stockholm, Sweden (Bergman, 2016). In 2009 the Municipal Assembly at the City of Stockholm agreed upon a vision of making the SRS an explicit environmental city district (Bergman, 2016). SRS is developed to focus on the three pillars of sustainability, the ecological, social, and economic aspects. During the construction process, the focus pillars will be achieved with a CLC (Stockholms stad, 2021a).

The CLC and the logistics solutions are governed by the Land Development Department and have a main project manager for the CLC that is responsible for the implementation and a general overview of the production in SRS. Already in the land development agreement, it was stated that a construction logistics solution should be used in the area but was not to a detailed extent. The *Project Manager CLC in SRS* states that the logistics solution and the decision to implement a CLC was based on the sustainability aspect for the whole area. The construction phase also needs to be in line with the focus pillars and according to the *Project Manager CLC in SRS* a CLC was a good solution in achieving this. Hammarby Sjöstad is another newly constructed area in Stockholm that used a CLC during the production phase and SRS was inspired by their solution. The effects of a CLC with short-time storage in Hammarby Sjöstad showed a decrease in transports and a better environment for the inhabitants because of better accessibility on the streets of less heavy traffic.

4.1.1 The logistic solutions of SRS and the development

In 2010 the framework for SRS was established and the agreement with the Municipal Assembly at the City of Stockholm was as followed:

> *"A logistic solution shall be established for sustainable construction transports which can then be further developed to coordinate the transport of goods for the entire SRS and shall be linked to water and rail transports. Goods transport must take place with environmental vehicles. Operations in the area must be offered help to minimize their transports through services from the logistics centre and by drawing up a transport plan."*
>
> *- (KF 2010)*

The *Project Manager CLC in SRS* states that at the beginning of the logistics plan in 2011 an operator was contracted to handle the services and use of the CLC. The City of Stockholm inquired a TPL through a competitive dialogue, which means that all tenders are invited for a dialogue before the tender is given, which is a part of the law of public procurement (Upphandlingsmyndigheten, n.d.). The *Logistics Consultant* at that time worked for a logistics service company and won the contract for the CLC and worked as a marketing manager and procured operators.

From the agreement *KF 2010* a logistics solution was implemented. The tender of the CLC operator started during the spring of 2012 and winners were two collaborating companies, one as a TPL and one haulage contractor (Bergman, 2016). In 2013 the CLC was established and all deliveries to the construction site that did not exceed 5 m^3 were obligated to go through the CLC (Bergman, 2016; CIVIC, 2018). The CLC was located in Ropsten with a clear connection to the incoming transports and close connection to the harbour enabling the possibility to transport by waterways (Bergman, 2016). The built CLC consists of an unheated warehouse, a waste disposal site and outdoor storage and has its systems for planning and booking of transports. The *Project Manager CLC in SRS* states that the planning and booking system is compatible with external planning systems. The client together with the operator of the CLC and suppliers developed technical products, services, processes and education about the CLC. The operator of the CLC was obligated to send out at least two routine vehicles from the CLC to the site per day, one in the morning and one in the afternoon. As the SRS project prolonged, services have been further developed by the CLC and the facilities and operation have changed (Bergman, 2016). The development and changes in the CLC appeared because of more knowledge and experience. In 2016 the agreement was further developed and shortened.

> *"Coordination of all construction transports to the area through a logistics centre."*
>
> *- (KF 2016)*

The SRS project acknowledged early on the need to communicate the aim of using a CLC for all stakeholders, external as well as internal. To achieve this, on-site information channels were implemented in the form of tv-monitors on site, different level of educations was taught and pamphlet, short videos and a website was created. The CLC has reduced the number of transports to the site as well as the amount of disposable waste. The result achieved during the SRS project is continuously implemented to achieve improvements. One of the goals with the CLC is also to increase the knowledge and research about CLC in general (Bergman, 2016).

One important aspect identified to successfully implement the logistic solution was that the client needs to provide a clear and straightforward structure over how to divide the work and responsibilities for the different processes. Acknowledgement made in 2016 was that the developer should be more involved in issues regarding production to reach the desired outcomes with implementing a CLC. The traditional competing tendering agreements were also considered to be insufficient in more complex projects. The tenders are believed to become better if they are instead based on collaboration strategies, where contractors are early involved, more flexible remuneration and emphasis on trust and knowledge exchange (Bergman, 2016).

In 2017 the agreement with the operator was cancelled because the Land Development Department lost control of the services and could not follow up the development and change processes which is one of the goals with the chosen logistics solution. Another reason for the cancelled agreement was the lack of communication from the operator to involved actors that the *Project Manager CLC in SRS* states is one of the most important aspects. In 2016 the *Project Manager CLC in SRS* got help from the *Logistics Consultant* to set up a new framework for the logistics in SRS.

A reorganization was conducted in 2018 to increase the level of communication for everyone involved and to regain control. The reorganisation increased the satisfaction rate among the actors because of better communication from the city and the CLC. The *Logistics Consultant* states that communication is challenging because it is hard to explain the effects of a logistics solution for someone that is not aware of possible gains. The business model for SRS is hard to understand and assimilate for the contractors. The *Logistics Consultant* means that the business model shall be developed and make it more feasible for someone that is not used to solutions like this.

In 2018 the Land Development Department procured a consultant organisation that rents the use of CLC, in order to eliminate the economic incitements for the organisation. The City of Stockholm further procured external services such as transport, warehousing, waste disposal and security with help from the *Logistics Consultant*. Figure 12 shows the organisation model of the CLC and how it is governed.

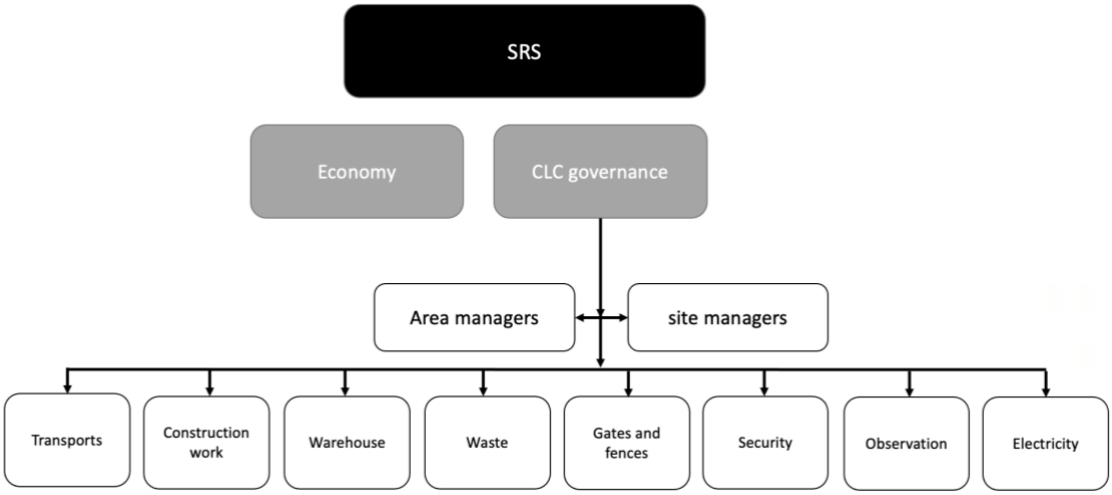

Figure 12 The organisation of construction logistics in SRS, illustration based on the Project Manager CLC in SRS presentation material

The organisation is governed by SRS and the Land Development Department, this has favoured communication and the conditions of competition to save costs. The CLC is governed with help from the consultant organisation that supports the site- and area managers. Area managers are coordinators over one specific area to control the logistics for several sites and reports to the *Project Manager CLC in SRS*. According to the *Logistics Consultant*, the area managers are a key role in a successful logistics solution. The City of Stockholm has agreements with every supplier to achieve high flexibility and a high degree of exposure to competition.

The *Project Manager CLC in SRS* further states minor changes after the reorganization. In 2019 the CLC moved to place it close to where the current construction appears, to

release access to the land and to further enhance the possibility to transport over water. In 2021 a new official statement was agreed on by the Municipal Assembly where the Land Development Department developed the documents.

4.1.2 The business model and costs to use the CLC

The *Project Manager CLC in SRS* states that the business model has been the same since the beginning of CLC in SRS. The costs are allocated among all contractors and are based on the gross building area. The total costs for the gross building area (GBA) have been the same, though the allocation of the costs has differed. The business model has three forms of remuneration. The initial affiliation fee paid for using the CLC, the fees when entering the gate at the site and the usage of services performed by the CLC operators with pre-established fees. The pricing of the CLC was based on three aspects, the actual costs, the revenue from the entry fees and the expected number of transports. Since the City of Stockholm is a developer in SRS, they did as well as the other actors pay an initial entry fee. Their fee was equivalent to 9-10 per cent of the total cost of the CLC.

According to Bergman (2016) the developer should be held accountable for the costs of the CLC. Bergman (2016) believes the developers should be held accountable to such a degree that they are motivated to improve the construction site logistics and to achieve as much effect from the CLC as possible. The business model assigned all risks to the client, the City of Stockholm, which means they became responsible to pay for all costs connected to operating the CLC. The compensation for the CLC operators work was priced by following the Law of Public Procurement (Bergman, 2016). Figure 13 presents the business model of SRS, agreements between the City of Stockholm were contracted upon with the developers, contractors, and clients, regarding the obligated usage of the CLC and the cost and usage specifications. Different CLC customer agreements were also signed, both between the CLC and the developer, the CLC and the contractors as well as the client and the CLC.

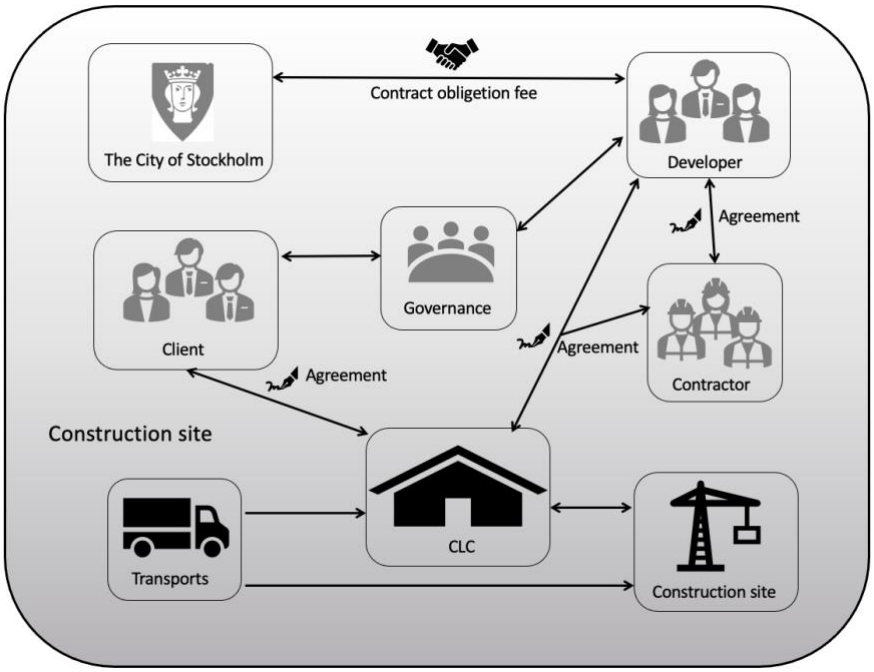

Figure 13 Business model of the CLC in SRS, illustration based on the Project Manager CLC in SRS presentation

The contract model in SRS has three steps, the first is a land development agreement by the City of Stockholm together with the developer. Before the developer starts the design phase the *Project Manager CLC in SRS* meets the developer for an information session about the CLC. Secondly, it is the signing of the contract to join the CLC, which must be signed six months before the start of construction. Lastly, the *Project Manager CLC in SRS* is responsible for establishing a customer agreement and a framework for economy, safety, and insurance. The *Project Manager CLC in SRS* states the importance of a logistic plan for each project, and that the developer must make a logistics plan early in the process when they procure contractors. In the logistics plan, it is important to have fact about the project, the logistics strategy, materials handling, conditions for the organisation, disposition plan and operation plan.

4.1.3 The goal with a CLC for SRS

The City of Stockholm has set up environmental goals for SRS with requirements of how to use the land in terms of coordination of logistics solutions (Boverket, 2020a). Furthered, when a CLC was agreed upon, the Land Development Department's objective for the project was to;

1. Create a sustainable and resource effective construction.
2. Be an effective and competent service organisation for the construction industry.
3. Promote research, development, and innovation within construction logistics to encourage for sustainable construction in the industry.

At the beginning of the implementation in 2011 the Land Development Department in Stockholm ordered an early logistics analysis from a consultant (Bergman, 2016). The *Project Manager CLC in SRS* states that an agreement about a short-term CLC was agreed on together with the City of Stockholm in 2011. Furthermore, the *Project Manager CLC in SRS* states that an alternative to a short-term CLC would be for the municipality to state requirements about filling rates in the vehicles.

The CLC was implemented in 2011 with six aims that the Land Development Department formulated together with the city. The *Project Manager CLC in SRS* formulated these aims, which are presented below, to help visualize the intended outcome with the CLC for developers and contractors.

1. Decrease the number of transports to sites.
2. Coordinate all logistics solutions for the area.
3. Create effective processes for construction and logistics solutions.
4. Create value for construction within the area. The *Project Manager CLC in SRS* states that the goal is to attract contractors, so they want to build in SRS.
5. Create a safe, effective, and clean working environment. (The *Project Manager CLC in SRS* states that this is regulated by rules and laws.)
6. Be a part of the development within the research field of construction logistics.

To achieve these desired outcomes by the use of a CLC seven conditions were formulated and are presented below.

1. It is mandatory to obligate to the CLC.

2. All incoming transports need a booking in the transport booking system.
3. No material is allowed to be stored on site.
4. A collective waste disposal system needs to exist on the site.
5. The site must be gated.
6. Co-loading must be used until a certain volume is achieved.
7. All vehicles over 2 m long need an exemption to enter the site.

The *Project Manager CLC in SRS* highlights the importance that it is mandatory to obligate to the CLC, it is stated as a requirement in the agreement between the developers and the City of Stockholm. The *Project Manager CLC in SRS* means that it should not be a question if it is worth or not to obligate to the CLC, because the idea with a CLC is best working when all contractors and developers work together. The *Logistics Consultant* that works as a site manager at the CLC states that in an early-stage state about construction logistics solutions creates awareness among all contractors. For example, stating in the land allocation process creates an awareness of the logistics solutions and spread of information among contractors. The reactions from contractors have differed, from the beginning, the CLC faced resistance because it seemed complicated and complex. However, with more time and experience the contractors gave the solution a chance and the reactions became more positive. The *Project Manager CLC in SRS* states that one important thing is to communicate early that it is mandatory to use the CLC. In the land development agreement, it is stated that it is mandatory to use the CLC, this has facilitated the understanding and the way to use the CLC when it has been communicated several years in advance.

According to the *Logistics Consultant* the City of Stockholm has achieved the goal to promote research and be a role model for logistics solutions. The next step is to spread the knowledge and manage the learnings SRS has entailed and make it possible to set a standard framework for construction logistics solutions. The *Logistics Consultant* states that municipalities are interested in the logistics solution in SRS and on how others can implement similar solutions in their municipalities. The *Project Manager CLC in SRS* has worked with spreading knowledge and educating the actors how to use their logistic solution, all site managers and contractors are therefore able to receive an education about the logistic solution. They have different seminars, workshops, and forums to discuss and spread the knowledge between actors. The *Project Manager CLC in SRS* mentions that the communication is challenging because there are continuously new actors that have to be informed. The contractors need to be informed to an extent so they can further spread the knowledge to their subcontractors and suppliers. The *Project Manager CLC in SRS* states that the communication appears on many levels and that the knowledge spreading between contractors and their subcontractors is the hardest because it is out of the CLC's organisations control. The problem is often in the economic calculation in the contractor's procurement process. Without knowledge about costs for the CLC, it is complicated to calculate the right costs when the conditions are unclear. The *Project Manager CLC in SRS* is continuously working with evaluations to be better in spreading knowledge and how to communicate.

4.1.4 Effects of using a CLC

The yearly traffic flow in Hjorthagen, one area in SRS, connected to the construction site was estimated to generate 35 000 - 40 000 vehicles in movement which could be reduced between 15-30 per cent due to coordination and planning of traffic within the

construction site (Stockholms stad, 2021a). The *Project Manager CLC in SRS* calculates transport flows and states that 76 per cent of all transports were direct transports to checkpoints, while the other 24 per cent was transports to the CLC. Further the *Project Manager CLC in SRS* states that the transports have decreased by 23 per cent in 2021 because of coordinated distribution of goods. The analysis recognized the important aspects for establishing a CLC based on national as well as international research (Bergman, 2016). The aim of the implementation of a CLC was to reduce traffic, using hybrid vehicles for co-loading and increase the fill-rate of deliveries as well as increase the accessibility and enabling collective waste management (Stockholms stad, 2021a). The *Project Manager CLC in SRS* states that collective waste management has decreased the total transports connected to waste disposal by 50-70 per cent. Further, an investment of an electric truck has been made to achieve the goal of emission free transports and noise reduction. However, the *Logistics Consultant* states that the potential positive effects of using a CLC are many but due to the cost of implementing them, they do not all always add essential value.

4.1.5 City of Stockholm's role in SRS

The City of Stockholm is responsible for establishing and constructing the CLC and is the responsible actor to hire contractors and relevant equipment for the CLC (Stockholms stad, 2021b). In 2021 the Land Development Committee decided upon a new implementation decision and more funds for the CLC. This was decided upon a suggestion stated by the operators of the CLC together with the Land Development Department and furthered to the politicians in the Land Development Committee. To get the suggestion accepted the Municipal Assembly needed to accept the new plan regarding financial funds (Stockholms Stad, 2020c).

The Land Development Department is the main administrator for the organisation of the CLC. Further, the *Project Manager CLC in SRS* states that the Land Development Department collaborates with the Environment Administration because one of the main reasons for implementing construction logistics solutions is to achieve the environmental goals. Though, other administrations are of relevance and can contribute depending on different questions and challenges that appear. The City of Stockholm has a forum with a cross function where discussions among different administrations and academia can take place to achieve the sustainability goals and development of construction logistics solutions. The *Logistics Consultant* states that the municipalities' role should set requirements and that they can do it in the land allocation process because it is the first time the contractor gets in contact with the municipality. The *Logistics Consultant* means that the logistics solution needs to be clearly stated in the land development agreement to facilitate constructing the framework.

4.2 Construction logistics specialists

The *Logistics Researcher* and the *Logistics Consultant* both have years of experience in working with construction logistics solution in different contexts. The *Logistics Researcher* from academia and the *Logistics Consultant* with different implementations of construction logistics.

The *Logistics Researcher* has researched the regions and municipalities governing role in construction logistics. The result from the research was a design process and how

everyone's interest can be combined in a construction logistics solution. The *Logistics Researcher* has researched both construction and city logistics and these two constitute of similarities. Although, city logistics is more developed, and construction has a lot to learn from city logistics. The *Logistics Researcher* states that the mistakes that are currently happening in construction logistics were previously mistakes in relation to city logistics and construction logistics could learn from these. The L*ogistics Researcher* means that a mistake is to only have one perspective and not looking at the general perspective including all stakeholders interest in the supply chain.

The *Logistics Consultant* has worked for several companies with a focus on logistics and lately with construction logistics for hospitals and different logistics solutions. The *Logistics Consultant* was a part of SRS at the beginning of the CLC in 2012 as a service company but changed focus to be part of the development of the construction logistic framework. Previously, the role was more focused on operating work within the already set framework. The *Logistics Consultant* instead wanted to be the one that set the framework and chose the logistics solutions. The *Logistics Consultant* means that someone with the competence and knowledge about construction logistics should set the framework for the logistics solutions in the land development agreement. Sometimes, when a contractor is hired with the responsibility to set the framework, they lack the right knowledge to create the best solution for the project. In 2018, the Land Development Department in Stockholm hired the *Logistics Consultant* to be a site manager for the CLC in SRS.

4.2.1 Logistics solutions

Construction logistics solutions is a new phenomenon in the industry and in recent years a rapid development has occurred. The first known project that used a construction logistics solution was Hammarby sjöstad during the 1990s that had a CLC. The *Logistics Researcher* and *Logistics Consultant* gives an example of a solution for a project in Stockholm, called Urban Escape, they had a CLC out of the city and a checkpoint at the construction site. Measures showed that the construction logistics solution decreased the total transports by 82 per cent. According to the *Logistics Researcher*, some type of construction logistics is always performed but sometimes without consciousness. In recent years, the attitude from contractors and suppliers towards construction logistics has changed, due to the collaboration between contractors, clients and municipalities are better because of closer relationships. Many of the actors have an increased interest in construction logistics because it has become more important. After all, construction logistics is more forced with construction sites in dense urban areas and limitations in space.

The *Logistics Researcher* means that the restrictions, such as weight and size of trucks and disturbances restrictions have been a driving force for an increased interest in how to handle construction logistics. Further, the *Logistics Consultant* sees that the interest has increased and thinks that the Land Development Department should form a framework for a common solution. In the common solution, all areas within a municipality should use the same construction logistics solution. The structure should be the same within the same municipality regarding how to force the contractors to connect to a logistics solution by stating it in the land development agreement. The *Logistics Consultant* believes that we should learn from the SRS case, but the framework shall not be the same as the land development agreement in SRS. It is

important in an early stage, in the land development agreement, to state the choice of construction logistics solutions and that it should be used in the project.

The *Logistics Researcher* states that the construction industry is not collecting and analysing data to a great extent and the impact it entails on certain construction logistics solutions. In general, the industry lack analyses of the outcome and the *Logistics Researcher* highlights it as a challenge, the industry needs to be better at analysing the results from the solutions. The transport flows and the emissions connected to a construction site could be better measured in order to get a better understanding of the off-site construction logistics solutions impact. Analysing could also lead to increased interest because the benefits are easier to understand with real data and experiences. The *Logistics Consultant* states that it is not a challenge to analyse the data since they have the knowledge, experience and necessary data that is relevant to make reasonable estimations.

The *Logistics Researcher* states that all types of construction projects need logistics solutions, independent of the size, location, and budget of the project. However, the ambitious level of the solutions can differ depending on the conditions. All projects can benefit from planned logistics solutions but should be adopted to the specific project and result in economic, social, and ecological advantages. On the other hand, the projects that can, or must implement construction logistics are the bigger ones located in dense areas. The *Logistics Researcher* states that projects such as SRS and Älvstaden need robust and extensive solutions. To fulfil this, a jointly agreed plan among all actors is important and that the framework is adapted to the project's conditions. A challenge in adopting a construction logistics solution is that some of the large construction companies in Sweden have their own logistics systems and ICT tools that do not always fit new solutions. The solutions need to be flexible, so everyone can benefit from them.

The *Logistics Researcher* describes the process of implementing a construction logistics solution in an urban area. Often the process starts with a stakeholder analysis together with all the involved construction projects in the specific area. It could be to analyse how the neighbouring areas and the roads are affected by the transport flows and the complexity of rearrangements of flows in the city. One important aspect in the implementation of a construction logistics solution is to create an awareness of the value an implementation entails. The awareness and the spread of knowledge creates an acceptance and interest among the actors, an important aspect according to the *Logistics Researcher*.

The solution should be communicated early in the process, in the land allocation process or the land development agreement, in order to reach out and get acceptance by the contractors. It does not need to be detailed in the land allocation plan but should inform about the idea and create an awareness of the upcoming implementation. The *Logistics Researcher* states that this is important because it facilitates and minimizes contractor's misunderstandings when they procure subcontractors and suppliers. It is important to have an agreement to use construction logistics in a contract already in the procurement process to give the right conditions and cost calculations for the bidders. What the *Logistics Researcher* highlights is the power of communication, both early in the process but also during the process and to be clear with the conditions. The *Logistics Researcher* means that the construction industry is open to new solutions. The problem has been that changes appear late in the process, which has contributed to resistance

towards change. If the conditions are clear from the beginning it will eliminate misunderstandings and greed towards new solutions. The *Logistics Researcher* highlights the importance of communication and how necessary it is in an early phase to communicate the plans. Communication and collaboration with the right stakeholders are necessary in order to achieve the intended success of a construction logistics solution. As the *Logistics Consultant* states the biggest challenge is to implement a comprehensive solution and that everyone follows a logistics solution and understands the meaning of it. The construction industry has knowledge in the construction logistics field, according to the *Logistics Consultant* the industry needs better communication over the borders to learn from each other, but it is a big challenge to overcome.

Two of the most common construction logistics solutions according to the *Logistics Researcher* are a CLC or a checkpoint. Which solution is implemented in which project is independent because these solutions have different benefits and challenges. A CLC decreases the transports in certain areas, while a checkpoint enables control of flows in the area. The *Logistics Researcher* states that the different solutions give value in different ways and it is important to adapt the solution for the project. Construction logistics solutions are most common in dense city areas. The *Logistics Consultant* has experience in several different logistics solutions and the choice of solution is depending on the type of project. Further, the *Logistics Consultant* describes that the logistics solution term is widespread and that logistics solutions can include everything from spreading awareness to a bigger, more complex CLC solution, like the one in SRS. What the *Logistics Consultant* states is important is the planning of transports to prevent queuing of vehicles into the construction site and therefore checkpoints are a good solution.

The *Logistics Consultant* analyses covers potential logistic solutions considering the location, risks in the area and benefits from the location with highways and roads. The logistics analysis is important because it helps in describing the type of logistics solution the municipality can use. The *Logistics Consultant* gives an example of a project in Norrköping and that the land allocation agreement states that a logistics solution is necessary. In the Norrköping project, the information about logistics is limited, and it is up to all the involved contractors together to agree on a specific solution. The *Logistics Consultant* means that this is challenging since nothing is stated in detail, and all contractors have different qualification conditions.

The *Logistics Consultant* has experience from the CLC solution in SRS and the solution with a CLC in Uppsala. The general structure of these two is that SRS is one area with several smaller areas while in Uppsala it is three areas around the city. The on-site logistics are similar, but the organisation differs. The *Logistics Consultant* highlights the benefits with area managers and thinks that the success of the CLC in SRS is because of the area managers.

4.2.2 Roles connected to construction logistics

In a construction project, many stakeholders are involved and collaborate on different levels and in different phases with each other. Construction logistics has previously been the task of the contractor to communicate with the supplier how deliveries shall be handled. Many actors have seen construction logistics as “someone else’s problem”

and with a lack of information and communication stakeholders in between. In an urban development project, someone needs to take on the role of implementing construction logistics and the *Logistics Researcher* states that the municipality have an important part to play in an implementation. The municipality should set up the framework and conditions of the potential solution. Though, an important aspect the *Logistics Researcher* states is that it is not the municipalities' role to act as the expert and in detail control the logistics solution. It is important to have someone with the right competence to control the details about the solutions to make the solution credible for contractors and clients. The *Logistics Consultant* agrees with the *Logistics Researcher* that the municipalities' role is to understand that they need to have requirements stated in the land allocation agreement but should hire a consultant to look further into the solutions. The municipality's role is to set the requirements of a solution and to hire someone that can develop the construction logistics solution. The *Logistics Consultant* also explains it as the persons with the right knowledge about construction logistics solutions should set the framework in order to achieve the desired outcomes the municipality has defined.

The *Logistics Consultant* that works for the Land Development Department says that they were hired in SRS through public procurement as an organisation to help with the implementation and to contribute with the right expertise within construction logistics. In the procurement process, the City of Stockholm explained that they wanted an implementation organisation for the CLC in SRS to take the lead for including the CLC in the tender documents. The *Logistics Researcher* highlights the municipality's role is to communicate the chosen solution and the value it will entail for the contractors to increase the acceptance among involved actors. In many cases, the clarity of the goals with the solution increases the interest among the actors. The *Logistics Consultant* means that the municipality needs to understand that they should take the lead for an implementation of a logistics solution. The municipality needs to start the process of implementation with a desideratum of construction logistics and further hire someone with the right competence to fulfil it.

Construction logistics is often a question about costs, if the solution is communicated in an early stage the costs become visible and facilitate tendering in procurement. Resistance of change among contractors is lower in the early stages of a construction process. One way the municipality can show their interest is to take part in the costs connected to the construction logistics solution. The *Logistics Researcher* means that if the municipality requires something, they also need to support the project financially to enable the possibility of implementation. The business model shall include how costs will be allocated among the stakeholders and the stakeholders' utilisation of the logistics solution. The *Logistics Consultant* states that the costs are challenging, how it shall be funded and how the costs should be allocated. In SRS it is the contractors that pay for the logistics solutions, but the *Logistics Consultant* states that it is not a good business model to allocate the costs completely to the contractors. The benefits of the business model in SRS and that the costs are based on the GBA is that the contractors have an exact number of the costs early in the process. The challenge is the variable costs and how they should be considered, it entails difficulties in estimating deliveries because of an increase of uncertainties in the estimation and could be costly. A good business model according to the *Logistics Consultant* is to only have an entry fee based on the GBA, to eliminate the risks of potential costs.

The *Logistics Researcher* and *Logistics Consultant* state the municipality's role to increase the interest and knowledge about construction logistics. One suggestion the *Logistics Researcher* has discussed within an EU project is to add the requirements of construction logistics in the construction documents and attach a construction logistics plan to get it approved.

The municipality, developer and contractor are the key actors in achieving a good construction logistics solution according to the *Logistics Researcher*. These actors need synergy, communication, and well-functioning collaboration to meet the demands of construction logistics solutions in complex projects. When these three actors are in line and synchronized with the solution it is easier to comprehend the solution with haulages, suppliers, and TPLs. The *Logistics Researcher* states the most important administrations within the municipality are the Land Development Department, the Urban Planning Department, and the Urban Transport Administration. These are important because the Urban Transport Administration has the power to regulate the local laws about transports connected to construction. The Land Development Department and the Urban Planning Department have an important role in the development of land allocation, comprehensive plan, and detailed development plan. All these three administrations have knowledge about the building process and the progress of the projects which is important in the development of a construction logistics strategy. However, the *Logistics Consultant* thinks that the Land Development Department is the main actor from the municipality, at least in the City of Stockholm.

The municipality should have an interest in construction logistics solutions because as the *Logistics Researcher* states it is the municipality that has the responsibility for the society and to meet the citizens demands. Construction logistics is a solution to reduce disturbances and decrease emissions and that the municipality should have an interest in this to meet the inhabitants' needs.

The *Logistics Consultant* describes different projects and how a logistics solution can be implemented. In the land development agreement, the Land Development Department states the requirements for logistics solutions. The *Logistics Consultant* means that logistics solutions are often agreed on in the land allocation process and that the municipality cannot force or require the contractors to adapt to logistics solutions if it is not stated in any of the agreements. What the municipality can do in case of a late implementation is to persuade the contractors about logistics solutions and the benefits it entails. The contentions about logistics solutions in later stages are often that it is costly, and contractors rather prefer nothing than something that costs money and the municipality face resistance if it is not stated in agreements.

According to the *Logistics Consultant*, the key to successful construction logistics is to involve all contractors in the solution and that the municipality has the overall responsibility. The challenge as the *Logistics Consultant* states is to make contractors that already have started their projects to obligate to a construction logistics solution. The *Logistics Consultant* thinks that the solution is to force contractors to use a logistics solution. The SRS case shows that the contractors are satisfied if everyone needs to obligate to the solution and when the results are visible.

4.3 The City of Stockholm

The City of Stockholm has a population of around 975 000 citizens and is the most populated municipality in Sweden. The City of Stockholm has the ambition to be at the forefront of being a sustainable city and follow UN SDGs and has set up the goal to be fossil fuel free by 2030 (Stockholms stad, 2020b). Regarding construction logistics, the City of Stockholm has an extensive solution in SRS where the Land Development Department's perspective has been studied. Further, other departments such as the Stockholm Urban Transport Administration (SUTA) and the Environmental department are studied to complement other perspectives in construction logistics.

SUTA's main responsibilities are ownership, operation and maintenance of the city's streets and squares. According to the *Traffic Strategist* at SUTA construction logistics is part of the strategic work. Most of the SUTA's assignments are foremost stipulated by the politicians and are endorsed in confinement with allocating the cost of the budget. SUTA does, according to the *Traffic Strategist* and the *Traffic Planner*, work in close collaboration with the Urban Planning Department. Recently more collaboration has also occurred between SUTA and the Environmental Department. SUTA works, according to the *Traffic Strategist*, collaboratively and with a mindset of working for the entire City of Stockholm.

4.3.1 Construction logistics in Stockholm

The *Traffic Strategist* states that SUTA works with construction logistics by working in externally financed research projects. SUTA focus on educating themselves in the construction logistics by staying up to date with how other projects are dealing with issues related to construction logistics. The *Traffic Planner's* task is to make sure traffic is handled in an appropriate way within each project. However, the *Traffic Planner* empathizes that it mainly is the Land Development Department that implements construction logistic solutions. SUTA has according to the *Traffic Planner* become better at acknowledging a need to reduce traffic in the city by implementing a CLC outside of the city. The lack of spaces is identified by the *Traffic Strategist* to have been a driving force to develop construction logistics by SUTA as well as private actors, even though the *Traffic Strategist* believes that the forces should be to develop more sustainable transport alternatives. An example was given by the *Traffic Strategist* that in the project Urban Escape the number of trucks going into the site was reduced by 80 per cent.

More widespread awareness of construction logistics has been distinguished by the *Traffic Strategist* in relation to increasing interest in sustainability and a focus on becoming fossil fuel free. SUTA does perform general measurements of traffic flows in the city, but most measurements are performed within projects. SRS is one example of a project where statistics has been collected. Other logistics solutions seen in Stockholm are a checkpoint in a project in Hagastan and a CLC in Sätra used in the centrally located project Urban Escape. The reason for implementing a construction logistics solution was identified by the *Traffic Strategist* to reduce the disturbance and traffic. The *Traffic Strategist* states to be unsure if SUTA has formulated requirements to use logistics solutions. However, the *Traffic Strategist* states that SUTA can help enhance the benefits of construction logistics and the reason behind why requirements are formulated. Generally, the city can, according to the *Traffic Strategist*, collectively

decide that all projects should reduce traffic, but such an agreement does not exist today.

According to the *Traffic Strategist* at SUTA, construction logistics should be financed within each project's budget, unless monetary incentives can be attained through research and innovation. The *Traffic Strategist* also acknowledges that a project possibly can minimize costs by implementing construction logistics. Construction logistics is something the *Traffic Strategist* believes should be considered early on in a project and in the detailed development plan process. Decisions about construction logistics should, however, according to the *Traffic Strategist*, be made early on by the Land Development Department and the Environmental Committee in the land allocations before the private actors are implemented. The complexity in a construction project with many actors with different competence is identified by the *Traffic Strategist* as a challenge regarding construction logistics. Many resources are needed to coordinate all actors and to coordinate how SUTA can formulate requirements. The *Traffic Strategist* acknowledges that SUTA cannot have requirements on private actors regarding usage of construction logistics.

When working with construction logistics, SUTA works interdisciplinary with the Traffic Committee, the Land Development Department, the Urban Planning Department, the Environmental Committee, the Property Management Department, and construction companies. However, the Land Development Department should, according to the *Traffic Strategist*, be the primary actor enforcing construction logistics due to their involvement in the procurement and their ownership of large areas of land. In order to increase the interest in construction logistics, the *Traffic Strategist* states that the municipality can enhance examples of implementations of logistics solutions and generate incentives for the usage of logistic solutions as well as pedagogically communicate sustainable actions are taken to establish an acceptance.

According to the *Environmental Specialist* at the Land Development Department reducing the environmental impact, utilizing the spaces, and economical savings is what motivates the City of Stockholm to use construction logistics solutions. The *Environmental Specialist* states that the City of Stockholm can take on the active role of implementing construction logistics. This by formulating requirements in procurement with the contractors and in the land allocation agreements as well as providing spaces and taking on a coordinating responsibility. The City of Stockholm does, according to the *Environmental Specialist*, believe they share the responsibility of implementing construction logistics with the contractors and developers. However, the *Environmental Specialist* states that the City of Stockholm can take on a more extensive coordinating role when the implementation regards a large area with multiple detailed development plans and developers. Since using construction logistics can save time and money and is beneficial to the environment, there exists an interest in the matter from the City of Stockholm. The *Environmental Specialist* argues that it is through procurements and contracts different construction logistics solutions can be promoted by the City of Stockholm.

4.4 The City of Gothenburg

Gothenburg is a city with many ongoing projects in the city centre with a strive to establish cohesion. The municipality is the owner of about half of the land in the city,

with established detailed development plans for most of the areas (Göteborgs stad, n.d.). The City of Gothenburg is organised in a similar way as other municipalities but has Property Management Administration, which is equivalent to the City of Stockholm's administration named Land Development Department. According to *Land Development Manager A* the City of Gothenburg is planning to undergo a reorganisation of the administration and municipality-owned companies.

Älvstranden Utveckling (ÄU) is a municipality-owned company that works from a directive from the City of Gothenburg. ÄU's commission is to develop a sustainable city centre along the river in Gothenburg. From the start of the Vision Älvstaden, ÄU has built 8000 new residents and during the year 2019, the total amount of produced residents was around 2000 (Älvstranden Utveckling, 2021a). ÄU's board is politically elected and can stipulate requirements on the developers when the developers purchase property from ÄU. Figure 14 presents the organisation of the City of Gothenburg. It is the Municipal Assembly that gives ÄU their assignments. According to *Project Manager B* ÄU and *Land Development Manager A* ÄU have similar assignments as the Property Management Administration. However, is ÄU's work limited to the area along the river and their projects are often of a bigger characteristic than the projects handled by Property Management Administration.

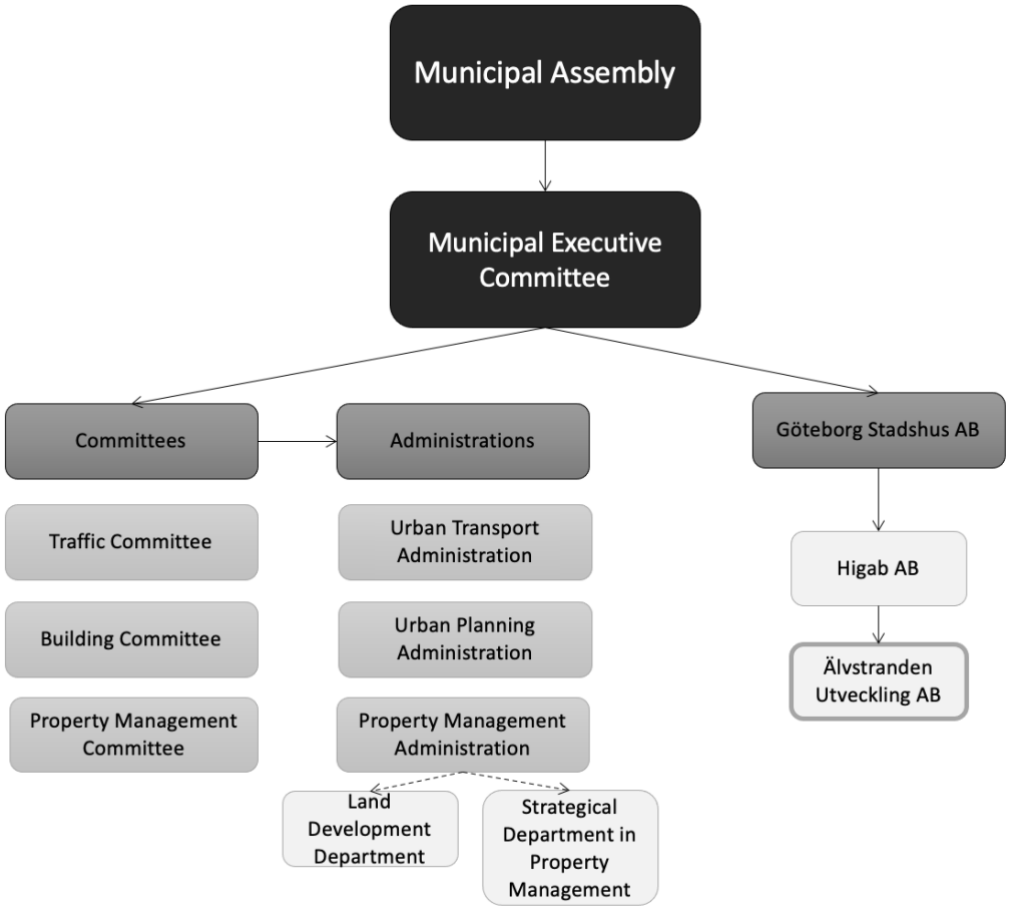

Figure 14 A part of the city of Gothenburg organisation and the place of Älvstranden Utveckling AB (ÄU) discussed in this chapter.

ÄU together with private and municipal developers established a consortium to develop the city district, Älvstaden. Consortiums were established early in the project before a detailed development plan existed. The detailed development plan is owned by the

Urban Planning Department, but it is ÄU's responsibility to coordinate interest and issues with the plan and forward these to the Urban Planning Department. According to *Project Manager B ÄU*, it is important to collaborate with the Gothenburg Urban Traffic Administration (GUTA) during the planning to ensure good accessibility during the construction phase.

GUTA attain their assignments from the politicians in the Traffic Committee, but assignments can initially spring from inhabitants, other municipalities, the Swedish Transport Administration as well as GUTA themselves but it must be approved and assigned by the Traffic Committee. The *Goods Planner* states that the assignments regarding the planning of goods are to enable goods to be delivered on time even though more people and companies are entering the traffic flows. The *Mobility Manager* at GUTA states that a part of their role is to ensure that the city is not disturbed. Meaning that the citizens, visitors, businesses and all the different transports are not affected during construction.

The goal of many projects at GUTA is by the *Goods Planner* identified to make a cohesive city with efficient densification. The *Goods Planner* acknowledges that it is challenging to avoid that citizens will not have to relocate themselves during heavy construction in the areas. GUTA has according to the *Goods Planner* a traffic strategy called *Grön transport plan* that acknowledges three main goals: travels, urban spaces, and goods transport. These goals are to make Gothenburg competitively strong, improve the quality of life and establish sustainable development. The goal of goods transports is stated to be about how to make Gothenburg the Nordic logistic centre, where new and existing industries can evolve to generate work opportunities.

The *Goods Planner* states that Gothenburg is a divided city, the division is because of the physical barriers such as a river and main roads as well as segregation. According to the *Goods Planner*, this division makes it difficult in the traffic planning and diversion of traffic in case of construction areas. While *Project Manager B ÄU* states that one should take advantage of the river as an alternative transport mode because this avoids disturbances for the citizens and the local shops.

4.4.1 A new strategy about construction logistics in Älvstaden

Recently ÄU released a strategy about construction logistics for Älvstaden together with the assistance of Linköping University and their experts in construction logistics. Previously, logistics have not been an issue and could be neglected in Gothenburg, but as the city is developing at a high pace with 10 000 new residents in the coming years in a dense city area the logistics has become an issue. *Project Manager B ÄU* that is responsible for the construction logistics strategy states that they have worked with construction logistics, but nothing has been planned on a strategical level. In 2020 ÄU realised that it was going to be challenging to finalize their projects on time and to the set budget if a strategy of construction logistics was not conducted. This led to a new strategy about construction logistics that will be valid until 2050. ÄU does not build anything themselves, therefore they have formulated a strategy about construction logistics applicable by the contractor and contains recommendations and checklists. Both *Project Managers ÄU* states that in the future the strategy is to be incorporated into the business plan and therefore be a hieratically superior plan, but it is the next step in the implementation of the strategy.

A goal with the construction logistics strategy for ÄU is to implement an action plan for all new constructions in the establishment of the land allocation agreement. A second goal is to lower the CO_2 emissions, calculations show that construction logistics during the production phase can lower the emissions by 3-4 per cent. The construction logistics strategy highlights that it is important to implement logistics solution in an early phase in all projects, analyse the prioritized goals, and adapt to relevant logistics solutions. (Älvtranden Utveckling, 2021b)

According to the *Project Managers ÄU*, they aim to reduce the CO_2 emissions for new developments by 50 per cent, which is done through requirements within the land allocation. In the procurement process with developers ÄU signs the land allocation agreement and the transfer agreement. In this process, the developers can provide attachments to the contracts with specific plans of how they will deal with environmental and social issues as well as ownership of the building. In *Project Manager A ÄU's* project, a sustainable development program was established, with subgoals and appropriate actions to meet the environmental requirements.

According to *Project Manager B ÄU*, the main idea of the strategy is to know what they can require as a landowner in the land allocation agreement. Both *Project Managers ÄU* points out the importance of early involvement in construction logistics and being proactive. An example is that they can put requirements about a CLC for the entire area of Frihamnen and that all contractors building in the area must obligate to it. The business model is not yet developed and the *Project Manager B ÄU* states that they need the right competence about construction logistics and to collaborate with other administrations in the municipality to develop it. *Project Manager B ÄU* sees many advantages with construction logistics; the optimizing of resources, better working environment and that the economic incitements will be paid back. Though, the challenge is to involve the actors and start working with construction logistics. *Project Manager B ÄU* states that someone must be the engine in the implementation. ÄU must be a better landowner and use their resources, such as land allocation agreements to put requirements on how construction logistics will be performed. To do this, *Project Manager B ÄU* states that they commonly need to develop the business plan within the municipality, with the Municipal Assembly and politicians.

Before the development of the new construction logistics strategy at ÄU the use of construction logistics solutions was limited and the contractor's responsibility. The *Project Manager A ÄU*'s experience within construction logistics is limited but states that two feasibility studies were performed in one of ÄU's projects and that construction logistics was included in the project budget. The feasibility study investigated the usage of a CLC, but the consortium concluded that a coordinated solution would be costly and decided to put the work with construction logistics on hold until a greater need was identified. The decision was taken by a collaborative group named *Byggsamordningen* and not a political decision. In the consortium, each of the developers was represented as well as ÄU. *Project Manager A ÄU* acknowledges that developers usually handle construction logistics issues on their own together with the contractors within the project's budget. The consortium did not see a need for collaborative work within logistics in the project.

Project Manager A ÄU distinguishes a lack of knowledge and examples to compare with. Knowledge should be gained through action taken internally by the developers. *Project Manager A ÄU* states that all type of projects could benefit from using construction logistics but that different sizes of a project require different solutions. According to *Project Manager A ÄU* there is a need for coordinating construction logistics within the entire development of Älvstaden.

The new strategy is partly financed with funds by the European Union and by Vinnova, which is an authority that finances sustainable innovation initiatives (Vinnova, 2021). *Project Manager A ÄU* believes that both public and private actors can finance construction logistics solution but emphasise that regarding innovation an early investment without expectations of short time revenues is required. The *Mobility Manager* also states that construction logistics is most beneficial in projects with a large number of transports and that construction logistics should be financed within the budget of a construction project. According to the *Project Manager A ÄU*, construction logistics should be discussed in an early stage to reduce the possibility of surprises and costs. *Project Manager A ÄU* believes it should be included in the plan of the project and the contracts. In the case where municipalities are selling the land, construction logistics should be included in the land allocation. Furthermore, *Project Manager A ÄU* states that what is required is a commitment and clear strategy without explicit details, the details about the construction logistics performance can evolve with the project.

4.4.2 Administrations connected to construction logistics

Collaboration is important and in the City of Gothenburg, assignments are divided between different administrations as well as different municipality owned companies, such as ÄU. According to the *Project Managers ÄU,* they should collaborate with GUTA, the Urban Planning Department, the Property Management Department and the Park and Nature Administration regarding construction logistics. According to *Land Development Manager A,* ÄU has similarities to the assignments at the Property Management Department, though the differences are that ÄU works with larger project areas.

The *Goods Planner* believes that GUTA should collaborate with the Property Management Department, the Urban Planning Department and ÄU when working with construction logistics. However, the *Mobility Manager* works collaboratively with the different city districts to receive valuable inputs since they are working in close connection to the citizens, a collaboration that possibly will change in the future due to reorganisation. *Land Development Manager A* also mentions the reorganisation and that the Property Management Department shall have all the resources connected to exploitation in the same department.

Political decisions on construction logistics are made by the Municipal Assembly because it is a decision about investments on a strategic level. *Project Manager A ÄU* believes that demands of construction logistics can be incorporated in a certain project or the detailed development plan. *Land Development Manager A* states that in the case of privately owned land a land development agreement must be signed before the detailed development plan is finalized. *Land Development Manager B* further states that the politicians have policies that regulate the requirements in a land allocation agreement. It is always the politicians that regulate what can be written in the agreement

by suggestions from the administrations. *Land Development Manager B* states that construction logistics can be discussed in the land allocation and can be described on different levels regarding details but shall not be too technical about the construction process. According to *Land Development Manager B* construction logistics is not always necessary but it has to be synchronized with other projects in the area.

The *Project Manager A ÄU* states that the legal aspect of what can be required is complex but that ÄU enters civil law agreements. According to the *Urban Planning Director,* the detailed development plan legally regulates the use of land in detail. However, neither the comprehensive plan nor the detailed development plan covers the construction phase and can therefore not regulate construction logistics according to the *Urban Planning Director*. Following, three managers working at the Urban Planning Department in Gothenburg ascertain that they currently do not have any connections to construction logistics. Following, the *Environmental Director* states that construction logistics is nothing they currently have worked with but states that the Strategical Department can give suggestions about logistics connected to construction.

The *Mobility Manager* at GUTA is unsure how construction logistics has changed over time due to urbanisation but states that it is obvious that the more deliveries to construction sites the more restrains on the city logistics. According to the *Goods Planner* at GUTA construction logistics is for the most part managed by developers. Construction logistics is perceived as a major part of the planning process of a construction project. According to the *Mobility Manager,* the planning of construction logistics is performed within each project and GUTA evaluates the project's traffic management principles concerning the entire city logistics. The *Urban Planning Director* also states that the developers have to make a plan of the traffic flows for GUTA to approve. The *Mobility Manager* followed by stating that GUTA requires that the projects formulate traffic management principles before diversions and road closure. According to the *Mobility Manager,* GUTA also have demands on the client about mobility and states that these are collected in two guides written by GUTA.

According to the *Project Manager A ÄU,* construction logistics is something that should be implemented early in the construction process. *Land Development Manager B* states that construction logistics can be added early in the land allocation or in parallel with the detailed development plan together with the developer. The benefits of having the developer in the process are because they can in detail describe the construction logistics solution and adapt it to the specific project. The *Goods Planner* believes that the municipality should include construction logistics as early as possible in a project and that the planning should be done in the comprehensive plan when knowledge is gained regarding which project exist. All actors in a construction project and the strategic administrations should cooperate to distinguish what logistics solution to use. The *Project Manager A ÄU* continues by stating that administrations need to consider construction logistics early in the strategic and planning stage of a project. In the *Project Manager A ÄU*'s project, ÄU was the one that initiated the possibility of implementing construction logistics. The *Project Manager A ÄU* believes that the municipalities should work more actively with implementing construction logistics in the urban development process or the strategic process considering their plan monopoly.

The incentives for GUTA to implement construction logistics is by the *Goods Planner* identified to be making the logistics process in a project more simplistic, safe, reliable,

and rapid. The *Mobility Manager* sees advantages in using construction logistics and states that implementation would be beneficial for general traffic planning. Challenges with construction logistics are by the *Goods Planner* identified to relate with many construction projects happening at the same time which results in traffic congestion, traffic queuing and settlement.

4.5 Municipality of Uppsala

The municipality of Uppsala wants to be at the forefront when it comes to reducing climate changes and make sure that the city expands smartly and sustainably. The expansion aims to reach both the municipality's goals and budget as well as the new requirements set for transports, construction, energy, and provisions. (Uppsala kommun, 2020)

4.5.1 Construction logistics in Uppsala

The first and only CLC in the municipality of Uppsala was established in 2018 and is connected to three different construction sites; Rosendal, Ulleråker and Östra Sala backe (Uppsala kommun, 2020). The three large areas are scattered around the city and Ulleråker is an important area that was bought from the regional council since it is the city's source of groundwater. The CLC in Uppsala was implemented as a solution to minimize the traffic to the construction sites affecting the surrounding environment. To solve the issue with many transports the municipality of Uppsala turned to SRS for suggestions and inspiration.

In 2018 a consulting manager was appointed to help develop the concept of the chosen logistics solution. As a solution, a CLC was established much like the one in SRS with an operating manager for the CLC. The solution in Uppsala is according to the *Operating Manager CLC* more focus on simplifying for all involved actors and not as much on development within research on construction logistics as in the case of SRS. According to the *Logistics Consultant*, there is a big difference between the logistics solution in SRS and Uppsala. The framework with a CLC is similar but the implementation organisation of the CLC's differ. The implementation in Uppsala has, according to both the *Operating Manager CLC* and the *Logistics Consultant*, suffered due to downpipe organisations. The *Logistics Consultant* states that in SRS the *Project Manager CLC in SRS* is responsible for all the area managers while in Uppsala the operating manager is not responsible for the area managers. This is by the *Logistics Consultant* distinguished to be problematic since the *Operating Manager CLC* has not enough resources to run the CLC properly. Without power and influence over the area managers, the operating manager cannot implement changes acknowledged by the municipality of Uppsala to improve the CLC. The *Logistics Consultant* further states that the people responsible for the area managers is negative towards the construction logistics solution which has negatively affected other's opinions towards the CLC. The *Logistics Consultant* would like to replace the people responsible for the area managers and states that the implementation of construction logistics in Uppsala have not succeeded with the organisation of the CLC, but that SRS has. While the *Operating Manager CLC* has in retrospect acknowledged that implementing checkpoints at the different sites possibly would have made the construction logistics solution in Uppsala more successful.

Only deliveries that have a filling rate of 80 per cent can be delivered directly to the construction sites in Uppsala. The implemented solution has, according to the *Operating Manager CLC,* reduced the transports to the site by 79 per cent. For example, four transports arriving to the CLC can through co-loading be reduced to one vehicle leaving the CLC. The co-loaded vehicle is a rechargeable hybrid that drives from the CLC through the city to the construction site. The logistics solution has according to the *Operating Manager CLC* reduced the CO_2 emissions by 86 per cent. The *Operating Manager CLC* states the goal has been to co-load up to 65 per cent of the deliveries which was achieved with 78 per cent in 2019 and 70 per cent in 2020. However, these numbers can be misleading since they vary in respect to in which stage the project is. For example, the early stages of a project with the handling of residual material requires a lot of transports. Apart from the statistics connected to the transports to and from the CLC, the *Operating Manager CLC* does not have accesses to statistics over the total number of transports in the City of Uppsala.

When the initiative of a CLC was developed in 2018 the municipality of Uppsala was unsure of what part of the organisation should be responsible for construction logistics. Later in 2020, it was placed under the Land Development Department, which aligns with the *Operating Manager CLC* opinion of where it should be operated. The Land Development Department, which receives assignments from the politics, is in charge of planning and selling municipality owned land. The Land Development Department works collaboratively with for example the Building Committee, the municipality of Uppsala's equivalent to the Urban Transport Administration, and the Strategic Planning Committee. The *Operating Manager CLC* states that construction logistics is one piece of the puzzle connected to the work toward achieving the sustainable goals. However, the *Operating Manager CLC* is the only one within the municipality of Uppsala with knowledge about construction logistics.

The *Operating Manager CLC* states that the driving forces for municipalities to implement construction logistics is to reduce the environmental impact, establish safety for the people close to the construction site and organised a better work environment at the site. Further, the *Operating Manager CLC* states that the municipalities' role when implementing construction logistics is to contribute to smart and sustainable expansion through working with the sustainable goals related to air, noise, water, climate, safety, and attractiveness. The municipalities can according to the *Operating Manager CLC* take on the active role of encouraging the implementation of construction logistics forward by stipulating requirements on the developers to use a checkpoint and/or CLC as a prerequisite to allocate the municipal land. The contractor's already building in the area can also be offered to use the construction solution.

The *Operating Manager CLC* states that the biggest challenges identified for municipalities when implanting construction logistics are getting the developers and contractors on board with the initiative that intends to be an increased cost. Since the construction already had begun in Uppsala before the logistics solution of a CLC was implemented it was, according to the *Operating Manager CLC,* challenging to convince the developers already involved to use the solution. The *Operating Manager CLC* discuss motivating developers and contractors by sharing that the usage of the CLC is beneficial for them. Benefits such as more planned and precise deliveries which enable time that otherwise would be spent looking for the material as well as fewer stops and interruptions in the production process. Further, the *Operating Manager CLC* wishes

that a model for allocating the cost saving for a contractor using a CLC would exist to show what developers were receiving for the money invested in the construction logistics solution. Since municipalities are using tax funded means they need to be careful with how the money is used and a construction logistics solution should not be profitable. The *Operating Manager CLC* believes construction logistics solutions should be financed with an affiliation fee to the CLC that the fee should be based on each project's GBA. If the affiliation fee is already established in the procurement, it would be beneficial, since that will leave little room for discussion later on about payments for services that one is not using according to the *Operating Manager CLC*.

The *Operating Manager CLC* states that usage of a construction logistics solution is best initiated early in the construction process in the land allocation agreement. What the municipality is authorized to stipulate requirements of is something the *Operating Manager CLC* is unsure of but knows that it is possible to set requirements for a CLC. The *Operating Manager CLC* believes that laws regulate what is required to be able to stipulate requirements. The *Operating Manager CLC* believes that requirements regarding what routes the transports are to take, noise and emissions should be established in the procurement to enable consideration of these requirements in the tendering process. The *Operating Manager CLC* further states that an actor will receive a fine if the requirements are not followed and that if results are better than requirements, the actor could receive a cost reduction.

4.6 Municipalities of Södertörn

Eight municipalities in the region of Södertörn did in 2010 form a collaboration committee and are jointly called the municipalities of Södertörn. The municipalities are Botkyrka, Haninge, Huddinge, Nynäshamn, Nykvarn, Salem, Södertälje and Tyresö. The aim of the collaboration is to align and create a common approach among the eight municipalities to strengthen regional and local development (Söderström, 2021a).

The committee consists of the chairman from the municipal Executive Committee of each of the municipalities that meet around six times a year. The municipalities' directors or similar officers are to attend the meetings and the committee annually assigns a chairman and vice-chairman of the committee. The eight municipalities pay a fee to the committee annually that is based on a per centage reflecting the size of the population within each municipality. The collaboration committee did at the start in 2010 formed a development program with four focus areas, which are climate, business and university, inequity and diversity and infrastructure. (Söderström, 2021b)

All eight municipalities have similar aims and have sustainability plans, but some municipalities are according to the *Coordinated Distribution Manager* at Södertörn working more actively with sustainability than others. The communication is divided between the committee within the municipalities, and they then collaborate and communicate with each other and have established a collaborative network for example between the *Sustainability Strategist* or the Urban Planning Departments. According to the *Coordinated Distribution Manager,* the municipalities follow the same framework. The *Sustainability Strategist* at Nynäshamn states that their municipality has set up guidelines for sustainable construction and is based on the UN's SDG. The *Coordinated Distribution Manager* states that Nynäshamn is the municipality with the most focus on sustainability. One initiative that the committee has been working on since 2011

within the focus of sustainability has been to establish a coordinated distribution of goods within the Södertörn region (Eitrem, 2012).

4.6.1 Coordinated distribution of goods

The Södertörn's municipalities collaborate with coordinated distribution of goods, which extends to include sustainable transports. This was a united decision from all the municipalities Municipal Executive Committees that was further communicated to the administrations to different extents. A project organisation was established with representatives for each municipality and the initiative was implemented as a project for three years. The representatives had a connection to purchasing and the municipalities did at the same time incorporate an electronic purchasing system. According to the *Project Manager Tyresö,* the collaboration is working well but sometimes the private actors think it is more expensive to jointly distribute the transports and prefer to do it by themselves. The collaboration is complex and needs alignment on a regional level to reach an impact. The *Coordinated Distribution Manager* states that with a separation between purchasing of transport and goods it has become easier for the municipalities to set sustainable requirements on the purchasing of transports and not only, as previously, on the goods.

The city logistics solution of the coordinated distribution of goods has a positive impact on the environment in Södertörn. The emissions have decreased by 70 per cent because of fewer transports (Södertörnskommunerna, 2021). A key factor to the success of the implementation in the different municipalities is according to the *Coordinated Distribution Manager* how it was communicated. The *Coordinated Distribution Manager* acknowledged learnings from the project to be the importance of being persistent when implementing something new and that the ecological goals should be evaluated to the same extent as the more prioritized economical goals. A working collaborative between several municipalities is by the *Coordinated Distribution Manager* seen as beneficial in the aspect of being able to take on bigger projects, working more efficiently and the ability to split the costs. The negative aspects are believed to be that it at times can be hard to combine the municipalities different goals and approaches, leadership and political views concerning for example sustainability as well as to join the municipalities different cultures. The latter is a factor that according to the *Coordinated Distribution Manager* can be hard to identify. The *Coordinated Distribution Manager*, however, states that the collaboration between the municipalities has worked surprisingly well.

4.6.2 Construction logistics in Södertörn

The municipalities in Södertörns have individual organisations and are organised in different ways. Currently, the municipality of Tyresö transforms their organisation, from a downpipe organisation to a more generalized to enable more collaboration. According to the *Project Manager Tyresö,* the new organisation will facilitate the collaboration with construction logistics within the same organisation. The *Project Manager Tyresö* states that many actors and departments should be involved in the planning of construction logistics and hopes that the new organisation will facilitate communication.

Currently, Tyresö discusses the opportunities with construction logistics and studies a framework of how construction logistics can be used. According to *Project Manager Tyresö*, they have not used construction logistics solutions in previous projects. Many new construction projects will soon arise and the interest in construction logistics at the Land Development Department has increased. The *Project Manager Tyresö* states that they develop a framework of construction logistics and benchmark to the SRS project to analyse how it can be applied in their municipality.

The *Project Manager Tyresö* mentions that much of the focus in developing the strategy for construction logistics is on environmental sustainability and how to decrease emissions. Tyresö's sustainability goals are based on UN's SDGs and the Swedish Public Health Agency's mission (Tyresö kommun, 2017). UN's global SDGs are also mentioned by the *Coordinated Distribution Manager* as well as following environmental legislation and becoming fossil fuel free. The *Coordinated Distribution Manager* states that the municipalities own work is aiming towards being fossil free. According to the *Project Manager Tyresö* construction logistics is one part of the solution in how to achieve the sustainability goals and the *Project Manager Tyresö* has been a part of the development of the action plan in achieving these goals within the comprehensive plan of Tyresö. The *Sustainability Strategist* at Nynäshamn states that they have developed checklists to achieve sustainability in construction. Construction logistics is not directly connected to these checklists, but the checklists work as guidelines that shall be adopted for each project's conditions. Following, the checklists work for both internal and external parties, so that developer also can apply them to their projects to meet the sustainability goals for the municipality.

Another driving force for implementing construction logistics is that Tyresö is going to have many construction projects running in parallel in the same area. Previously, the logistics have not been an issue and has been solved during the project's progress. The *Project Manager Tyresö* mention that the municipality needs to align the construction logistics to meet the time frame and decrease the disturbances for the residents in the neighbouring area. Important aspects to consider in strategy development of construction logistics are control of traffic, storage of material, decrease in transports, avoiding congestion in the city along with social aspects of the residents according to the *Project Manager Tyresö*.

Both the *Project Manager Tyresö* and the *Coordinated Distribution Manager* believes Södertörn has not implemented construction logistics so far, but that construction logistics would be beneficial to implement. The *Coordinated Distribution Manager* believes that the reason why Södertörn has not implemented construction logistics is because it is a new work methodology. Implementation of construction logistics can become more costly than profitable and inhibit the usage of smaller local businesses. Small businesses do not have the same means to implement construction logistics as bigger contractors. The *Coordinated Distribution Manager* does however believe that construction logistics can generate possibilities to save money, enhance the planning as well as synchronize and use resources more effectively. The positive aspects that could motivate Södertörn to implement construction logistics are by the *Coordinated Distribution Manager* believed to be the sustainable consideration and a more active role regarding the outcome of the environmental work expanding beyond the actions at the construction site.

Much of the power and the decision making takes place at a political level and the *Project Manager Tyresö* role is to develop a strategy for the politicians to decide on. The *Coordinated Distribution Manager* believes that decisions for implementing construction logistics would need to be taken in the Municipal Executive Committee much like the one taken for the collaboration on the coordinated distribution of goods.

The *Project Manager Tyresö* highlights important aspects in the implementation of construction logistics. It is important to early in the process, for example in the land allocation agreement or the comprehensive plan, have a clear idea of how the construction logistics will be executed and financed. According to the *Coordinated Distribution Manager*, construction logistics should be considered in the early stages before the design phase and should be included and clearly stated in the procurement to minimize the possibility for misinterpretations and legal reconsiderations. The economic aspect is complex, and the municipality does not have the resources to finance logistics solution without incentives and approvals from the Municipal Assembly. The *Coordinated Distribution Manager* believes construction logistics needs to reach an economic equilibrium when implementing new solutions, in construction many actors need to collaborate and be drivers from different perspectives. According to the *Project Manager Tyresö*, the Land Development Department and the Urban Planning Department along with the Strategical Department have to communicate and mediate an understanding of construction logistics solutions. Many actors do not know how construction logistics can be applicable. The *Project Manager Tyresö* hopes that the new organisation structure will enable collaboration between several administrations and committees and facilitate new incentives for construction logistics collaborations.

To implement construction logistics within the municipalities of Södertörn the *Coordinated Distribution Manager* believes that a change agent is required, that possibly is working at the Urban Planning Department, or with traffic or procurement. Further, the *Coordinated Distribution Manager* acknowledges that there is a possibility to set requirements but is difficult because it should not be to someone's advantage. This means that the municipality must be careful and argue why a change or implementation is needed. The *Coordinated Distribution Manager* believes that municipalities can motivate external actors to use construction logistics. By first and foremost believing in its value themselves and then by communicating how it relates and is important to reach the municipalities visions and goals. Showing statistics and effects of construction logistics is something the *Coordinated Distribution Manager* believes will motivate external actors.

5 Discussion

In the discussion, the theoretical framework in chapter 2 and the empirical inquiry in chapter 4 are discussed and compared. The discussion forms the basis of the conclusions in chapter 6 and different aspects of the municipality's role in construction logistics are discussed and compared. Chapter 5.1 presents the current situation and the municipalities thoughts and knowledge about the benefits and challenges of construction logistics. Further, chapter 5.2 discusses the next steps for future implementation of construction logistics solutions.

5.1 Current situation of construction logistics

The term construction logistics can be interpreted in several ways and all the municipalities mention to some extent that they use construction logistics solutions, but that those solutions are not governed by the municipality. The definition, meaning, and examples of construction logistics solutions differ among the interviewees. A reason may be that all municipalities have different prerequisites, demands, and organisations. The municipality is governed by the citizens' demand (Sveriges Kommuner och Regioner, 2019) and depending on political governance and proposed recommendations from authorities (Boverket, 2020) the usage of construction logistics can differ. The organisation of the municipalities differs in administrations and departments and smaller municipalities do not have the same resources as larger ones. The municipalities have implemented construction logistics solutions in varied ways, but it has been a increased interest in it.

5.1.1 The municipalities' current perspectives of construction logistics

Stockholm has had several projects and city areas where different construction logistics solutions have been applied and have inspired for other solutions and new initiatives in projects in Sweden. SRS entails an extensive construction logistics solution and the City of Stockholm early on realised that they needed to do an investigation of how a possible implementation could be developed. This to meet the Municipal Assembly's goal of an environmental district. This form of a logistics analysis is as Lindholm and Browne (2015) defines it, a pre-study to identify the effects of construction logistics if the solution would meet the desired goals for SRS. Uppsala's implementation is inspired to a high extent by the SRS case and their solution, as they used the ideas behind the solution and implemented it into a new area but used the CLC for several construction sites. The *Logistics Consultant*, however, states that it is not possible to implement the exact same logistics solution in a new project or area. The solution should be customized to the specific project to meet the prerequisites for that specific area and its contextual factors. This is an effect of the characteristics in construction industry where each project differs and has different demands. To meet the desired outcome the construction logistic solutions should therefore be customized (Vrijhoef & Koskela, 2000).

The two other studied municipalities, Gothenburg and Södertörn, have not implemented a construction logistics solution on a municipality level yet. In Gothenburg, it has been the contractors that have handled it. The *Logistics Consultant* means that in dense urban areas, such as Gothenburg, construction logistics solutions are needed. The responsibility lies on the contractors since the municipalities have not worked on a

collaborative solution. For the contractors they do not have a choice to neglect construction logistics as they need to feed the construction sites with materials and equipment to carry out production. *Project Manager A ÄU* states that they did a logistics analysis in an early stage but as a part of the municipality it was possible for ÄU to neglect it. Construction logistics was not necessary because the effect for the municipality was not enough nor worth investing in. However, ÄU working for the City of Gothenburg changed their mind and in 2020 they released a strategy for construction logistics. The *Logistics Researcher* states that cities with robust construction in dense urban areas need a logistics solution and was worried that without a logistics solution in Älvstaden would infer problems without a logistic solution. This was one of the reasons why the City of Gothenburg chose to develop a strategy and invest in a construction logistics strategy.

Södertörn and the collaborating municipalities are more complex since it involves many stakeholders, and among these politicians with different volitions and political position. The eight municipalities have collaborated in the coordination of goods to strengthen the development of the region and have a high involvement relationship on a strategic level. Currently, there are no discussions on further collaboration in other industries than the construction industry. Guerlain et al (2019) state that it can be difficult to implement construction logistics similarly to city logistics since the prerequisites differ between the two industries. Further, since the characteristic of construction is complex (Dubois & Gadde, 2002; Ekeskär & Rudberg, 2016; Fadiya, et al., 2015; Vrijhoef & Koskela, 2000) and not comparable to manufacturing, changes and adaptation would require resources and time if the same collaboration should be implemented in a construction logistics manner.

Each municipality works separately with sustainability goals and has different strategic plans for it. For example, the *Sustainability Manager* at Nynäshamn states that they have developed checklists to facilitate sustainable construction. In the checklists there is no information directly connected to construction logistics but as the *Logistics Researcher* states that awareness about the effects could entail an adaptation to the checklist about construction logistics requirements. The same applies to ÄU's strategy that also has developed checklists to start with construction logistics solutions. Checklists have been developed with the hope of a better understanding of construction logistics and how to apply it in new projects.

Currently, the most well-known solution in Sweden is the SRS case and both the *Operating Manager CLC* in Uppsala and the *Project Manager Tyresö* have been in contact with the *Project Manager CLC in SRS* to learn from SRS's construction logistics solution. As the *Project Manager CLC in SRS* states the goal with the construction logistics solution is to be at the forefront of construction logistics and since many have been inspired by their solution it is seen to be a successful solution. The *Logistics Researcher* states the importance of awareness and knowledge about construction logistics in an implementation. The reason why SRS has been an inspiration for Uppsala and Tyresö is that they have a good reputation for success in construction logistics and the effects it entails because of the initiative of research and innovation invested in SRS.

The most common solution noticed during the study are CLCs, but also checkpoints have been used. CLC and checkpoints are often the main solutions and work together

with ICTs and are governed by a TPL. Janné and Rudberg (2020) discuss the TPL's role in the supply chain and that they work as an external party to coordinate and manage stakeholders. SRS later in their logistics solution hired a TPL because they needed an external actor to get control over the economic incitements, this is in line with the *Logistics Consultant*s thoughts about using a TPL. Janné and Rudberg (2020) further state that with help of a TPL the costs become visible and therefore this also facilitate the framework of the business model. The *Logistics Consultant* means that the municipality is lacking the right knowledge to have the mandate to implement a well-functioning solution on their own. The *Logistics Researcher* also discusses the importance of a logistics plan and a clear framework to involve all the actors. A TPL can coordinate the stakeholders' interest and increase the involvement of the solution. Both *Logistics Specialists* argue that the municipality should get help from an external actor with the knowledge to be sure that the desired outcomes for the municipality are met. They further state that the municipalities' role is to take on the role of implementing construction logistics and set the requirements in agreements about a construction logistics solution. The *Operating Manager CLC* in Uppsala also agrees that the municipalities' role is to implement construction logistics and set requirements. Janné (2018) similarly states that the responsibility can be placed on municipalities because they have the mandate to regulate in agreements.

The *Logistics Consultant* states that a construction logistics solution is forced when constructing in dense urban areas because there are no alternatives if the time and budget in the project shall be accomplished. The reason for Uppsala to implement a construction logistics solution was because of the increase of heavy traffic in the city. The CIVIC handbook (2018) states that to solve infrastructural problems a plan and alignment is needed. It is the municipality that has the controlling mean in the traffic planning and can regulate the traffic for temporary solutions due to construction (Trafikanalys, 2016b). The reason for the implementation of a construction logistics solution is to decrease the traffic, which accordingly was one of the main goals in both SRS and Uppsala. In Södertörn they have decreased the traffic by coordinating transports of distribution of goods and learnings from such an implementation can be adopted into construction logistics according to the *Logistics Researcher*. Although, in Södertörn deliveries for the construction industry are not involved in the city logistics because the characteristics of the industries are different in terms of need according to Guerlain et al (2019). Another aspect of construction is that the goods are heavier and of larger size and are challenging to coordinate together with other deliveries. Though, smaller goods necessary for construction can go together with other deliveries if complements are necessary to decrease the number of trucks with low filling rates.

Transports are an important part of the supply chain and relate to the CLC and checkpoint solutions, with less focus on the on-site logistics for a municipality perspective. The CSCM roles identified by Vrijhoef and Koskela (2000) in a construction logistics solution could therefore be role 2 and role 3 that focus on the supply chain and the transferring activities from the construction site to the supply chain. By implementing construction logistics solutions such as a CLC or a checkpoints material are no longer handle on site to the same extent. Furthermore, by implementing and using ICT tools the process becomes more effective and with better coordination and planning. Both roles focus on reducing the costs connected to lead times and the time of activities (Vrijhoef & Koskela, 2000) which is of importance according to the *Logistics Consultant*.

In SRS the Land Development Department has the main role in operating the CLC and the municipality has a key role in the implementation. During the study, the increased interest among municipalities in construction logistics has been noticed. It could be because the municipality and especially the Land Development Department have had an important role. A second reason is that both *Logistics Specialists* state that construction logistics is a necessity when building in dense urban areas. The City of Stockholm early realised that a construction logistics solution was necessary to meet the demands from the citizens and since it is the municipalities responsibility to plan for a good society and well-being for their citizens (Sveriges Kommuner och Regioner, 2020). The responsibility for construction logistics solutions was therefore assigned to the municipality and further to the Land Development Department because they are involved in the early phases of construction, in the land allocation process.

The *Logistics Specialists* discuss the administrations that should be involved in construction logistics and mention the Land Development Department, the Urban Transport Administration, the Environmental Administration, and the Urban Planning Administration, all these departments have a role in the building process (Boverket, 2020d). A good result is achieved when expertise is used with a good collaboration (Janné & Fredriksson, 2019) and the *Logistics Specialists* enhances that knowledge and expertise are key factors in the implementation of construction logistics to achieve a fruitful and desirable outcome. This concludes that the mentioned administrations and departments all have an important role but to a different extent. The interviewees at the Urban Transport Administration state that they collaborate with the Land Development Department about traffic planning and see themselves as a part of construction logistics even if they currently do not have a direct connection to it. The same applies to the Environmental Departments, they have a responsibility regarding sustainability and environmental goals. It is in line with the *Logistics Researcher's* thoughts the necessity to collaborate and communicate with the right stakeholders to achieve the intended success of construction logistics solutions. Further, the awareness about the different solutions is significant of whom to include and get the knowledge from and that many different administrations and departments should be included. It is difficult to tell which administration should take the responsibility since they have different roles in the municipality but also in what stage the implementation occurs. For example, *Project Manager A ÄU* suggests that construction logistics can be described in any of the comprehensive plan or detailed development plans because of the municipalities plan monopoly. Though, according to Professor J. Bröchner, these plans do not cover the construction phase and do not regulate transport routes or requirements about construction.

Analysis shows that the Land Development Department has an important role in an implementation of construction logistics solutions, independent on the overall organisation in the municipality. Among the interviewees the Land Development Department is highly discussed as the administration within the municipality that should be responsible for construction logistics which possibly could be because they are the operating administration in SRS. Many municipalities take inspiration from SRS and benchmark them as they are seen as a role model example. The Land Development Department is responsible for the land allocation process and land development agreement. In SRS the construction logistics solution was stated in the land allocation agreement, and this provides an argument why the Land Development Department

should be the responsible actor for implementing requirments of construction logistics solutions.

5.1.2 The driving forces for implementing construction logistics

The urgent need and goal of reducing the climate impact (Lundblad, 2020) is identified by several of the municipalities to be a driving force for implementing construction logistics solutions. Both interviewees from the municipalities of Södertörn and SUTA discussed the aim towards achieving the sustainable development goals established by the UN as a driving force. Like the UN SDG, the aim of becoming fossil fuel free is mentioned as a driving force by the *Coordinated Distribution Manager* at Södertörn and SUTA. However, the City of Stockholm's aims higher than the national goals and according to SUTA the municipality of Stockholm wants to become fossil fuel free five years prior to the national aim of becoming fossil fuel free by 2045 (Miljödepartementet, 2019). Since the construction industry is responsible for 20 per cent of the emissions from heavy traffic in Sweden (Sveriges Byggindustrier, 2010) and the construction industry is responsible for approximately 40 per cent of all emissions (International Energy Agency, 2019; Kvint, 2021), the construction industry needs to reduce emissions to reach these goals. The fact that the construction process generates as much CO_2 emissions as using the finished building for 50 years (Kvint, 2021), also shows the importance to focus on the construction process. The municipality of Uppsala and ÄU acknowledge that construction logistics is an important part that can contribute to reaching their sustainable environmental goals and ÄU calculate a 3-4 per cent reduction of emissions due to implementing construction logistics solutions.

The *Coordinated Distribution Manager* at Södertörn identifies that environmental legislations also are a driving force contributing to the municipality of Södertörn motivation towards implementing construction logistics. The environmental legislations in Sweden have been developed since 1969 (Sveriges riksdag, 1969) and new laws are continuously in force. One of the new propositions are requirements of emissions declarations that are suggested to be in forced in 2022 (Regeringskansliet, 2020) that will require municipalities to acknowledge and consider their emission. Receiving an approved declaration by reducing emissions will become a greater driving force towards implementing construction logistics. However, the environmental laws are currently not mentioned to a great extent as a driving force by the different municipalities.

Improving the city environment in aspects such as traffic, accessibility, reducing disturbance and safety are also discussed as driving forces for implementing construction logistics solutions. Traffic flow is possible to reduce with coordinated deliveries and due to efficient construction logistics, traffic can be reduced by 60-80 per cent (Abrahamsson, et al., 2019), which has been seen in both SRS and at the CLC solution in Uppsala. In Uppsala, co-loading reduced transports by 65 per cent. The reduction of traffic was mentioned as a driving force by the *Project Manager Tyresö* and the *Traffic Strategist* at SUTA. As cities are becoming denser there is an increased need of attaining accessibility and reducing disturbance in urban areas (Janné, 2018; Janné & Fredriksson, 2019). Both the municipality of Gothenburg and the municipality of Uppsala have acknowledged that due to densification the need for construction logistics have emerged. Establishing better accessibility and reducing disturbance have also been identified as driving force by the *Logistics Researcher* and both the

Environmental Specialist and *Traffic Strategist* at the City of Stockholm. The alternative usage of rail transport, which would imply noise reduction due to higher frequencies (Larrson, 2020b) in cities has however not been discussed to a great extent. The City of Gothenburg have on the other hand started to investigate alternative transport by using waterways and SRS has changed the location of their CLC to enable water transports. Water transports will reduce traffic and have environmental benefits but is distinguished to be a more expensive solution and generate more noise (Fredriksson, et al., n.d.). However, water transports would possibly be able to transport larger volumes than road and could in that aspect be especially beneficial in stages of the construction process that requires many transports, such a removal of residual material.

Since the municipalities work is close to the citizens (Sveriges Kommuner och Regioner, 2019) and their focus is on the citizens' well-being (Sveriges Kommuner och Regioner, 2020), increasing citizens safety has been a driving force for some municipalities. The aspect of safety for citizens was discussed by the *Traffic Strategist* at the City of Stockholm and the *Project Manager Tyresö*. Logistics analysis that is performed early on plays an important part in assuring that the off-site transports are routed and optimized to improve safety as well as reliable deliveries, reduced emissions and congestion (Lindholm & Browne, 2015). If the routes are not considered and reflected upon it can reduce safety and disturb vital operation. When transports for example are to be routed next to hospitals and schools, a logistics analysis is essential to perform to improve the safety of children and enable the hospitals to continue their vital operations without disturbances. Safety can be improved if the transports are not routed in close connection to sensitive areas and operations.

However, if the construction site is located in close connection to citizens their safety can be attained through the usage of a checkpoint. Using a strategically allocated checkpoint enables a controlled flow of traffic and JIT deliveries to the designated unloading location (Ekeskär & Rudberg, 2016). According to the *Logistics Researcher*, the usage of a checkpoint controls the flows while a CLC reduces the number of transports to the construction site. Usage of a CLC can reduce transports by 70 per cent, increase productivity by 6 per cent and reduce waste by 7-15 per cent (Lundesjö, 2011). Statistics from the municipalities that have implemented construction logistics all show a reduction in transports. That the usage of a CLC in the project Urban Escape in Stockholm reduced transports by 82 per cent and in Uppsala transports was reduced by 79 per cent. Co-loading in SRS is identified to have reduced the transports connected to waste by 50-70 per cent while transports were reduced by 23 per cent. An important aspect to consider is, however, as stated by the *Project Manager Tyresö* that the different stages in a construction project require a different number of transports. Therefore, the driving force to improve safety and minimize traffic will be even more important at the different stages of the project.

Usage of construction logistics can also improve the safety, productivity, and waste management on the construction site due to less material stored on-site and better synergy between on-site and off-site activities (Lundesjö, 2011; CIVIC, 2018). The productivity is stated to improve by 30 per cent by implementing construction logistics (CIVIC, 2018), which contributes to better time management and is seen and acknowledged as a driving force for implementing construction logistics. The usage of construction logistics in SRS was considered to establish efficient processes as well as

a safe and accessible work environment. The *Goods Planner* at GUTA discusses that construction logistics will be beneficial in the aspect that it makes construction processes more simplistic, reliable, efficient, and safe. The *Coordinated Distribution Manager* at Södertörn stated that construction logistics improve planning and the utilization of resources. The *Operating Manager CLC* in Uppsala also acknowledges a safe working environment and better material handling as a driving force for implementing construction logistics. Apart from time, construction logistics also enable cost savings by 20 per cent with better planned transports and efficient construction logistics (Sundquist, et al., 2018; Dubois, et al., 2019). Both the *Coordinated Distribution Manager* at Södertörn and *Traffic Strategist* discuss the possibility of cost savings due to implementing construction logistics solutions.

In the SRS project construction logistics was initiated by the City of Stockholm and the main driving force was to lead the research and innovation of construction logistics forward and to establish an outstanding environmentally friendly city district. Similarly, the formulation of a construction logistics strategy by the City of Gothenburg was established to make Gothenburg, a Nordic logistics center and the municipality of Uppsala has a vision of being at the forefront of a sustainable and smart city expansion. Knowledge was transferred from the project of SRS and research from academia in both the implementation of construction logistics in Uppsala and the construction logistics strategy by ÄU. To increase motivation to work with construction the network system needs to become more tightly coupled through knowledge exchange. Since complex issues such as logistics are addressed more efficiently and knowledge exchange enables more strategic innovation (Dubois & Gadde, 2002). Gaining knowledge from previous examples and academia is therefore a vital part and motivation to implement construction logistics to achieve the strategic long-term visons. Long term visions such as being in the forefront as an environmental district or a Nordic logistic centre.

5.1.3 Challenges when implementing construction logistics

The construction industry is recognized as being resistant to change. and project-based (Lines, et al., 2015). The industry is described as complex with many different stakeholders and project-based with temporary organisations (Dubois & Gadde, 2002; Ekeskär & Rudberg, 2016; Vrijhoef & Koskela, 2000). These characteristics of the construction industry have been distinguished to hinder the implementation of construction logistics solutions. Implementing construction logistics solutions would shift the production to not only be handled on-site and move from a de-centralised coordinated configuration towards a supply network coordinated configuration (Dubois, et al., 2019). Changing configuration requires adaptation and changes (Moran & Brightman, 2001) such as more interaction between stakeholders and possibly fewer temporary organisations which result in a new work methodology. The *Coordinated Distribution Manager* acknowledges a new work methodology to challenge the implementation of construction logistics. The challenges with resistance toward changes in the construction industry is also acknowledged by the *Logistics Researcher*, who further discuss the issue to be related to where in the process the change is implemented. The later in the process an implementation is suggested the more resistant it generates.

Construction logistics have previously mainly been solved within each project and construction logistics is often, according to the *Logistics Researcher*, seen as someone else's problem. Since it has been handled within each project large construction companies have established their own logistics systems and ICT tools. This requires the new implementation of construction logistics solutions to be adaptable to fit these already used and established systems to be advantageable and not identified as conflicting. Resistance towards adapting is, according to the *Logistics Researcher*, motivated by the fact that it is easier to continue using the known work methodology with logistics issues. The *Logistics Researcher* therefore points out that resistance will increase if the new implementation does not align with the previous method.

The construction industry is categorized to involve many stakeholders and the relationships between the stakeholders in a project are acknowledged to be tightly coupled while the system network is distinguished to be loosely coupled (Gadde & Dubois, 2010). The complex nature of relationships between stakeholders in the industry is acknowledged by many of the municipalities as hindering the understanding and conviction of the benefit of an implementation of construction logistics solution. The *Traffic Strategist*s mentioned that the complexity of construction projects requires many stakeholders with different competencies and that a big challenge with construction logistics is to coordinate all actors. The implementation of the CLC in Uppsala struggled to be implemented due to downpipe organisations with a lack of communication and dependency between organisations. The implementation was hard to motivate as beneficial since all actors involved had different driving forces for the implementation. While the *Logistics Consultant* stated that the industry needs to become better at communicating and learning from each other and that the main challenge is to implement a comprehensive logistics solution that is understood and accepted by all actors. The implementation of the CLC in SRS was challenging since the stakeholders believed the implementation was too complex, which may have been a result of that the implementation process was not communicated properly.

Private actors are discussed to be more motivated to implement construction logistics if it is monetarily beneficial, while municipalities can be motivated by attaining a public value (Janné & Fredriksson, 2019). During the implementation in Uppsala, the *Logistics Consultant* and *Project Manager Tyresö* acknowledge this challenge with a monetary driven agenda. The *Logistics Consultant* states that contractors will not be interested in taking part in something that will be a cost for them if it is not necessary. The *Project Manager Tyresö* similarly stated that contractors rather dealt with the logistics issues themselves than an increased cost connected to a joint logistics solution. Financing construction logistics solutions has been acknowledged to be a perplexing issue and the interviewees had different beliefs in the matter. The *Logistic Consultant* also more specifically discusses that the variable costs are the most challenging cost since it is difficult to estimate the number of deliveries beforehand. In the case of the cost of the CLC implementation in SRS the estimation of the cost was identified as a challenge in the procurement process, especially if the requirements in the procurement were ambiguous.

Improving logistics have been shown to reduce the number of transports, which reduces emissions. However, is data discussed to be missing to receive more knowledge on how to achieve the reduction of emissions (Fredriksson, 2021). Both the *Project Manager Tyresö* and the *Project Manager A ÄU* discussed that many actors lack knowledge

regarding how to implement construction logistics. *Project Manager A ÄU* states that examples of how construction logistics has been used would be beneficial to enable comparisons between construction logistics solutions. The *Logistics Researcher* also acknowledges that the industry needs to be better at collecting data and analysing outcomes due to implementing construction logistics. The *Logistics Researcher* follows by stating that off-site logistics solutions can be understood better if the transport flows and emissions are measured to a greater extent. Similarly, to the *Project Manager A ÄU's* statement the *Logistics Researcher* believes that data from examples will enhance the understanding of construction logistics, which can be discussed to reduce the complexity and resistance experienced in connection to implementing construction logistics.

5.2 The next steps for future implementations of construction logistics solutions

It is evident that the construction industry, construction logistics, and the structure of municipalities all are complex with many stakeholders and long supply chains. This means that planning and coordination are of high importance and as the *Logistics Specialists* in these matters state the key is clarity and communication. To realize a construction logistics solution many learnings can be taken into consideration, both from previous adaptations of construction logistics but also from city logistics. Recommendations of what is important to think of are further discussed to distinguish the important aspects in the implementation of construction logistics solutions.

To implement a construction logistics solution, someone needs to be responsible for the coordination. The municipalities have a governance role to achieve well-being in the city and to achieve the intended sustainability goals (CIVIC, 2018; Janné & Fredriksson, 2019). As the municipality has a governance role, they can also take on the role of implementing construction logistics. If the municipality does not take on the responsibility and leave it to the developers and contractors, the municipality loses its control in achieving its intended goals. The developers and contractors focus more on their companies' goals and their gain in terms of cost and time. While the municipality can govern over the developers and put requirements the developers need to follow to reach public value (Janné & Fredriksson, 2019). The *Land Development Manager B* did however discuss the benefits of including the developer later in the detailed development plan process since they can describe the chosen logistic solution and the adaptation to a certain project. Therefore, all actors have valuable input regarding the construction logistics solution needed but the municipality should take on a bigger role when many projects are appearing in the same area as proposed by the *Environmental Specialist*.

The importance of early contribution to changes or implementations in construction is clearly stated both in the empirical results and the theory (Janné & Fredriksson, 2019; Gadde & Dubois, 2010). The *Project Manager CLC in SRS* and both the *Logistics Specialists* state that a plan about construction logistics in early phases facilitate the implementation. Janné and Fredriksson (2019) emphasize that concerns among stakeholders need to be identified early in the process. A reduction of misunderstandings can be accomplished by early contributions and communication among the involved stakeholders. The municipalities agree that the earlier construction logistics solutions can be agreed upon the better result and higher satisfaction rates

among actors will be achieved. The agreements the municipality can use to state requirements about construction logistics are the land allocation agreement or the land development agreement (Boverket, 2020b; Berggren & Ingelstam, 2018). The Land Development Department is the one responsible for land allocation and land development agreement and it is their tools and agreements they can regulate in and should therefore be a responsible administration for construction logistics. The *Logistics Specialists* think that the land allocation agreement is the right document for the municipality to state the framework about construction logistics because it is early in the process and where they can put requirements about solutions in the building process. A benefit in using these agreements is that they occur early in the process which the interviewees' mention is important in an implementation like this.

The clarity of the construction logistics solution is of importance to reach the stakeholders to approve the solution. The balance of how detailed the solution should be discussed in the agreements is up to the project and size of the organisation according to the *Logistics Specialists*. Since all municipalities have different prerequisites, it is not possible to conclude upon to what extent the solution should be described in the agreements. If the solution is intended to be on a strategic level and a long-term process the clarity and goal are important to increase the interest among stakeholders (Lines, et al., 2015). The risk if the solution is not described and only mentioned is that the definition of construction logistics varies, and the municipalities' goals are not met. This is what happened in Norrköping where the municipality stated in the land allocation agreement that a construction logistics solution should be agreed on among the involved contractors but without any more details about how to do it. On the other hand, a too detailed logistics plan in the early agreements would be too complex and the interest among possible tenderers would decrease and is a risk during the procurement process. The *Logistics Consultant* means that someone with expertise and knowledge should set the framework of the construction logistics solution and describe a possible solution in the land allocation or land development agreement. The *Logistics Researcher* also discusses the importance of a logistics analysis with a plan and a clear framework to involve all the actors. The recommendation and clarity about a construction logistics solution in a land allocation or land development agreement should be stated with a logistics analysis performed for the intended project or area. This means that a construction logistics solution should be stated in an early agreement and cover what type of solution and which the municipalities' goals and driving forces are, based on the logistics analysis.

Since the politicians exercises the power in municipalities (Kullander & Langlet, 2020b), knowledge about construction logistics must be advocated by the officers to reach the politicians. Many of the municipalities do not have the proper knowledge of construction logistics and therefore need to obtain this to move forward with an implementation. In SRS and Uppsala where construction logistics solutions have been implemented external expertise was obtained through the usage of a TPL and officer. An officer at the Land Development Department that believed in the benefits of using construction logistics worked together with a TPL, which has been advantageous to implement a change. A change agent is of importance and can be both external and internal. The internal is especially important since an internal change agent has knowledge of the organisation (Cameron & Green, 2020). Further, *Project Manager B ÄU* and the *Coordinated Distribution Manager* acknowledge the municipality needs for change agent to implement construction logistics. As Battliana and Casciaro (2013)

explain a change agent should be informal to increase communication, trust and to influence other employees in the organisation. Both an external and internal change agent is important since if only one has knowledge about construction logistics and is lacking knowledge about the governance in municipalities it will be difficult to implement a change in the organisation. On the contrary, if there only exists knowledge about the organisation but nothing regarding construction logistics solutions the benefits and understanding of construction logistics might be lost. It is of importance to assure that the internal change agent believes in and understand the cause as well as is given the mandate to influence the construction logistics solution. The *Logistics Consultant* discussed that the key issue to why the CLC in SRS has been more successful than the CLC in Uppsala, was because the operating manager at Uppsala that had knowledge and belief in construction logistics was not given the proper mandate and could not advocate the cause. Therefore, a change agent with the right mandate and motivation towards implementing construction logistics solutions is a key factor to succeed with an implementation, preferably an officer working at the Land Development Department. If the officer lacks the proper knowledge an external actor is needed to contribute with knowledge.

The *Logistics Researcher* and the *Coordinated Distribution Manager* compare city logistics and construction logistics and the possibilities to learn and apply the collaboration of coordination of goods into construction. The change and implementation process of city logistics and the learnings from such an implementation of collaboration could be helpful in how the organisation should be structured with a general perspective of all stakeholders' interest. In the smaller municipalities, the local companies need to be supported. The *Project Manager Tyresö* and the *Coordinated Distribution Manager* are worried that collaboration among the eight municipalities in construction logistics would be too competitive by the large contracting companies and conquer the local ones. It is hard to tell the significance of the municipalities' size in an implementation of construction logistics, but it is possible to collaborate and learn from the coordinated distribution of goods in Södertörn. A 70 per cent reduction in emission was achieved in Södertörn due to the coordinated distribution of goods among the eight municipalities.

The financial risk and responsibility of implementing construction logistics is a complex issue. The *Coordinated Distribution Manager* stated that the implementation should be financed equally by all stakeholders. The *Traffic Strategist* on the other hand believes that construction logistics should be included in a project budget unless financial means can be received from research funds due to the project contribution to innovating research about construction logistics solutions. Since innovation only is valid for a certain time receiving means due to innovation will only exist for a limited period of time. As of now, projects investigating transports over water or rail could possibly search for funding due to an innovative approach towards construction logistics. However, funding due to innovation and research is not a long-term solution but has been received by both SRS and ÄU in their construction logistics solutions.

The *Logistics Specialists* discuss that the municipality should take part in the costs associated with the logistics solution and not solemnly address it to the contractors. According to the *Logistics Researcher*, the municipality should take some part of the cost to manifest their involvement and support. Since municipal work is funded out of tax money it means that municipalities need to be cautious with how financial means

are used. Therefore, if a logistics analysis is performed and proven beneficial, municipalities should consider both the tax means that were used to perform the logistics analysis and their aim towards the well-being of the citizens. The cost of implementing a construction logistics solution suggested from the logistic analysis needs to consider both the possible cost savings with an implementation and the money already spent on a logistic analysis if no solution is implemented. Another aspect to consider is to make sure that the developers and contractors to some extents are financially accountable, to be motivated to make the logistics solution effective and affordable. By including construction logistic solutions at an early stage is beneficial since it allows the developers to include the cost with a construction logistics solution in the tender. Which also makes sure that it does not appear as an additional cost at a later stage, resulting in a negative attitude towards the logistic solution. In SRS the fixed cost was better accepted than the variable cost. The variable cost was connected to the number of transports and since they are difficult to calculate for the municipalities, the variable cost was met with some resistance.

To reach the general sustainable goals as many municipalities acknowledge to be a driving force for implementing construction logistics solutions it will be beneficial to divide them into sub-goals and relate them to the effects of construction logistics solutions. The result shows that construction logistics solutions can reduce transports by 80 per cent which will help municipalities reduce emissions, but since the facts of the number of transports in a city is not accessible to many within the municipalities it is difficult to understand how many transports occur. Hopefully, the climate declarations proposed to be enforced in 2022 will increase the municipalities knowledge of the number of transports since they have to be declared. Making the statistics and data more visible will possibly make it easier to stipulate more specific goals towards construction logistics and eventually meet the urgent need to reach the UN's SDGs and become fossil fuel free.

6 Conclusions

The thesis aims to investigate the municipalities' role, incentives, and responsibilities in achieving sustainable construction logistics. Chapter 6.1 presents the conclusions derived from the discussion in relation to the research questions about driving forces, challenges, and the leap forward. In addition, suggestions of future studies are presented in 6.2.

6.1 Driving forces, challenges and the leap forward

Construction logistics solutions are implemented to a varying extent in municipalities due to different volitions, needs, and political views. The City of Stockholm and the municipality of Uppsala have implemented construction logistics solutions as a necessity to solve problems regarding emissions, lack of space and traffic congestion to achieve an attractive environment. The City of Stockholm and the project Stockholm Royal Seaport (SRS) has been an inspiring example for other municipalities, such as Uppsala and Tyresö. The City of Stockholm has implemented construction logistics solutions in the form of a construction logistics centre (CLC) and checkpoints, while the municipality of Uppsala has used one CLC for several different areas in the city. The most common solutions are CLC and checkpoints because they fulfil the goal of decreasing traffic in the cities and enable control of the logistics flows to the sites. The municipality of Tyresö and the City of Gothenburg have started contemplating implementations and have with help from academia and SRS gained better knowledge about how to establish strategies for implementation. The definition and understanding of different construction logistics solutions vary in all municipalities, but all believe that it is beneficial to implement. The interest in construction logistics is present in all municipalities and they believe an implementation of a construction logistics solution should be at an early stage to increase acceptance among stakeholders.

One of the municipalities' responsibilities is to meet the citizens' needs and accomplish an attractive environment, which is identified as a major driving force for implementing construction logistics solutions. Construction logistics help in increasing accessibility and safety in the urban environment by reducing disturbances from heavy traffic. Another responsibility of the municipality is to accomplish the desired environmental goals of becoming fossil fuel free. By implementing a construction logistics solution emission decreases by 4 per cent during the construction process, wherefore it plays a part in this achievement. If the municipality wants to be fossil fuel free, they need to act and excel to succeed. Implementing construction logistics solutions is one step in the right direction.

The major challenges identified regarding implementing construction logistics solutions are the characteristics and traditions in the construction industry, that has both complex relationships and is resistances towards changes. Municipalities are complex in their organisations and how the division of responsibilities are allocated in the plan process. It is a challenge how the division of construction logistics solutions could be managed between the municipality and the developers because of the complex relationships. The developer that previously often manages construction logistics will be resistant toward changing their work methodologic, since it can be both time consuming and more expensive especially if implemented at a late stage in the project. Commonly, construction logistics have been managed within each project with a rather low degree of the coordination that is needed to improve the organisations of the loosely

coupled relationships in the supply network. A lack of data, statistics and examples are pointed out by both academia and municipalities as an obstacle to increase the knowledge, interest, and acceptance of construction logistics solutions. Since risks and responsibilities have not been allocated purposefully among the various actors and no one is taking on the role of leading the implementation, which is needed.

The municipalities have a great responsibility in implementing construction logistics solutions to make an impact on society and achieve sustainability goals. A municipality can, by using its governmental position, affect and inspire construction project stakeholders to implement construction logistics solutions. To get the most out of implementation it is important to communicate the prerequisites of the intended construction logistics solution in an early stage. In order to do so, the municipality should perform a logistics analysis prior to the project start to research the conditions because it is important to adopt solutions for the specific conditions since all projects are unique and face various types of complexity.

The land allocation agreement and the land development agreement are an important stage in the development process of a construction project where requirements about construction logistics solutions can be stated and explained. These two agreements are important because they are settled early in the process and reach stakeholders both if the municipality owns the land but also if the land is owned by a private actor. In these agreements, the construction logistics solution should be described to an extent that the intended goal and the type of solution to be used are clear. A change agent employed at the municipality that strongly believes in the implementation and has a mandate to enforce solutions plays a key role in pushing the implementation process forward. However, knowledge and experience are crucial to be able to develop a sustainable solution and if this is lacking internally at the municipality organization, the municipality can take help from a logistics consultant, such as TPL, to reach the full potential of the implementation.

6.2 Future studies

This study investigates the three municipalities City of Stockholm, City of Gothenburg, and the municipality of Uppsala as well as one collaboration between municipalities in Södertörn. All of them represent rather large municipalities. Further studies could include both large and small municipalities since all 290 municipalities have different needs and resources in relation to size, geographical location and so on. This study mainly covers the municipal officers' perspectives and responsibilities. To advance the understanding of construction logistics solutions and the implementation in urban areas, other perspectives such as the politician's, developer's and contractor's perspective should also be studied.

As mentioned by both municipal officers and experts within construction logistics there is a lack of statistics and data regarding construction logistics solutions. More studies are thus needed that captures data and statistics to provide for numerical values. How climate declarations will affect the development and organising of construction logistics solution is another interesting subject for future studies. Furthermore, as shown in this study, the project SRS is considered a benchmarking case for many municipalities as the City of Stockholm is in the forefront of implementation of construction logistics solution. How knowledge regarding construction logistics

solutions and implementation can be transferred between municipalities within the loosely coupled supply network systems would therefore add to the understanding of how advancement of construction logistics can take place. Lastly, financing of construction logistics solutions has also been distinguished to be a complex issue. Future studies could focus on how the financial responsibilities and risks should be allocated to meet both fixed and variable costs connected to an implementation of a construction logistics solution.

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Appendix A

Interview questions about construction logistics

Introduction

1. May we record the interview?
    a. Is it okay to mention the administrations/committee's name in the report?

2. Could you please give us a short introduction about yourself?
    a. Name? *(You will remain anonymous, no personal names will be written in the report)*
    b. What are your role and responsibilities?
    c. Background?
    d. Education?

General questions about administration/committee

3. What are the administration/committee's biggest responsibilities?
    a. Do you have different areas that are focused on within the administration/committee?

4. How does the administration /committee receive their assignments?
    a. Who formulate the guidelines/goals for the assignments?
    b. Has urbanization affected the municipalities assignments?

5. Who do you collaborate with? For example, committees or administration.
    a. In what way do you collaborate?

Construction Logistics

6. How would you describe construction logistics and how do you relate it to the administration/committee's responsibilities?

Our definition: Construction logistics consist of planning, organization, coordination and control of material flows and transports connected to the construction site to improve the urban area.

7. What is your relationship with construction logistics?
    a. Has it changed over time due to urbanization?
    b. How is your access to data regarding traffic in urban areas? How is it collected and analyzed?

8. What are the main driving forces for the municipality to use/not use construction logistics solutions?

Examples of construction logistics solutions:
Construction Logistics Center, CLC – A CLC is used to enable co-loading transports to reduce the number of transports to a construction site. A CLC is also used to store material since space can be limited at the construction site.
Checkpoints – These are located in connection to the construction site and are used to control the flows in and out from the construction site and enhance Just-In-Time deliveries.
Digital systems – Digital system enhance communication and planning of construction logistics for example, can delivery planning systems, where all deliveries are appointed in a calendar to prevent deliveries to arrive at the same time and create queues to the construction site.
Logistics analysis – A pre-study and analysis of data and statistics of how logistics can be beneficial and what the effects will be.

9. Do you believe the municipality has implemented construction logistics?
    a. If yes, in what way?
        i. Why does the municipality implement construction logistics?
        ii. When did the municipality implement construction logistics?
        iii. In what project have construction logistics been implemented?
        iv. What construction logistics solutions have been used?
        v. Why these construction logistics solutions?
        vi. How have the construction logistics solutions been evaluated?
        vii. Have you received any measurable effects? *(Data, statistics, emission reduction etc.)*

    b. If no, why not?
        i. What construction logistic solutions have you heard of?
        ii. Do you think construction logistics can be beneficial and what would the greatest befits be?
        iii. In what project and in what way would construction logistics been useful?
        iv. Has the municipality discussed or investigated any construction logistics solutions?

10. How and with what means should construction logistics be finances according to you?

11. At what stage should the municipality discuss construction logistics in the construction process? *(Comprehensive plan, Detail development plan etc.)*

12. What requirements can the administration/committee have on the developer connected to associability in an urban area? For example, closing roads, re-directing traffic, noise levels, emissions etc.

13. What challenges exist with construction logistics?

14. What other municipal committees or actors should one cooperate with regarding construction logistics?
15. Who do you believe should be the one to take on the role/roles to implementing construction logistics?

16. How can the municipality enhance the usage of construction logistics to increase external actors' interest in it?

Political/legally

17. What does the process regarding decisions of construction logistics issues look like?
    a. Who should make the decision?
    b. What forms the basis for a decision, what basis is needed?

Sustainability

18. What sustainable development goals do the administration/committee strive for achieving to generate a better urban environment
    a. Do any specific goals connected to construction logistics exist?

Miscellaneous

19. Do you know anyone with knowledge in the subject that you believe would be relevant for us to get in contact with?

20. Is it okay if we contact you again if we feel that a follow-up interview would be beneficial?

Appendix B

Interview questions about land allocation and land development agreements

Introduction

1. May we record the interview?
    a. Is it okay to mention the administration/committee's name in the report?

2. Could you please give us a short introduction about yourself?
    a. Name? *(You will remain anonymous, no personal names will be written in the report)*
    b. What are your role and responsibilities?
    c. Background?
    d. Education?

3. What is the Land Development Department responsibility within the municipality?

4. What kind of assignments does the Land Development Department work with?

5. What is the difference between land allocations and land development agreements, what is included in them?
    a. How can the Land Development Department include requirements in these agreements?
    b. What parties/actors are affected by that kind of requirements?

6. If the land is not municipally owned, how can one make private actors follow exploitation allocations?

7. How can one include requirements of construction logistics in land allocations/ land development agreements?
    a. Or should requirements be included at a later stage? For example, a comprehensive plan/detailed development plan.
    b. How detail should the requirements of construction logistics be?

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